INDRIS

Final Report of INDRIS

Workpackage 17

final report

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Abbreviations

AIS	Automatic Identification System
ADNR	Accord European relatif au transport international des marchandises Dangereux par voie de Navigation interieur Rhin
ARGO	Electronic Navigation Channel Information System for the Rhine
ATA	Actual Time of Arrival
ATD	Actual Time of Departure
AVV	Adviesdienst Verkeer en Vervoer (Transport Research Centre)
BASWIN	Berekenen en Analyse van de Seinvoering van schepen voor Windows
BC2000	Berichtencentrum 2000 (Reporting Centre 2000, NL)
BICS	Binnenvaart Informatie en Communicatie Systeem (Inland navigation Information and Communication System)
BIS	Barge Information Server
BIVAS	Binnenvaart Intelligent Vraag en Aanbod Systeem (Inland Navigation Intelligent Cargo Supply and Demand Bourse)
CD-ROM	Compact Disc Read Only Memory
CEPT	European Conference of Postal and Telecommunications Administrations
DASA	Deutsche Aerospace
DCA	Digital Channel Allocation
DCS	Digital Channel Selection
DECT	Digital Enhanced Cordless Telephone
DGNSS	Differential Global Navigation Satellite System
DGPS	Differential GPS
DGON	Deutsche Gesellschaft für Ortung und Navigation
DSRR	Digital Short Range Radio
DTF	Digital Terrain File
DVK	Dienst VerkeersKunde
ECDIS	Electronic Chart Display and Information System
EDI	Electronic Data Interchange
ELWIS	Electronic Waterway Information System
ENC	Electronic Nautical Chart
ERC	European Radio-communication Committee
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETSI	European Telecommunications Standards Institute
FIS	Fairway Information System
FTP	File Transfer Protocol
GEO	Geo-synchronous Earth Orbit
GIS	Geographical Information System
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communication
HAZMAT	Hazardous Material Directive
HCC	Harmonised Customs Code
HITT	Holland Institute of Traffic Technology
HSCD	High Speed Circuit Switched Data
HTML	Mark Up Language
HTTP	Hyper Text Transfer Protocol
IALA	International Association of Lighthouse Authorities
IBIS	Informatiesysteem BInnen Scheepvaart (Information system for Inland Navigation)
ICT	Information and Communication Technology
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IFN	Institut Français de Navigation
IFTDGN	International Forwarding and Transport Dangerous Goods Notification message
IHO	International Hydrographic Organisation
IMO	International Maritime Organisation

INDRIS	Inland Navigation Demonstrator of River Information Services
Inland ECDIS	Inland Electronic Chart Display and Information System
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISI	Inter System Interface
ITU	International Telecommunication Union
IVS’90	Reporting and information system in the Netherlands
LEO	Low Earth Orbit
LMS	Litton Marine Systems
MARPOL	Marine Pollution
MATIAS	MAritime Traffic Information and Assessment System
MEO	Medium Earth Orbit
MIB	Reporting and information system in Germany
MSC	Mobile Switching Centre
MSR	Marine Safety International Rotterdam
MT	Mobile Terminal
NMEA	National Marine Electronics Association
OFS	Official Shipping Number
PABX	Private Automatic Branch Xchange
PBX	Private Branch eXchange
PC	Personal Computer
PSTN	Public Switched Telephony Network
RINAC	River based Information, Navigation And Communication
RIS	River Information Services
RPA	Rotterdam Port Authority
RTA	Required Time of Arrival
RTD	Required Time of Departure
RTIS	Regional Traffic Information System
RTD	Required Time of Departure
RTCM	Radio Technical Commission for Maritime services
RWS	Rijks Water Staat (DG of the Ministry of Transport, the Netherlands)
SA	Selective Availability
SAR	Search and Rescue
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
STI	Strategic Traffic Image; Strategic Traffic Information
STN-Atlas	System Technik Nord Atlas
TCP	Transfer Control Protocol
TDMA	Time Division Multiple Access
TETRA	Terrestrial Trunked RAdio
TFP	Traffic Fusion Process
TS	Technical Standard
TTI	Tactical Traffic Image
UAIS	Universal AIS
UMTS	Universal Mobile Telecommunication System
UTC	Universal Time Code
UN	United Nations
VBD	Versuchsanstalt Binnenschifffahrt, Duisburg
VDL	VHF Data Link
VHF	Very High Frequency
VPN	Virtual Private Network
VNF	Voies Navigables de France
VOIR	View Of IVS90 Routes
VTM	Vessel Traffic Management
VTS	Vessel Traffic Services
WG	Work Group
WLAN	Wireless Local Area Network
WP	Work Package
WSD	Wasser und Schiffahrts Dienst
WWW	World Wide Web

PREAMBLE

This INDRIS final report is to be read in combination with a number of work package reports such as: WP 1 input from other research tasks, WP 3 standardisation of communication and standardisation of technical of data exchange and messages, WP 4 standardisation of data, etc. These reports are available on the INDRIS CD-ROM.

The CD-ROM also contains:

1. Video outlining the project and its results
2. Project results, in the form of PowerPoint presentations

Furthermore, this report contains three annexes that contain:

- Partner list of the participants
- List of events such as exhibitions, work shops, conferences where the project has been presented and promoted
- List of final reports of Work Packages and their main authors

1 EXECUTIVE SUMMARY

1.1 Introduction

In transport and definitely in inland shipping, the use of Information and Communication Technology (ICT) is dramatically increasing. ICT is potentially an important instrument for promoting transport over water. It can provide inland shipping with a competitive edge over road transport.

In the European context, in recent years, a concept for harmonised information services to support traffic and transport management in inland navigation including interfaces to other transport modes has been developed under the name of River Information Services (RIS). An important aspect is that the RIS structure also allows information sharing with transport companies, thus enhancing the efficiency of transport management. This concept has been further detailed in the INDRIS project, which started in 1998.

The name INDRIS stands for Inland Navigation Demonstrator for River Information Services. The project is a joint venture between national public authorities, the transport industry, the ICT-industry and research institutes from Austria, Germany, Belgium, France, Italy and the Netherlands. The project has started in January 1998 and is formally completed in June 2000.

The INDRIS project has started by describing the functions of RIS for all potential users (public authorities and transport industry) and specifying relevant information processes (SWP 6.2: “User requirements”). These were used as the basis to develop a set of open standards for information exchange among public authorities and inland shipping parties. Open standards were defined for both information content (Work Package 4 (WP 4): “Data dictionary and data standards”) and for information communication (Work Package 3 (WP 3): “AIS and GSM standards”). These standards form basically the core of the project.

To avoid a situation whereby inland shipping is faced with a multitude of required communications systems, it was decided to develop this standard at a very early stage. This is done to prevent a situation comparable to what happened in the eighties, when ships had to be equipped with at least three different mobile phones to make calls on the river Rhine between Rotterdam and Basle. Information exchange in RIS is usually between shore and ship. Consequently, the method of wireless data-communications between ship and shore and vice versa must be standardised. The standards set in INDRIS have been submitted to the European Commission to achieve a wide acceptance, making use of the channels that are capable to discuss and adopt these standards.

After the completion of the standardisation phase and the basic user requirements, the architecture of RIS has been defined. This is performed in WP 5: “Data-architecture” and WP 6: “Functionality of RIS”.

From October 1999, through June 2000, a number of practical tests have been successfully demonstrated the value of RIS for the users and the practical use of the standards. These practical tests or "demonstrators" have been conducted in four regions in Europe[1]. In 1999 three demonstrators took place on the river Danube in Austria, on the river Seine in France and in the port of Antwerp. The fourth demonstrator took place on the river Rhine, in Germany and the Netherlands, including the Rhine-Scheldt link. This demonstrator started in May 2000 and is finalised at the end of June 2000.

A major strength of this project is clearly that public authorities of the Netherlands, Belgium, France, Germany and Austria took an active role in participating at both policy and technical levels. The industry and transport companies in these countries have also played an important and active role in this project. The project is a true example of a successful Public-Private Partnership.

The role of the Authorities is to optimise the use of their infrastructure by introducing effective traffic management making use of advanced reporting procedures, whilst at the same time facilitate through demonstration the potential use of such information as contributor to efficient transport management. At a later operational stage, the business community needs to make its own arrangement in using the developed standards and making the software that is developed, available to the market place.

1.2 RIS and INDRIS objectives

The general objectives regarding RIS are fourfold:

1. RIS will enhance the safety of inland navigation in ports and rivers in a preventive sense and contributes to any remedial measures, which are deemed necessary by the competent authorities,
2. RIS will protect the environment by, among others, providing dangerous goods information to the competent authorities assigned to combat pollution within a pre-defined response time,
3. RIS will expedite inland navigation, optimise inland port resources and manage traffic flows,
4. RIS will build on an infrastructure to exchange information to vessels concerning relevant resources (terminals and locks) and the state of these resources of the ports.

The objectives of INDRIS are summarised below:

- To harmonise communications on European inland waterway network and to provide a methodology and guidelines for the development of these communications in order to achieve this harmonisation across Europe,
- To harmonise reporting procedures in the European inland waterway network and to show the benefits of harmonised reporting procedures,
- To demonstrate the provision of shore based or shore made traffic images on-board of inland vessels,

[1] The preparation of the demonstrators took place in the WP 7 (Rhine), WP 8 (Danube) and WP 9 (Seine). Under WP 10 (Rhine), WP 11 (Danube) and WP 12 (Seine), these demonstrator have been executed. The Flemish demonstrator has been prepared and executed under WP 14. The results of the feasbility study for RIS on the Danube (Work Package 2) have been integrated in Work Package 8.

- To demonstrate the use of Strategic Traffic Images supported by databases using ship based electronic reporting procedures for Vessel Traffic Management,
- To demonstrate the usefulness of Fairway Information Systems to support the user in planning his voyages and to provide him with relevant fairway information. Such Fairway Information Systems will differentiate between fast time dependent and slow varying information,
- To demonstrate the importance of the application of ECDIS technology as the Inland ECDIS platform upon which safety systems are built,
- To provide a demonstration platform where applications can be shown to the relevant authorities and to future users who need to accept any future IT system.

1.3 RIS functionality

INDRIS project concentrated on developing and demonstrating the RIS concept as an important step towards a pan-European implementation of information services in Inland navigation.

River Information Services (RIS) is defined as a concept for harmonised information services to support traffic and transport management in inland navigation including interfaces to other transport modes.

In RIS the following main service categories have been defined:

1.3.1 Tactical traffic information or tactical traffic image (TTI)

TTI is the traffic information that supports the users in their short-term decision concerning navigation, traffic management and calamity abatement.

The TTI is a service category creating a display of the traffic in an area. This TTI can be used on shore and on-board of an inland vessel. On shore the TTI will support a new method of traffic guidance through monitoring traffic using Automatic Identification System (AIS), radar and Electronic Chart Display and Information System (ECDIS) technology. On-board of inland vessels the TTI will become the navigational display using the same technologies.

Currently, along the major rivers in the Netherlands and Germany, a number of Vessel Traffic Services (VTS) centres are active, which focus on providing traffic information to vessels in the blind spots in the fairways network. Some of these VTS centres use TTI based information from permanent radar stations. This image is further enhanced by reports from vessels to the information centre whereby an overview is generated of vessels active in the VTS area of responsibility. The AIS technology will improve the TTI in such a traffic centre since ships are now identified and additional information is available.

When vessels are equipped with Differential Global Positioning System (DGPS), to determine the position of the ship, and a transponder, which almost continuously transmits information about the ship's position, and the ship's identity, verbal reports

to traffic centres become redundant. The existing radar targets on the TTI can be enhanced by the precise position of the vessel and its identification label. In this manner the VTS-operator will know each vessel's position at any time.
The TTI, including identification data of other vessels, can also be used on-board.

This TTI may be enhanced in two ways:

- Firstly, the shore-based radar used in the VTS centre can provide information on vessels not being equipped with AIS. Some slots in the AIS can be used to transmit the so-called radar tracks. These may be displayed on the ship's TTI.
- Secondly, the ship's radar may be used to pick up the targets that the ship's radar antenna can sense.

The new technology enables the skipper to have a TTI that also contains targets of vessels that were not visible with conventional radar systems. The need to interpret and approve additional traffic information via Very High Frequency (VHF) has gone.

The TTI also enables the skipper to identify vessels with which he desires to make navigational arrangements such as turning, overtaking and passing of other vessels. A complete TTI on-board enables the skipper to assume full responsibility for his own navigational decisions. Communications between the VTS centre and ships can now be limited to information or advise in those cases that participants wrongly interpret developments in the traffic, or fail to make clear navigational arrangements. The traffic operator can restrict his activities to pure safety information.

On-board AIS (Automatic Identification System) transponders may also be used in an autonomous mode in geographical areas where VTS centres or shore-based-radar stations are not available. Transponder information is, after all, exchanged among transponders. Transponders transmit their information – position and identity - in packages using a time-sharing procedure. Each new transponder in an area listens to other transponders for a while and then decides which time slot is available to him to transmit the information. The information contained in the time slots generates a traffic image without the benefit of any on shore infrastructure, whereby this traffic image can be integrated in the on-board radar image thus substantially extending the information supplied by the on-board radar.

The benefit of an on-board transponder in the event of a calamity, for instance a collision between two ships, is clear. When ships are equipped with an AIS transponder, information will be immediately available on-shore concerning the ships' identity and, even more importantly, the cargo carried by these ships. The immediate availability of actual data such as position of accident, identity of ship and hazardous cargo, if any, will drastically limit adverse consequences of the accident, due to a fast and appropriate response from rescue and calamity abatement authorities.

1.3.2 Strategic Traffic Image

A Strategic Traffic Image is the traffic image that supports the users in mid and long-term decision with regard to Traffic and Fleet Management.

STI is useful for a number of users. A STI enables the authority to exert their power in Traffic Organisation Services. Such services are useful when traffic in fairways is approaching its maximum capacity. Monitoring a large stretch leads to improvement of throughput and minimises accidents. The monitoring capability of RIS may also be used for patrolling the fairways to monitor decent navigational behaviour and check conformity with navigational and sailing rules.

For transport industry users tracking and tracing as well as fleet management are important applications. The STI provides information on the whereabouts of vessels and also provides the availability of other vessels, thus contributes in solving the transport capacity questions.

The role of Vessel Traffic Management will change. The present VTS centres are providing general as well as traffic related information. The VTS operator's instructions will be reduced to the bare minimum. The new TTI on-board and the STI on shore will imply a new division of responsibilities. The skipper will be responsible for his navigation decisions and he is now able to do that. Verbal communication using the VHF will be largely reduced and the VTS-operator or rather the RIS operator will be mainly dealing with traffic planning and monitoring traffic safety.

1.3.3 Strategic information

Strategic information is traffic and transport information that supports the users for the mid and long-term decisions with regard to voyage planning, lock planning, terminal planning.

Strategic information focuses primarily on planning and monitoring of transport activities over water. Skippers or ship-owners need information to plan a voyage and possibly adjust the planning to accommodate emergencies and changing conditions in the fairway network during the voyage. Managers of terminals or ports need Estimated Time of Arrival (ETA) information to plan cargo-handling activities in their port or terminal. ETA information can also optimise planning in relation to the vessel's passage through locks and/or bridges.

This information function represents an added value for shipping provided by RIS, since it allows an improvement of logistics processes, such as transhipment. When a port or terminal has no capacity left the skipper may be informed of a Requested Time of Arrival (RTA). The skipper can consequently reduce the speed of his vessel or plan other activities. This will reduce fuel costs or and improve the business process of a vessel.

Strategic information can also serve authorities' needs. When sailing-schedules and ETA's for all ships are known, the lock cycles and transit times can be planned with higher accuracy. Lock keepers will then be able to ensure optimum use of lock-capacity. If the planning process is completed the lock keeper can inform approaching vessels of their RTA's. These messages may lead to savings on fuel consumption. Such a planning system can, at its extreme, postpone the realisation of new construction of lock chambers at a specific lock complex. Improved planning will also lead to reduced need for mooring facilities at lock-complexes. This in turn might lead to substantial savings in public expenditures.

1.3.4 Fairway Information System (FIS)

Fairway Information is the dynamic and static information regarding to the use and status of the inland waterways.

FIS primarily supplies information to support tactical and strategic decisions.
It includes traditional information supply, such as notices to skippers and actual and predicted water levels and currents. The notices to skippers primarily include information about availability of the infrastructure. Water level reports are extremely important for vessels, since they determine the quantity of cargo a ship will take on. Reliable water level forecasts are of vital importance. The opening of the Rhine-Main-Danube canal has created greater opportunities for inland vessels. But these opportunities can only be fully utilised when water level forecasts for the entire route can be made available. Currently these forecasts are not available.

Information concerning fairways geography, parameters and usage constraints is of major importance to present traffic information at tactical level and for planning and monitoring voyages. Activities in this context include the integration of electronic chart with ship's radar and transponder generated information in order to provide a TTI.

In Germany, Austria and the Netherlands, electronic charts are, at the end of INDRIS, available of parts of the rivers Rhine and Danube. These electronic charts are rather dynamic in nature. They may be regarded as geographically oriented databases. In future, electronic chart displays will include both static items such as traffic signs and opening hours of bridges and locks as well as dynamic information such as water levels and obstructions on fairways.

1.4 Standards

To fully benefit from RIS, it is necessary that different systems are interchangeable and capable of mutual communication. Although each party should be able to develop their own system with special functions, it advisable to adhere to a minimum set of basic principles. These basic principles are laid down in the INDRIS data and communications standards. Once all parties adhere to these standards all over Europe, authorities and the industry will be able to exchange data. This will mean substantial cost savings by abandoning the costly development of interfaces for the authorities and the shippers.

1.4.1 Data standards

International maritime and hydrographic organisations (IMO and IHO) have developed a hydrographic and geographic oriented information system for maritime shipping under the name of *ECDIS - Electronic Chart Data and Information System*. ECDIS runs on two international agreed standards to exchange information on objects and the presentation of these objects. These standards have been extended to accommodate inland shipping specific needs and objects for inland fairways as apart of the work of the Concerted Action Inland Navigation that was launched by the European Commission.

These standards are used to define chart information and to describe in a harmonised format objects along the fairways. At later stage water level information, as well as narrative information on locks and weather reports will be standardised. This information will be made available for presentation on an electronic chart, using the presentation standard. Currently the Inland ECDIS standard for presenting and exchanging geographically oriented information for inland fairways has been accepted across Europe. This new standard is developed in a close co-operation between representatives of INDRIS and the Electronic Navigation Channel Information System for the Rhine (ARGO) project of the German Ministry of Transport.

The importance of harmonising transport or logistics data along the entire transport chain, regardless of modality, has been acknowledged for some time. Internationally, this has led to the development of a set of data standards for Electronic Data Interchange (EDI). In maritime and inland shipping, a number of specific *EDIfact* messages have been defined. These messages have been adopted in INDRIS with a few modifications and extensions.

1.4.2 Communication standards

Two standards are used for communication purposes. For FIS and strategic information, use is made of the Transfer Control Protocol / Internet Protocol TCP/IP protocol and the Global System for Mobile communication (GSM) as the communications technology. The last mentioned, however, should be replaced without delay, anytime after new wireless technologies become available, such as Universal Mobile Telecommunication System (UMTS).

The dynamic traffic information, such as used in the TTI and STI, uses the AIS transponder as it has been standardised in maritime shipping by International Maritime Organization (IMO). The messages that are used in maritime AIS have been modified for inland navigation. AI allows simultaneous communications among a great number of ships.

1.5 Demonstrators

The INDRIS project contains, in addition to defining RIS and developing standards, four “demonstrators” of applications, systems and technologies developed to meet part of the RIS functions. These “demonstrators” provided skippers, VTS centres, terminal operators, etc., with the opportunity to test the applications over a longer period of time in everyday practice and to assess their added value. These demonstrators are also intended to demonstrate to policy makers and potential users the opportunities provided by RIS and the added value of standardisation.

Three demonstrators took place in 1999. The first one was organised on the river Danube (Danube demonstrator) in Austria. The second one took place on the river Seine (Seine demonstrator) in Paris, France, the third in the port of Antwerp (Flemish demonstrator). The fourth demonstrator was on the river Rhine, in the Netherlands and Germany including the Rotterdam-Antwerp link (Rhine-Scheldt demonstrator). This demonstrator started in May 2000 and lasted until July 2000. The transponder network in the Netherlands will be operational until the end of 2000; the on-board applications of the participating vessels will remain operational until December 2000.

1.5.1 Danube demonstrator

On the river Danube, the Austrian Ministry for Transport has commissioned a demonstration that was primarily focused on the presentation of a TTI. The demonstration took place on the Danube near Grein, a mountainous stretch with some narrow river bends. This area is rather complicated for navigation. Due to situations offering blind spots and at times strong currents, it is prohibited to overtake and sometimes to pass at such hazardous locations. When, however, ships can in time observe each other, such manoeuvres should be possible. Using in the future, AIS, DGPS and Inland ECDIS similar to those demonstrated, ships are expected to be able to pass and overtake each other at locations where currently this is prohibited.

In the demonstrator the traffic information has been integrated in an ECDIS environment and presented on-board the demonstrator vessels, at locks in the area as well as in a temporary traffic centre for monitoring the traffic in the area of Grein. Basically, the idea is to have all equipment portable and handed out at the locks. At the next lock the equipment will be returned again after being used in the stretch between the two locks.
For strategic purposes, an application for electronic reporting has been also demonstrated. Electronic reporting will be fully operational at the end of 2000.

1.5.2 Seine demonstrator

The demonstration in France, on the river Seine, focused among other things on an aspect of RIS that has not been addressed before. The RIS information included a market (commercial) function. The Seine demonstrator intended to create an electronic inland shipping market with demand of cargo space over a certain route and supply of vessels that are able to transport the offered cargo. The required information exchange to make a transport deal is conducted via GSM and Internet between cargo owners and providers of cargo space.
These systems could lead to improved communication between shippers and transport companies.

In addition to the electronic market, the demonstrator in the river Seine focused on the Internet site (VNF2000) for Fairway Information Services with a harmonised connection to electronic reporting according to the INDRIS standard.

The demonstrator successfully showed the inter-operability of the VNF2000 system with the Electronic reporting standard, the provision of fairway information to skippers and other users as well as RIS interfacing to external commercial system as an added value to the RIS concept.

1.5.3 The Flemish demonstrator

The demonstration in Antwerp focused on two elements of the RIS concept: STI, strategic information and FIS, Fairway Information Services. In addition a tele-market was demonstrated.

The demonstration contained two parts that partly existed as a prototype. The Flemish exercise was undertaken to demonstrate the willingness of the Flanders Government to discuss and finally accept the standards that were developed in INDRIS as well as to prove the technical feasibility to amend their systems in compliance with the RIS standard. A one-day demonstrator is considered to be sufficient to meet these objectives.

The Informatisering BInnenScheepvaart (IBIS) system has been demonstrated, providing specific information on the waterway network. Additionally, the system transmits position information of vessels (based on Global Positioning System (GPS)) combined with characteristics of these vessels to a central database. The central database is providing information on vessels to lock keepers that will use the locks. This strategic information is visualised in a Geographical Information System (GIS) environment.

One of the functions of the IBIS system is reporting on a vessel's voyage and its cargo to the authorities, according to INDRIS standard for reporting.

The second part of the Flemish demonstrator dealt with Binnen Vraag en Aanbod Systeem (BIVAS): an interactive Internet site where supply and demand of cargo confronts each other. This is seen as a tool in order to promote inland navigation in a liberated market. By means of E-mail or fax, the industry can offer supply of cargo. By means of mobile data-communication, the skipper or shipping company will be informed about suitable cargo. The skipper can now start negotiations with the cargo owner to obtain a transport contract.

IBIS and BIVAS were in a test-phase for a longer test period than the one-day INDRIS demonstrator.

1.5.4 Rhine-Scheldt demonstrator

This is the largest in scale of the 4 demonstrators of INDRIS. The demonstrator took place on the river Rhine and the connection to the river Scheldt. The test has involved 30 ships. These ships are equipped with on-board DGPS transponder, computer and GSM. The vessels have a number of on-board applications capable of creating a TTI, providing strategic or planning information as well as supplying support information from FIS.

More specifically, these vessels receive Notices to Skippers and water-level data via GSM on their PC screens. In addition electronic charts (ECDIS-ENC's) are available for parts of the river Rhine and the connection to the Scheldt for tactical and planning purposes. Aided by DGPS, AIS and PC, a TTI can be constructed and other vessels, when equipped with AIS, will be visible on the chart. On board of one of the demonstration- vessels, the on-board radar information is also integrated in the TTI.

In VTS areas, particularly those of Dordrecht and Nijmegen, this information is supplemented with shore based radar information available at these VTS centres.
The INDRIS tactical images and the regional traffic image replace some existing radar displays at VTS centres. The regional traffic image created the possibility to monitor all traffic movements on the stretch from Rotterdam up till the German border.

After selecting their route, participating ships can present ETA's at their final destinations and at specific points (including locks) allowing them to design a voyage

that is reliable and provides maximum benefits. Locks can inform skippers about expected lock cycle times, allowing skippers to adapt his speed on the basis of this information. When the voyage is delayed, due to congestion, the ETA can be adjusted and parties on shore can be informed automatically.
In future, strategic traffic images can be supplied to shipping lines. Ships will be continuously "visible" to them, allowing optimum planning.

A number of inland container lines, united in Central Bureau for Rhine and Inland Shipping, have developed an interactive Internet planning site called BPS (Barge Planning System). BPS intends to achieve full co-ordination between container shipping on the river Rhine and on the link with Antwerp, with the terminals in Rotterdam, Antwerp and along the river Rhine. By this method information will exchanged as to which containers must be un-loaded or loaded and as to where such containers are located or should be placed. Since this information can be made available long beforehand, and since continuous updates about the ship's ETA are available at the terminal, substantial efficiency gains are expected at the transhipment stage. This will benefit both shipping and the terminals.

During the Rhine-Scheldt demonstrator a calamity has been simulated whereby, in the course of alarm and assistance, the benefits of early, complete and reliable information supply in the event of calamities have been successfully demonstrated.

The 30 vessels equipped with several applications including AIS and ECDIS continued a field test operation well beyond the demonstration period. This has lasted until the end of 2000. The intention is to facilitate an evaluation of the technology and assess the opinion of the skippers.

1.6 Assessment

1.6.1 Users satisfaction assessment

The Danube demonstrator and the Rhine-Scheldt demonstrator were concluded with a user satisfaction assessment. The results of both demonstrators showed a very positive idea of RIS. It was thought that a RIS system could heavily contribute to the efficiency and safety of inland vessels. Those involved in transport management could also exploit the RIS-information. A few notes were made related to the commercial use of RIS and the protection and confidentiality of data. When these comments are taken into account most of the user groups think that RIS will provide a large contribution to traffic management and improve the inter-modal transport chain.

After the formal finalisation of the INDRIS project, a number of skippers remain using and testing the RIS applications and the AIS network of the Rhine-Scheldt demonstrator. Consequently for the Rhine-Scheldt demonstrator we still need to collect and analyse the skippers experience with the different RIS applications and the AIS network performance.

1.6.2 C/B (Costs / Benefits) analysis

A C/B[2] analysis is an important tool for policy makers, taking into account the direct measurable benefits and costs is the primary factor for public and private participants in the transport process to adopt new strategies.

Moreover, a societal C/B analysis is thought to be important as well.
The real benefits and the costs of other modalities should be studied in order to see whether INDRIS and inland navigation might offer a better transport solution. The reliability of inland transport and its effects on the environment may affect the modal split.
Using these considerations three types of C/B analyses have been undertaken.

1 Private parties such as skippers who use the waterway
2 Waterway authorities
3 The society as a whole

The first group is required to make and earn back their investments in a rather short period of time. If RIS is made available on the major waterways the B/C ratio is about 3.5. The benefits of RIS for this group are related to improved management of the vessel and the reliability of transport that can be improved by voyage planning and draft management. These improvements are taken into account by reducing fuel consumption and reduction of waiting times at locks in a RIS covered area. The costs are the RIS ship-borne equipment like AIS, computer, ECDIS and voyage planning software and communication devices.

The second group is responsible for traffic management and management of the infrastructure. Their costs are related to implementation of RIS centre, inland ECDIS as well as RIS systems at locks. The benefits for this group relate to the reduction of dredging work, replacing VTS-centres by RIS centres, smaller investments in deceleration works and delay of investment of locks could derive benefits.
The B/C ratio of RIS for the competent authority is about 1. This value includes the reduction of VTS centres and implementation of a RIS centre. During 5 years both systems are operational and during this time, the costs are extremely high.

The third group is the society as a whole. One important issue here is the assumption that a reliable inland waterway network may contribute to a modal shift. This shift may include large social costs. These costs need not to be paid when a part of road traffic is shifted to waterborne transport. A societal C/B analysis sums up all benefits and costs, independent of the beneficiary or the costs bearing parties. Since the social costs are very high for lorry transport in heavy populated areas, large benefits are expected. The B/C ratio for the entire project is about 5.

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[2] The collection of data to make a full societal C/B analysis is difficult. The only location where sufficient data is available is a stretch on the Dutch part of the Rhine from Zaltbommel to Lobith. This stretch was used to provide a template of the C/B analysis.

1.7 Major conclusions and achievements

INDRIS started as an ambitious project with ambitious objectives. The project has attracted parties that were not part of the project at the beginning. This has contributed positively to the final results as nearly all West European countries now support the project's results.

Looking back at the INDRIS project, one could conclude that this project came at the right time and started up series of projects in telematics for inland navigation and formed the beginning of a European network of VTMIS systems for inland navigation.

The conclusions can be divided into a number of categories:
- Co-operation between EU member states and industrial partners
- Technical issues and feasibility
- Benefits for users
- Organisational requirements

1.7.1 Co-operation between EU member states and industrial partners

The following conclusions have been drawn:
- An excellent working co-operation has been achieved in INDRIS by creating common objectives and win-win situations by sharing results and information.
- Co-operation between industrial partners should be stimulated. Industrial partners are inclined to look more at commercial issues and competition rather than at co-operation to achieve efficient and cost effective transport.
- Co-operation between industrial partners in a project should be co-ordinated by a non-commercial management of such a project.
- The approval of a EU project is more important to some partners than the actual execution of the project and the exploitation of its results.
- Some partners are only interested in their own work and did not show much concern to the overall objectives of the project.

1.7.2 Technical Issues and feasibility

The following conclusions have been drawn:
- The technical realisation of RIS and many of its elements has been demonstrated successfully on several locations in Europe.
- Interconnectivity within RIS and between RIS and other systems can be realised by setting and maintaining open data and communications standards.
- Inland ECDIS is a very strong platform as a reference for geographic information and applications using this information. The Tactical Traffic Images and Strategic Traffic Images on-board and on shore for Vessel Traffic Management, Planning purposes and safe navigation exemplify this.
- Inland ECDIS charts are available for part of the Rhine and the Danube.
- On the basis of Inland ECDIS standards commercial suppliers of various types of systems can design, develop, build and sell their own applications.
- EDI reporting as used in Binnenvaart Informatie en Communicatie Systeem (BICS) is already an operational success.

- AIS transponders according to the IMO standards can be applied in inland navigation, thus contributing to safe navigation. They are particularly useful in areas of mixed traffic of maritime and inland navigation, areas with high shipping densities and areas with special navigational difficulties such as rivers in mountainous stretches like the Danube.
- Standard IMO AIS transponders are still non-existent: every supplier has its own specific peculiarities.
- INDRIS contributed to the standardisation committee of AIS transponders by upgrading the standard for inland navigation use.
- Standards for data and communication in inland navigation are available for operational use.

1.7.3 Benefits for the users

The following conclusions have been drawn:

- Voyage planning can be improved and rationalised using the INDRIS applications.
- Fuel consumption can be reduced with INDRIS voyage applications, as the skipper will have exact information about RTA (Requested Time of Arrival) at locks and terminals.
- Just-in-time transport can be implemented as a result of the planning tools in RIS.
- Waiting times near terminals can be reduced as a result of better information exchange between terminals, barge operators and skippers.
- Safety can be enhanced at:
    - RIS Vessel Traffic Management centres because they receive:
        - improved and more reliable information
        - less VHF communication on safety channels
    - Ships because they have available:
        - improved and more reliable information
- The use of EDI leads to automatic reporting procedures resulting in less work for the navigator of an inland vessel.

1.7.4 Organisation Requirements

The following conclusions have been drawn:

- There is a strong need for a permanent European structure for maintaining, updating and harmonisation of standards.
- There is a need for a European committee to co-ordinate implementation of RIS. In the meantime the first step has been undertaken to establish an European RIS Platform with representatives of the competent authorities.

1.7.5 Achievements

INDRIS has clearly shown that, extensions of a VTM concept with numerous added value services to improve aspects of Transport Management, to be a valuable concept and as such form an important step forward. It has shown that inland navigation should become the backbone to a pan-European transport over inland waterways.

A positive and an important start are undertaken concerning the development of Public Private Partnership (PPP). The success of INDRIS can’t be acclaimed without the actual co-operation and effort invested by all parties concerned. However, the further development of PPP requires careful and meticulous attention. The vested interests and benefits of both sectors are quite different. The public authorities are responsible for safety, environment protection and the maintenance of fairways and its proper use while transport companies require to operate and survive in a highly competitive market place. The combined RIS services are major enablers to the planning, execution and support of the associated business processes.

The enhancement of maritime-based standards facilitates the compatibility, extension and linkage to maritime transport and the linkage to other transport modality (road and rail) and to commercially based systems (linking ports and short sea shipping) and thus enhancing common transport policy.

The co-operation between North Sea countries (Rhine countries) and Danube countries will be a stepping-stone for the establishment of the link between the North Sea and the Black Sea. This will open new perspectives for developing transport patterns.

2 INTRODUCTION

In transport and definitely in inland shipping, the use of Information and Communication Technology (ICT) is dramatically increasing. ICT is potentially an important instrument for promoting transport over water. It can provide inland shipping with a competitive edge over road transport.

In the European context, in recent years, a concept for harmonised information services to support traffic and transport management in inland navigation including interfaces to other transport modes has been developed under the name of River Information Services (RIS). An important aspect is that the RIS structure also allows information sharing with transport companies, thus enhancing the efficiency of transport management. This concept has been further detailed in the INDRIS project, which started in 1998.

The name INDRIS stands for Inland Navigation Demonstrator for River Information Services. The project is a joint venture between national public authorities, the transport industry, the ICT-industry and research institutes from Austria, Germany, Belgium, France, Italy and the Netherlands. The project has started in January 1998 and is formally completed in June 2000.

This final report contains an overview of the important results of the project. INDRIS started in January 1998 and its main activities were completed in June 2000.

Since the start of INDRIS, the project gained momentum and is considered to be a rather unique and successful project. The partners in the project acted enthusiastically during all phases of the project. They have worked hard to overcome the difficulties and have successfully brought the RIS system into its final conclusion.

During the project period, more partners have been acquired. These new partners have acknowledged the needs for European standards and have positively reacted to the work done by INDRIS in this area. One of these partners is the Flemish Administration. This administration has positively contributed to the project by providing demonstrators of projects that fitted within the framework of INDRIS.

This report is further divided into four main parts.

The first part concerns the description of the project INDRIS and the definition of the different elements of RIS. This is outlined in chapters 3 and 4.

The second part, chapter 5, deals with the design of standards that have been used in the demonstrations. These standards are suitable for implementation

The third part contains the demonstrations that have been commissioned to show the various applications, the use and benefits and to provide proves that the designed services could be used during operational conditions.

The third part is discussed in chapters 6, 7, 8 and 9. Chapter 6 discusses the Danube demonstrator, chapter 7 reports on the Flemish demonstrator, whilst the Seine demonstrator is described in chapter 8. The Rhine-Scheldt demonstrator is described in chapter 9.

The Fourth part discusses the assessment of the demonstrators in terms of compliance and user satisfaction. A tentative costs and benefits analysis is also given for a specified part of the demonstrator. Furthermore, the exploitation of the results and a general discussion of the results are presented. Finally the conclusions and the recommendations are presented.
The assessment is discussed in chapter 10. The possibilities of exploitation of the results are discussed in chapter 11.

A discussion of the project is given in chapter 12 and in chapters 12 and 13 the conclusions are drawn and the recommendations of the project are given.

3 PROJECT OBJECTIVES, PARTNERS, FINANCES AND STRUCTURE

3.1 Project Objectives and clarification of the objectives

3.1.1 INDRIS Project Objectives

The objectives of INDRIS are summarised below:

- To harmonise communications on European inland waterway network and to provide a methodology and guidelines for the development of these communications in order to achieve this harmonisation across Europe,
- To harmonise reporting procedures in the European inland waterway network and to show the benefits of harmonised reporting procedures,
- To demonstrate the provision of shore based or shore made traffic images on-board of inland vessels,
- To demonstrate the use of Strategic Traffic Images supported by databases using ship based electronic reporting procedures for Vessel Traffic Management,
- To demonstrate the usefulness of Fairway Information Systems to support the user in planning his voyages and to provide him with relevant fairway information. Such Fairway Information Systems will differentiate between fast time dependent and slow varying information,
- To demonstrate the importance of the application of ECDIS technology as the Inland ECDIS platform upon which safety systems are built,
- To provide a demonstration platform where applications can be shown to the relevant authorities and to future users who need to accept any future IT system.

These objectives have been derived from more general objectives regarding RIS. These objectives of RIS are fourfold:

- RIS will enhance the safety of inland navigation in ports and rivers in a preventive sense and contributes to any remedial measures, which are deemed necessary by the competent authorities,
- RIS will protect the environment by, among others, providing dangerous goods information to the competent authorities assigned to combat pollution within a pre-defined response time,
- RIS will expedite inland navigation, optimise inland port resources and manage traffic flows,
- RIS will build on an infrastructure to exchange information to vessels concerning relevant resources (terminals and locks) and the state of these resources of the ports.

3.1.2 Traffic Images

Two types of images can be distinguished: a TTI (Tactical Traffic Image) and a STI (Strategic Traffic Image).

TTI is the traffic information that supports the users in their short-term decision concerning navigation, traffic management and calamity abatement.

A TTI is a local display of traffic around the observer. The observer may be a VTS operator in a local VTS or a skipper who uses combined radar and Inland ECDIS display with AIS vessels presented on the display. This display shows the traffic around his vessel.

A Strategic Traffic Image is the traffic image that supports the users in mid and long-term decision with regard to Traffic and Fleet Management.

A STI is in fact a regional (strategic) traffic image based on a database with ship and cargo data. Verbal or electronic reports feed this database. Ships are reporting their present location and destinations as well as particulars of their cargo.

If a calamity occurs to a known ship, the database needs to provide details of the ship and its cargo to the on scene commander in charge of calamity abatement. Based upon the destinations of the vessels, their characteristics, current velocities and the traffic density, ETA's may be calculated at locks, bridges and terminals. Preferably vessels check these ETA's based on such calculations and give notice for any foreseen and/or intentional deviation of the normal passage.

These ETA's needed to be used for planning. Waiting times can be avoided, if vessels are advised of the required time of arrival at locks and bridges without loosing their priority number to be served.

Another important facet is not yet mentioned. Regional traffic information may provide an accurate tactical traffic image that can be used on-board. This traffic image is made by making use of a facility located on shore that interrogates vessels in the area of coverage on their identification and location. Information is collated and sends to all vessels in the area. This traffic image is dependent on AIS and DGPS. This image needs to be enhanced with radar image to cater for vessels that are not equipped with AIS and DGPS. The on-board tactical traffic image serves the purpose of improving the information on-board for navigational decision-making. The interpretation is the responsibility of the skipper.

3.1.3 Fairway Information System

Fairway Information is the dynamic and static information regarding to the use and status of the inland waterways.

A FIS is a system that provides information regarding the fairway and the meteorological and hydrological characteristics. This information may be divided in semi-static and dynamic information.

An example of the first is information about lock operating times and bridges, available shore facilities etc., whilst the second category contains vertical tidal data and flash information to shipping (such as sinking of a vessel in the fairway). The first information can be downloaded from, for example a web site, before the vessels starts its trip and the second information will be provided to the ship immediately or with a high frequency of updating.

FIS is also considered to consist of all types of information that is required for the skipper to prepare and execute his voyage.

A RIS is said to exist when at least FIS is available. Traffic images and their applications will be provided when sufficient traffic might benefit from that type of information for an efficient use of the transport capacity or when the competent authority requires enhancing traffic safety.

Hence, it is possible that a RIS in an area with low traffic densities (such traffic conditions prevail on most of the European waterways) only contains a FIS (Fairway Information Service) on an INTERNET web site. A user can download the particulars of the specific fairway or download programmes that are useful for planning of vessel movements and its optimum loading conditions.

3.2 Partners

The following partners have co-operated in this project:

- AVV, Transport Research Centre of the Ministry of Transport in the Netherlands, project co-ordinator,
- VNF, Voies Navigables de France,
- RMPM, Rotterdam Municipal Port Authority,
- IFN, Institut Français de Navigation,
- ET&S, Euro Trading and Systems
- 7C's, SevenCs Entwicklungsgesellschaft für Geo-Informatik GmbH
- DASA, Daimler-Chrysler Aerospace AG
- HITT, Holland Institute of Traffic Technology B.V.
- LMS, Litton Marine Systems BV - INA Division
- STN Atlas Elektronik GmbH
- EBD, VBD-European Development Centre for Inland Navigation
- Logica B.V. the Netherlands,
- D'Appolonia S.p.A.,
- Alcatel Austria AG,
- PBV, Promotie Binnenvaart Vlaanderen
- ANAST, Analysé des Systemes de Transport, Université de Liège
- BWV, Bundesministerium für Wissenschaft und Verkehr Oberste Schiffahrtbehörde Ministry of Transport, Austria,
- BVM, Bundesministerium für Verkehr, Bau und Wohnungswesen, Ministry of Transport, Germany,
- AWZ, Ministerie van de Vlaamse Gemeenschap Administratie Waterwegen en Zeewezen Ministry of Transport, Belgium.
- MET Ministry of Equipment and Transport, Belgium,
- As a supporting body: DGG, Ministry of Transport, the Netherlands.

Annex 1 contains further information on partners and their sub-contractors

3.3 Project Finances

The following table indicates the co-ordinator and the main contractors regarding EEC contribution and the planned budgets. The last column indicates the actual incurred costs of the project:

Partner	EEC contribution	Planned budget	Actual costs
	Euro	Euro	Euro
AVV as co-ordinator	777,146	1,554,291	3,228,505
Main participating partners	1,189,105	3,017,346	3,591,639
TOTAL	1,966,251	4,571,637	6,820,144

Table 3.1: Overview of planned and actual budgets

3.4 Project structure

3.4.1 Project phases

The INDRIS project is carried out in three main phases:

- Standardisation-phase: definition of standards for data-exchange
- Demonstrator phase: demonstration of RIS functionality's based on partly existing inland navigation applications with standardised data communication and data exchange.
- Assessment phase

3.4.1.1 Standardisation phase

This first phase of the project dealt in details with the definition of the River Information Services and with the standardisation aspects with the objective to realise:

- An open standard for communication for River Information Services (WP 3),
- An open standard for data exchange for River Information Services (WP 4),
- Definition of framework for (strategic) Traffic Information (WP 6) and the RIS-database structure (WP 5),
- Guidelines for a RIS concept for European inland waterways (WP 789). The guidelines provide information related to traffic and transport management.

3.4.1.2 Demonstrator phase

In the period from September 1999 till June 2000, four demonstrators at different European rivers have been executed after a preparation period that started September 1999:

- Rhine-Scheldt demonstrator (WP 7 - preparation- and WP 10 - execution of the demonstrator)
  - ∗ On the river Rhine and
  - ∗ On the link from Rotterdam to the river Scheldt

Demonstrating the complete RIS-concept.

- Danube demonstrator (WP 8 preparation and WP 11 execution of the demonstrator)
  - ∗ On the river Danube on a mountainous stretch near Vienna.

The demonstrator concentrated on issues on the tactical level with some information on strategic level.

- Seine demonstrator (WP 9 preparation- and WP 12 execution of the demonstrator)
  * On the river Seine near Paris.

The demonstrator concentrated on Fairway Information Services and an electronic cargo-bourse service.

- Flemish demonstrator (WP 14)
  * In the port of Antwerp.

The demonstrator concentrated on a Fairway Information Service, the electronic bourse, and electronic reporting and centrally monitored vessel movements.

3.4.1.3 Assessment phase

The project is finalised with an assessment (WP 13) of RIS making use of the results of the demonstrators. The objective of the assessment is to define policy requirements to the EC-DGVII and to the national administrations on the desirability and usability of River Information Services.

3.4.2 Work package structure

The INDRIS project focuses on the RIS concept as defined in the INCARNATION project. The INCARNATION project resulted, apart from the first global concept of River Information Services, in user requirements and the basic functional requirements for River Information Services.

During the start-up period of INDRIS, it became clear that there was a need for a more detailed specification of the services related to the Tactical Traffic Image, Strategic Traffic Image and the Fairway Information System. In addition to these services, it is required to define in more detail the information requirements of these services. The definition of the services as well as the information requirements is the basis for the standardisation phase and the development of the applications and systems of the demonstrators.

The Management Team installed a working group dealing with the definition and specification of the RIS services and the specification of the information requirements. The results of this working group[3] (see report of WP 6.3) are used for the standardisation phase and for the demonstrator phase. For WP 5 user needs is the basis for the specification of the RIS database. The specification of services and information requirements in combination with the standards on communication and information are the keystone towards the development of the different system modules

The work packages activities and their results are inter-related as depicted in figure 3.1.

[3] The detailed definition of RIS-functions and information has been realised in co-operation and combination with relevant partners in the RINAC project, WP 7 traffic information.

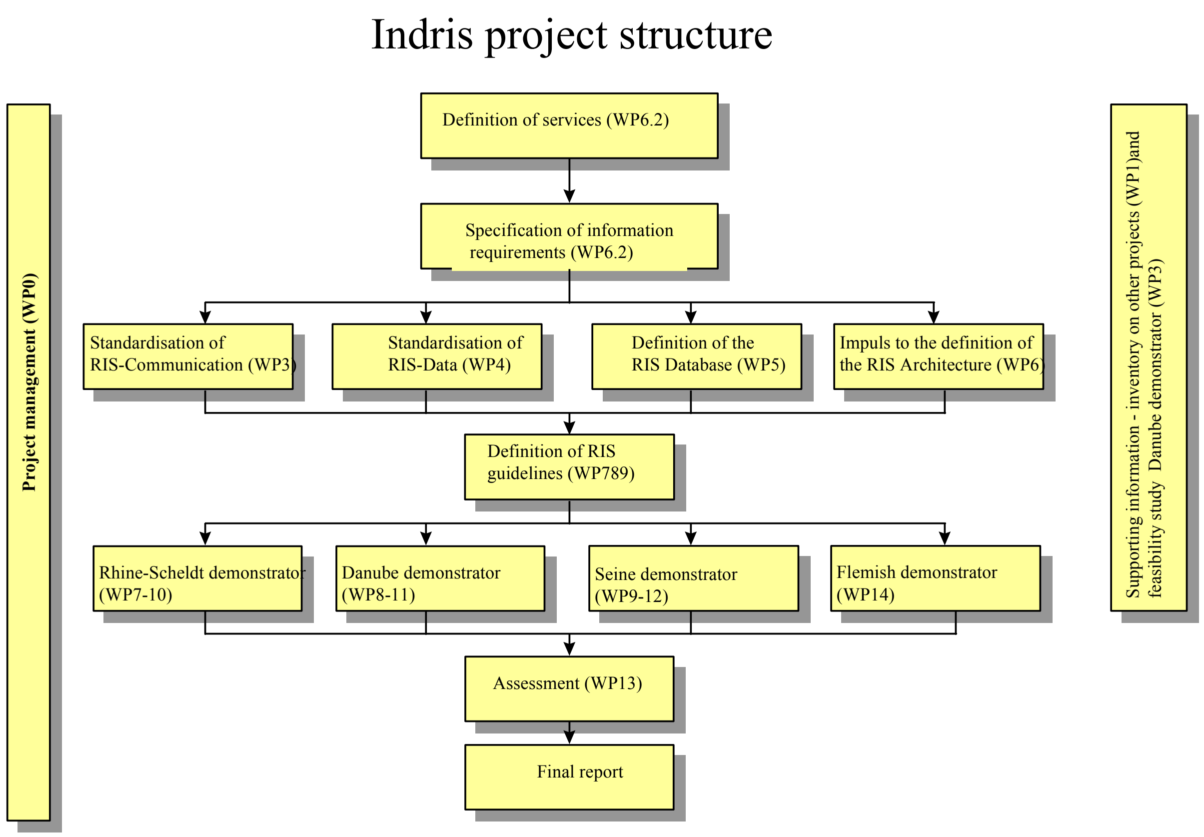

Figure 3.1: Structure of work packages in INDRIS

4 DEFINITION OF RIVER INFORMATION SERVICES (RIS)

4.1 General definition and description of RIS

4.1.1 Definition of RIS

RIS was originally seen as a concept that provides information on Vessel Traffic Management in its widest context. It was appreciated that the information in a VTMIS could be used for a large number of stakeholders. RIS was seen as a VTMIS for a river environment. Vessel Traffic Management suggests that the main purpose is safe navigation under the pre-condition that the available infrastructure is optimally used. Vessel Traffic Management also reaches out to other stakeholders. Hence, RIS can be seen as a concept for inland navigation providing a number of services or, at the other hand, it can be seen as Vessel Traffic Management Information concept that provides information in the widest context for waterborne users.

The discussion in INDRIS led to the following definition of River Information Services:

> **River Information Services (RIS) is a concept for *harmonised information services* to support traffic and transport management in inland navigation. It includes interfaces to other transport modes**

4.1.2 Elements of RIS

RIS contains 7(seven) characteristic elements:

1. Fairway
2. Tactical information
3. Strategic information
4. Shore
5. Ship
6. Local
7. Regional

This is based on an underlying conceptual model of the use of a vessel and a fairway system as a link in inter-modal transport. The core of the model is that inland navigation is an important modality for the transport of goods. In order to use the available fairway network optimally, information of this network should be available for the skippers who use this network. Skippers have two major duties: firstly they are responsible for the optimal use of their ship as a transportation means. Secondly they are also responsible for the safety when using the fairway network.

The competent authorities manage the infrastructure (fairway network) and play also a role in preserving the safety on the river as well as the safety of third parties living or working in the vicinity of the fairways. They are also responsible for the environmental issues associated with these fairways. In some cases the intensity of the use of parts of the network leads to the need to manage the use of the infrastructure in a safe fashion. In order to carry out these tasks, they require tools to get an overview of what actually happens on the river in order to preserve safety of vessels, environment and people.

Public authorities at the same time may have often the objective to facilitate the use of the network for transport goals. They pursue the goal of sustainable transport and in some cases desire to promote the use of water links.

A shore-based Tactic Traffic Image can provide the information required for Vessel Traffic Management. Such a traffic image can be on a local scale such as in a VTS, but it can also be regional. Such a regional traffic image may also serve strategic purposes, such as regulating traffic flows in a region when need be. In these cases a regional traffic image on shore is called a Strategic Traffic Image to indicate the fact that it is used to determine whether or not traffic measures are required to preserve a safety level.

In case of accidents in the fairway system, information regarding the accident, the actions required to alert emergency services as well as an overview of the traffic are parts of the information required for the on scene commander. This also applies to the crew in the calamity abatement centre who support decision-making regarding the crew and ship as well as third parties that may be affected.

It is a well-known fact that the driver of a vehicle is much better capable of driving his vehicle than somebody else, if he is provided with the accurate and timely information to take his decisions. This has led to the axiom that such a driver has the final responsibility for the conduct of his vehicle. This statement is certainly true for inland vessels where the skipper is the responsible person for the safe conduct of his vessel. Two types of information flows in relation to the skipper exist. The first one is the information on the optimal utilisation of his vessel in transport operations. This information has a planning or strategic character. The skipper will use that to consider transport contracts and to plan transports based on (intended) contracts, taking into account the relevant conditions. One of the decisions he has to make, are the amount of cargo to take on board and the times of delivery of the cargo. This requires route planning and the determination of drafts and ETA's. A lot of information is required to make these strategic decisions. He uses sometimes a strategic display on-board that provides information of the best routes, best drafts and best ETA's. These route planning and ETA determination uses an Inland ECDIS. Information with regard to the passage of locks and bridges as well as information regarding the use of terminal facilities will be taken into account.

When a voyage is planned then the voyage should be executed. The skipper is the best person to judge the course to follow and to deal with instantaneous traffic situations. This requires that tactical information is necessary. Tactical information is displayed in a geographic fashion to support immediate decision making of a skipper. The tactical information consists of information on his relative position in the fairway and the vessels in the vicinity irrespective whether they are or are not in visual sight. He needs a Tactical Traffic Image on board to collect and interpret the information for his navigation decisions. The range of such an image is restricted to an area where traffic can or will affect his decisions to act. During the execution of the voyage, lock and bridge transits need to be updated and information exchanged and the speed of the vessel sometimes adjusted based on actual messages of the state of the locks and bridges. This may be seen as some Strategic Traffic Information. This information can often be put in its geographical context and may then be called a Strategic Traffic Image on board.

The 7 above mentioned and described RIS elements are combined to form:

- Fairway Information System
- Tactical Traffic Image on Board of a ship
- Tactical Traffic Image on shore (RIS–centre, Lock, Bridge, Terminal, calamity abatement centre)
- Strategic Traffic Image on shore (RIS-centre, calamity abatement centre)
- Strategic Traffic Information on board

In the next sections the service categories of FIS and the traffic images will be discussed in more detail. These services cannot be performed without a database that supports the services specified. A section is given in which the database design and the relations to the different elements is specified.

4.2 Fairway Information Service

4.2.1 Notices to Skippers and Water Levels

FIS primarily supplies information to support tactical and strategic purposes. Information is supplied in electronic form. It includes a replacement of the traditional information supply, such as notices to skippers and actual and predicted water levels. The notices to skippers primarily include information about availability of infrastructure. Water-level reports are extremely important for shipping, since they determine the quantity of cargo a ship will take on. Especially reliable water-level forecasts are of vital importance. The opening of the Rhine-Main-Danube canal has created a much greater scope for shipping. But this scope can only be fully utilised when water-level forecasts for the entire route can be made for the coming 2 weeks. It will be clear that this is not, as yet, the case.

4.2.2 Inland ECDIS

Information about the geography of fairways and parameters and constraints with respect to the use of fairways that is of major importance both for presenting traffic information at tactical level and for planning and monitoring scheduled trips. Activities in this context include integrating electronic chart with ship’s radar and transponder information generated by the tactical traffic image.
These electronic charts are quite dynamic in nature and should be seen more as geographically oriented databases. In future, electronic chart displays will include both static items such as shipping route-signs and opening hours of bridges and locks as well as dynamic information such as water levels and obstructions on fairways.

4.3 Tactical traffic image on board

4.3.1 Introduction

The tactical traffic image is a display where on the basis of an Electronic Nautical Chart (ENC) vessels are displayed with their tracks and identification. The latter functionality is created by transponder or AIS system. Inland ECDIS and AIS have created a new generation of traffic guidance equipment on shore. Its application on board of an inland vessel dramatically improves on-board information supply.
Currently, along the major rivers in the Netherlands and Germany, a number of Vessel Traffic Services is active, which provides information and interacts with traffic at focal points in the fairway network. Presently, the traffic images used in VTS are based on signals from permanent radar stations. These images are enhanced by reports from vessels to the Vessel Traffic Centre, whereby an overview is generated of vessels active in the VTS-area.

The introduction of the new technology will improve the activities in a VTS centre and might have consequences for the future organisation of inland VTS. The most interesting improvement is that the new technology enables the authorities to have a clearer look at the traffic flows in a large area. This might increase safety levels as well as the efficiency of the traffic flows whilst minimising the number of personnel.

4.3.2 AIS transponders and radar information

When vessels are equipped with DGPS to establish an accurate position of the ship, and with an AIS transponder that almost continuously transmits information (signals) about the ship’s position and identity, reports to traffic centres and to ships in the vicinity can be generated automatically. These signals are used to enhance radar echo signals with an identification label. Often they are also used for so-called data fusion. This is the process where signals of different sensors are combined in such a way as to provide the most probable position of the vessel. In this way the VTS-operator or the RIS-operator as well as the navigator of an oncoming vessel will know each vessel’s position at any time.

This traffic image on board is sometimes based on radar information from shore radar. The AIS system may have spare capacity and this capacity is used to provide the vessel of radar information from ashore. This is important in those cases where the ship’s radar is unable to “see” vessels that are hidden by objects that interfere with the ship’s radar antenna. An important application is also the indication of other vessels that are not equipped with AIS.

Communications between a Vessel Traffic Centre or RIS centre and a ship can now be limited to traffic information or guidance in those cases where participants wrongly interpret developments in the traffic, or fail to make clear navigational arrangements. The VTS or RIS operator can restrict his activities to purely safety information.

4.4 Tactical Traffic Image on shore

4.4.1 Radar and AIS fusion on Inland ECDIS displays

When it is required to have independent VTS centres to deal with local Vessel Traffic Management, the most appropriate tool to depict traffic information and safety information is a display on basis of Inland ECDIS. Such a display identified vessels by fusion of shore-based radar and AIS information.

4.4.2 AIS and calamity abatement

The benefit of an on-board transponder in the event of a calamity – for instance a collision between two ships – will be clear. When ships are equipped with an on-board transponder, information will be immediately available on-shore concerning the ships' identities and – even more importantly – concerning the cargo carried by the ships. The immediate availability of data such as position of accident, identity of ship and hazardous cargo, if any, will drastically limit adverse consequences of the accident.

4.5 On board Strategic Information

4.5.1 Voyage planning

Skippers and lock operators as well as terminal managers need information of ETA's in order to plan their activities in advance.

4.5.2 ETA calculations

The determination of a precise time of arrival is a problem that has aroused a lot of interest. Different methods have been designed to provide accurate predictions. An important issue is here that an accurate ETA not only depends on the performance of the vessel in a hydrodynamic sense but that also the internal management of the vessel and the regulations has significant influence. The fact, that many locks have to be passed and that these passage times depend on traffic densities and procedures used in these locks are important parameters for the determination of an ETA. The labour schemes based on safety on inland navigation indicate that a skipper can only navigate his vessel for a restricted time also affects the ETA.

During a long time ETA information and ETA models was stored in the minds of skippers. Based on their experience and their knowledge of their vessels they were able to provide ETA's that were useful for the demands of the time. Hull forms and patterns of available water depths were instrumental is building a database. Since inland navigation is playing a role in inter-modal transport contributing to the logistical principles as just in time and supply demand management more sophisticated methods are demanded since the old methods were not providing the required accuracy.
Three basic methods are now in use:

- Methods based on extrapolation and a learning effect
- Methods based on fuzzy set theory and a learning effect.
- Methods based on hydrodynamic theory in shallow water

4.5.3 Fuel minimisation

Fuel minimisation is based on the assumption that the RTA allows the vessel not to use its maximum speed under all conditions. In general, a liner service will be set up that takes into account a variety of factors, such a variable flows of cargoes, variable available depths over the seasons. It will then be a rare occasion that the vessel will need to use its maximum power over the entire distance. On that basis it is possible to determine speeds on different legs of the voyage in relation to the draught and available depths.

An example is provided below that indicates that considerable benefits in fuel consumption may be reached. This example indicates the choice of the speeds in two sections of the fairway with different depths. The RTA is set in such a way that the total power available is not used. The speed in both sections can be varied. The optimisation criterion is the minimisation of the required fuel in order to arrive according to the time specified in the RTA. The following graph indicates the speeds and the minimum amount of fuel that is required.

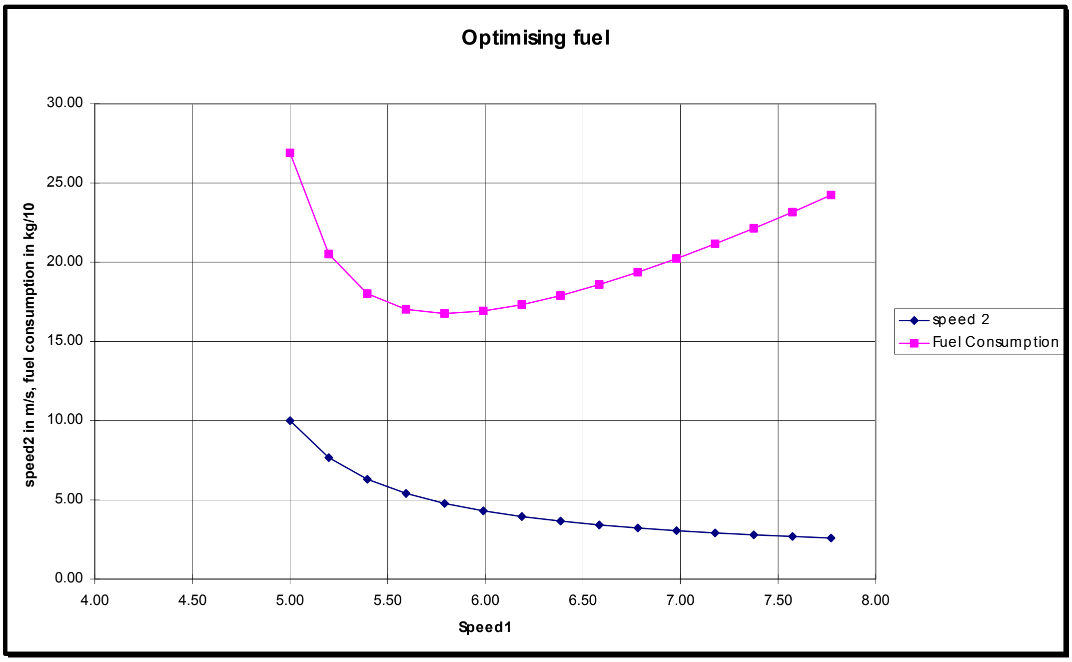

Figure 4.1: Optimum speeds for minimal fuel consumption

4.5.6 Net revenue optimisation

A further application mainly for the shore side and a logistical service provider is the question how profits may be optimised. In this way the revenue as a function of loaded units and their tariffs is taken into account as well as the fuel consumption of the vessel with different drafts and speeds relative to a given available depth.
It is now possible to determine the draft as a function of the number of loaded units on board. This in turn affects the resistance of the vessel since with increasing draft the ratio draught depth is being changed leading to a higher resistance and a higher required power and consequently more fuel is required. When the under keel clearance becomes small the power requirements are increasing fast. Since the power source can only provide a maximum value of the power the ship's speed will drop. This in turn affects the number of roundtrips and the capacity to transport the loaded units and thus revenue will decrease. From such a consideration it is possible to determine the optimum draught and speed as a function of for example fuel price. The liner operator is now able to assess the best conditions for transport, for example to introduce smaller draughts and adding a vessel to maintain the transport capacity, or

to change his sailing schedule in such a way that he optimises his revenues. This is made possible by extensions of voyage planning programs in association with geographical information as being provided by the Inland ECDIS. This is a large contribution to ensure the efficiency of inland transport using inland vessels. These applications are possible when the main parts of RIS are introduced in the European waterway network.
The next graph illustrates the revenue that may be expected as a function of speed and draft in a fairway with a given depth. This example shows a draft of the vessel, resulting in a large under-keel clearance, not using the entire capacity of the vessel. In other words, in the example selected, the extra revenue generated by the cargo is more than totally absorbed by the fuel costs that are necessary to keep the RTA. This example shows that a better utilisation of the cargo capacity resulting in small under-keel clearances might not always be the best strategic choice for revenue optimisation.

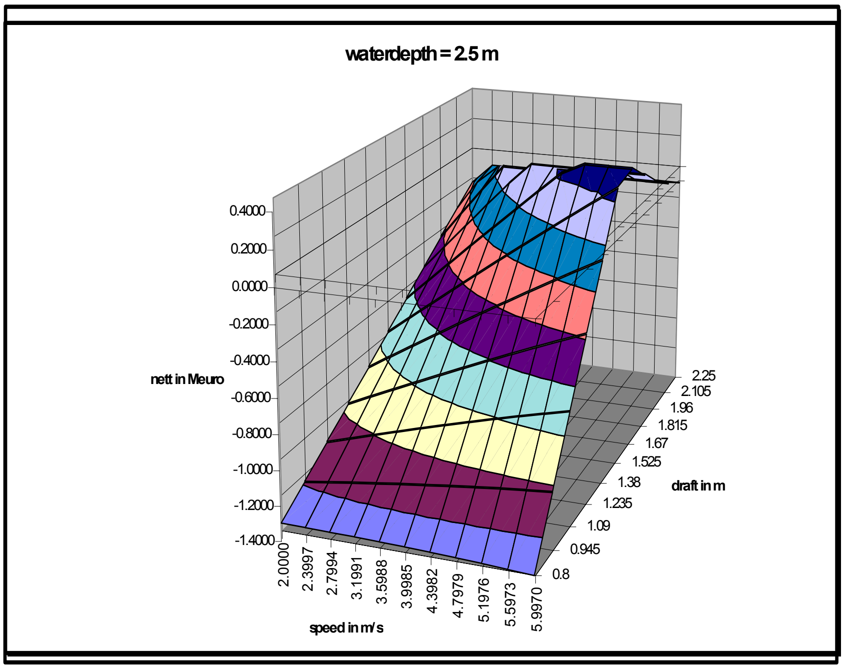

Figure 4.2: Graph showing optimum speed, and draft for maximum revenue

4.6 Strategic traffic image on shore

4.6.1 Traffic management

A strategic traffic image is an image that is used in a centralised Vessel Traffic Management Centre. Such a centre replaces a number of original Vessel Traffic Centres. This image can be obtained if shore infrastructure is used along the stretches. In this case no shore radar is utilised and as such it is an excellent alternative for local traffic management. It requires that all vessels being equipped with AIS transponders. Vessel Traffic Management may be modified since the possibility to monitor of large area will contribute to the efficiency of inland vessel traffic.
The Strategic Traffic Image may also have important consequences for what we may call strategic information.

4.6.2 View Of IVS90 Routes (VOIR)

VOIR may be seen as the primary example of a Strategic Traffic Image. VOIR aims to visualise the information of an IVS[4] system. This system is developed by the Dutch Ministry of Transport in order to collect dangerous goods information of cargo transported with inland vessels in the Netherlands. It is also used in connection of the management of locks. The system provides lists of arriving vessels in each lock based on average speeds in each stretch of the waterway system. Its main goal is to provide information for calamity abatement if a vessel loaded with dangerous goods is involved in an accident with spill.

The system has been adopted in Germany[5]. The visualisation is based on the knowledge of the presence of a vessel in a given stretch. The progress of the vessel is monitored during its voyage. The intensity of vessels is provided by a certain colour. A front-end database is sometimes installed that can provide answers to different questions related to the nature of the cargo. An example is that the system provides answer on the question how many benzene tankers are present in a stretch or provide answer on the question how many vessels are present with a draft more than a given value. It provides information for operational questions but also more policy related questions could be solved on the basis of the data stored in the IVS database. VOIR may be seen as the starting point of the development for a strategic traffic image and the development for more dedicated applications. It should be stressed that due to the confidentiality adopted by the Dutch authorities and the users no individual information is provided. The first release of VOIR was unable to track individual ships. In cases where the database indicates that only one vessel satisfy the search criteria the ship still had no identity. In later editions of VOIR individual vessels can be tracked and the viability of VOIR is enhanced.

VOIR is an excellent tool for illustrating the risk in a stretch and also provides policy answers on questions related to minimising risk profiles along rivers and the main canals.

4.6.3 Infrastructure management (lock and terminal management)

Strategic information can also serve authorities' needs. When sailing plans for all ships are known, then the arrival pattern at the locks can be predicted with more precision. Lockmasters will then be able to schedule the use of the lock in an improved way, ensuring optimum use of lock-capacity. Messages from the lockmaster to the skipper of a vessel can lead to savings on fuel consumption since they are able to adjust the speed of their vessels to the Required Time of Arrival. The introduction of such a system could also mean that new construction of lock-chambers at a specific lock-complex might be delayed to a later date. This might lead to substantial financial savings. Improved planning will also lead to a reduced need for mooring facilities to be installed at both sides of lock complexes. This in turn might lead to substantial annual savings on public expenditure.

4.6.4 Calamity information

The IVS system contains information regarding dangerous goods. As soon as a vessel is involved in an accident the IVS database can be consulted. This would immediate provide the nature and the size of the dangerous goods that are on board of such a

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[4] IVS is the Information Processing System for inland navigation in the Netherlands, see WP 1.

[5] It is called MIB (The German Information procssing system for inland waterways).

vessel. Other databases will inform the on scene commander of the properties of the dangerous substances and the way in which spills of these substances can be fought. Normally an accident is reported to a VTS-operator. A passing vessel using its VHF set to inform the nearest VTS station does this. Observers at shore will probably use a general emergency telephone number to inform authorities of the accident. If a VTS-operator receives the information he starts to determine the severity and then starts alerting the emergency services like police, fire squad and ambulances. If the accident exceeds some criteria the fire squad commander will take over and a colleague of the fire squad will act as the on scene commander. The VTS-operator is now providing assistance to this on scene commander and may advice to him. It may be necessary that the traffic in the stretch be suspended to allow rescue, fire or salvage operations to take place. A Strategic Traffic Image may be very helpful to address the vessels in the vicinity of the place of the accident and to provide information about a suspension of the vessel or to inform them about the small available navigable space adjacent to the place of the accident.

When a spill occurs oil spread programmes may be used on top of an Inland ECDIS to determine the size of the spill and the length of the banks that are or will be affected by oil, if no mitigating measures are taken.

Information stored in the IVS database as well as the use of a Strategic Traffic Image is helpful when an accident occurs to reduce the consequences and to protect other users from these consequences and provide support to the on-scene-commander.

4.7 RIS database architecture

The main goal of the RIS is to provide updated information in order to support users' operations. This is implemented through a number of Application Processes, each of them dedicated to a specific category of users: skipper, lock operator, bridge operator, terminal operator, VTS operator, Calamity Centre operator and transport provider.

The overall operational relations that exist among the various RIS users, define the "context" in which the RIS system must provide its functional support. The figures 4.3 and 4.4 illustrate the context diagram of the entire RIS system and the "Level 0" Data Flow Diagram.

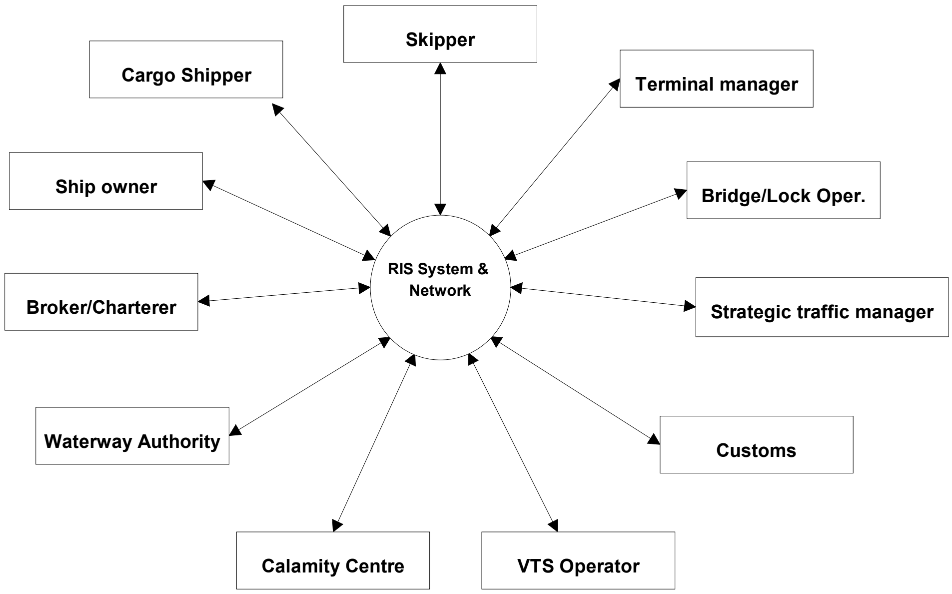

Figure 4.3: Context of the data flow diagram

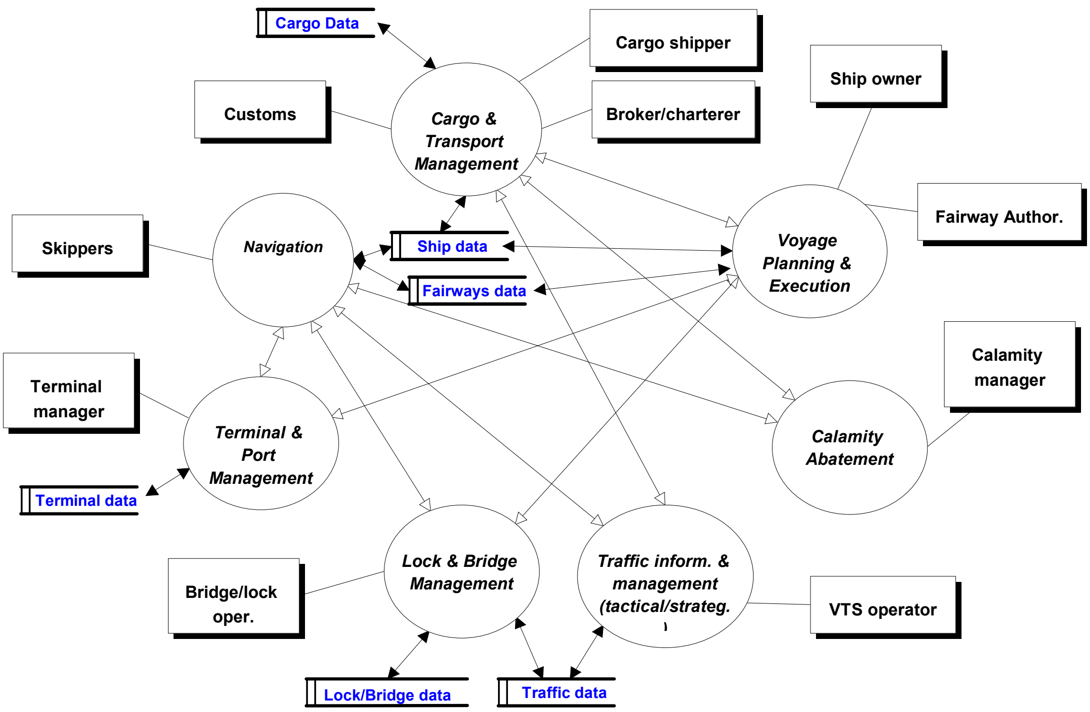

Figure 4.4: "Level 0" Data Flow Diagram of the RIS system with the main Databases

One function common to all processes is to present (i.e. display), update and collect simultaneously relevant information from the network and from other interested users. On the other side, background processes exist, running on *Info-servers* and implementing the functions needed for a smooth system operation but not directly visible to the final users, such as:

- Data collection from sensors and external sources (meteorological-data, hydrographical data),
- Data integration among nodes,

- Data provision to the RIS users, implementation of the data exchange mechanisms, message routing, store & forward etc.,
- Management of accesses rights (passwords etc.),
- Management of communications,
- System monitoring and diagnosis.

In order to cover all RIS regions the same background process will be replicated in different locations, with different sources of data in input. The respective nodes are inter-linked and interoperable each other.

4.7.1 The RIS distributed Database

The categories of data to be used within the RIS system (Ship's data, Voyage data, Cargo data, Fairway data, Fleet data, Meteorological data, etc.) will be stored and managed by RIS Info-servers placed at different locations. That is an implementation choice suggested by the following aspects:

- It is more flexible to solve national constraints due to different types of system implementation laid down by each National Competent Authority.
- The wide geographical distribution of the RIS area and the characteristics of the navigation process imply that a significant part of the RIS data (e.g. traffic data, short term planning of terminals-locks-bridges) is of interest only for local traffic. Thus the data exchange among regional nodes can be kept at a minimum level, only when requested by an authorised user.
- The robustness of the distributed architecture is better with respect to possible faults at the node level.

The respective databases will have to be replicated and integrated, allowing each authorised user to retrieve the relevant data independently from their physical location, within a predetermined maximum time delay.

4.7.2 Reference model for the RIS Database architecture

In the classical database textbooks, the architecture is divided into three general levels: external, conceptual and external. The external level is the one closest to the users; i.e. concerned with the way the data is viewed and used by the individual user. There are as many views as many users.

The internal level is the one closest to physical storage, i.e. concerned with the way in which data are actually stored. There is only one internal level.
The conceptual level is a “level of indirection” between the other two and can be regarded as being concerned with a community user view. There is only one conceptual level.

4.7.3 The 3-level Client-Server Architecture

It is worth noting that at the internal level many “single” databases can exist, each of them storing different classes of information: FIS data, ECDIS data, navigation data, transport data, weather data etc. It is important to point out that these internal single databases are not necessarily running within the same local computer system, but they can be even distributed on several interoperable networks.

It will be one of the tasks of the Data Base Management System (DBMS) to ensure each user obtains the correct "external" view of his own requested data, with the necessary availability and updating.

The ECDIS database deserves a special focus because it is concerned with standardised data that is better not to mix with other data into the same storage.
In fact, the reference model, the ECDIS data can easily be stored and managed following the standard formats and rules, in a separate way with respect to all the other RIS data.

4.7.4 A European RIS network

Looking at the feasibility of a European RIS network, the interoperability among the existing systems at both user level and system level (i.e. database, protocols, procedures etc.) is a very basic goal. Any current difference of the systems architecture and of the respective databases is not preventing the possibility of reaching a satisfactory interoperability among the various existing (and planned) databases. That can be true provided the standardisation of data is fully implemented.
The modern software technologies, especially those derived from the INTERNET technologies, allow in fact for integrated solutions and suitable interfaces. In particular, a flexible and feasible solution could be achieved by the so-called "3-levels client-server architecture". The basic structure of these systems is given in above figure, where the generic user can access an application server, even using a simple and standard "Internet browser" without installing any special application program on his own PC.

The design work carried out within SWP 5.2 - data access functions - is complementary to the database design developed within SWP 5.3, and is intended to provide a complete overview of the RIS possible functionality's, defining a reference system architecture to support RIS implementation in Europe. For a detailed description see the related annexes of the final report of WP 5.

4.7.5 Privacy aspects

The RIS databases, containing private information, will be hosted on dedicated network machines of the involved organisations, but some foreseen services associated to the RIS would call for the possibility of remote access to data via f. e. the Internet.
Since the RIS databases store and manage many personalised data linked to the private interests of skippers, shippers and owners of cargoes, a major concern arises, related to the security of these data against violations that could allow unauthorised users to get and/or modify data. Moreover, an attack leading to the corruption of the critical run-time data of the RIS could also affect the overall safety of navigation.
In general, a *threat* can be defined as a hostile agent that, either casually or by using specialised techniques, can disclose or modify the information managed by a system.
The violations to database security can be grouped into three main categories:

- *improper release of information*, caused by reading of data from intentional or accidental access by improper users,
- *improper modification of data*, involving all violations to data integrity through improper data handling or modifications,
- *denial of service*, involving those actions that could prevent users from accessing data or using resources.

Security threats can also be classified according to the way they occur: accidental and intentional threats. While the accidental threats are casual accidents, independent of a determined will to cause damage (disasters, hardware/software bugs, and human errors), the intentional attacks denote an explicit and determined fraudulent will to steal data or cause damage. Violations involve two classes of users:

- Authorised users who can abuse their privileges and authority,
- Hostile agents, such as hackers and crackers, namely improper users (outsiders and insiders), executing action of vandalism to the software and/or system hardware, or improperly reading or writing data.

With the overwhelming success and widely use of Internet, there are always more and more applications and services configured in order to allow remote users to access to (and sometimes to interface with) different data stored in the servers of the companies or organisations.

The problems arise from the fact that many components of the sites are not completely safe and secure, and could leave different chances to external intentional attackers to penetrate into the private networks. This increases the possibility that restricted information is misused. It also might affect the integrity of data and the behaviour of the systems.

Database security comprises a set of measures, policies and mechanisms to provide secrecy, integrity and availability of data and to combat possible attacks on the system (threats) from insiders and outsiders, both malicious and accidental.

Database security encompasses physical, logical and organisational issues, such as:

- Physical Security focuses on tools, devices and hardware and software techniques, able to prevent or detect unauthorised physical access to data storage facilities, and to provide database backup/recovery;
- Logical Security consists of control measures, models and techniques to prevent, detect or deter unauthorised logical (that is via software) access to data;
- Organisational Security concentrates on management constraints, operational procedures and supplementary controls established to provide database protection.

To reach a satisfactory and complete level of security for a site is a very critical task. Different aspects should be considered and faced in an exhaustive way. One very important point would be to define a *Site Security Plan*, where all the critical factors concerning security are identified and addressed.

For this purpose, the RFC 1244 *Site Security Handbook* is a very useful and complete document to be used as reference for the implementation of the security system for a site.

4.7.6 Protection of RIS Databases

The set of information that forms the “RIS database” is stored and maintained in various systems distributed all along the geographical area of interest. The basic scheme, hence, is that of a distributed architecture, where the different systems hosting the RIS databases are connected to a main node, the *RIS Information Centre*, which is the only point where direct services to the remote users are supported. The basic scheme of this architecture is introduced in the next figure.

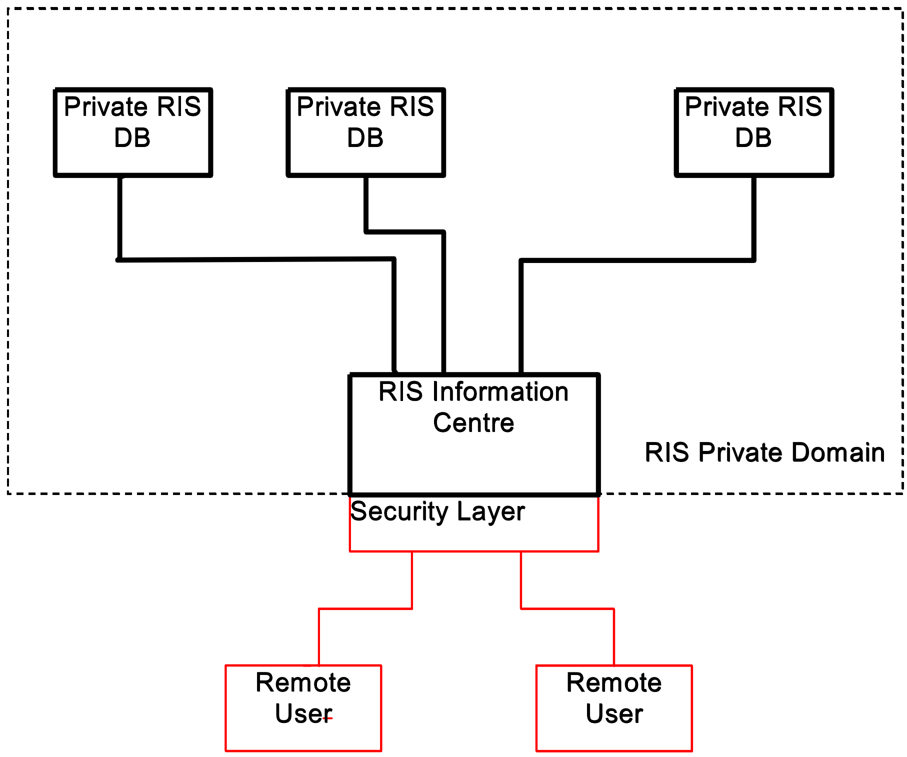

Figure 4.5: RIS databases architecture

According to this scheme no external access will be allowed to the peripheral RIS systems and their only possible data links will be connections to the RIS Information Centre and hence internal to the private RIS domain.
The users that will be allowed to access to the services supplied by the RIS system will connect to the RIS Information Centre where a dedicated security layer will implement all the necessary policies in order to grant the protection of the RIS Private Domain from unauthorised operations.
In particular, the telephone numbers that will be used for the remote connections to the RIS Information Centre will not be get public, but embedded in the client application delivered on users' terminals. Moreover, the key account information necessary to get access to the services (user ID and password) will be embedded in the terminal devices, related to their hardware and managed by a dedicated access-control server.
At the moment the services that will be supported by the RIS system will be of two kinds:

- Exchange of cargo-related information, via e-mail based systems;
- Distribution of specific information (e.g. fairway conditions) via web servers.

The impact of the general considerations would be the following:

- the responsibility to protect the data stored in each peripheral systems from local threats relies on the proprietary subjects, as it would be in a RIS independent fashion;
- the responsibility to protect the RIS Information Centre from local threats should be clearly defined;

- the application of the user authentication methods based on a dedicated access management server working also with client's hardware ID would provide a reasonable level of security from unauthorised users;
- the model of distributed databases that could be accessed from remote only through a private network (the RIS Private Domain) for well defined operations of data retrieval, based on views of the data, should reasonably protect from possible abuses of authorisations assigned to external users;
- at the moment it seems that there is no need for the encryption of data stored in the databases;
- the use of mail-based systems for the exchange of information would help the possibility to log all the events and detect unclear operations;
- in some cases the mail systems would allow not only the transmission of messages containing data requests and data contents but also the possibility to force some operations on the files of the remote machine; in this case the problem to prevent critical operations should be further investigated.

4.8 Reporting

4.8.1 Discrete reporting

The final result of voyage planning, possibly after several iterations to allow for the personal input of the skipper, is a (enhanced) schedule consisting of a sequence of destinations, ETA's and ETD's. This schedule and the relevant ship's data - including dangerous goods that may be carried - is communicated to the competent authority as well as to interested parties before starting the voyage. The basic elements of BICS are used. BICS is an electronic reporting application, operational in the Netherlands and Germany. During the INDRIS project the application is widely extended and enhanced with different functions as demonstrated in the INDRIS project.

The main objective of the BICS-application is providing support in the EDI (Electronic Data Interchange) link between a shipper, a charterer, a transport company, a shipping company, and a skipper of an inland vessel or manufacturer and a Data Processing System and between two BICS users with each other. The Data Processing System can be a Regional System (referred to hereinafter as the RIVS) positioned between the BICS and the IVS90 (and Maritime Information System in Germany (MIB)), or the IVS90 (or MIB) itself.

Examples of a RIVS are the "Zeeuws Haven Informatie Systeem" (ZHIS) [Zeeland Port Information System], the VBS [Information Processing Part of the Vessel Traffic Services] in Rotterdam, the NHIS [Northern Netherlands Port Information System] in Delfzijl, etc.

The RIVS determines whether a transport, reported to the RIVS by the user of BICS, will be reported to the IVS90 by the RIVS. It is possible that a notified transport takes place within a port area (e.g. the Rotterdam port area), but falls outside the tracking range of the IVS90 and therefore does not have to be reported to the IVS90.
The skipper can make use of BICS to send a declaration of the voyage and cargo data to another party, whether or not said party is a BICS user. However, said recipient has to be able to be reached via the mailbox system.
The following message types are exchanged between the BICS and the RIVS or IVS90:

- Notification of a transport (a voyage and possible cargo);
- Retrieval of the position of the ship (if the vessel concerned has given permission to do so);

Besides supporting the message exchange, BICS has another purpose which is at least as important, namely its ‘One-stop shopping’ concept, whereby the user lets most, if not all, of his data exchange with the RIVS run via BICS.

4.8.2 Continuous reporting and messages through AIS

AIS’ reporting is a continuous activity. This device sends position reports and the identification of the vessel in a prescribed format into the air according an ingenious algorithm that avoids parallel broadcasting.

5 STANDARDS AND HARMONISATION

5.1 Automatic Identification System

5.1.1 Introduction

It was agreed to use the ‘Automatic Identification System’ (AIS), as it is defined in the draft new recommendation International Telecommunication Union (ITU) document 8/15-E (annex 1), as the communication system of dynamic information for tactical activities in the RIS-system. During the definition phase of the tactical communication standard for inland navigation, the draft has been approved and its official name is ‘Recommendation ITU-R M.1371’. New messages for inland navigation purposes are possible, but to be compliant with sea going vessels, the use of defined messages will be preferred. In the near future the ITU recommendation will be described in an International Electrotechnical Committee (IEC) standard.

5.1.2 Background of AIS

It is proposed that AIS in inland navigation will work in the autonomous mode in almost all situations. This will avoid many expensive shore based stations and gives the opportunity to explore the systems along long stretches of rivers without any shore-based equipment. Only in specific situations, shore based stations will be used. This can be done for reporting purposes near locks and bridges and to construct a tactical traffic image for lock and bridge planning. Than the AIS will also operate in the autonomous mode. Furthermore shore-based AIS will be used in the ‘traffic image on board’ application. Besides monitoring for VTS purposes in manned traffic operation centres, AIS can be used to broadcast non-AIS vessels as AIS ‘position’ messages if it is a manned or unmanned station. Also in this situation it must be possible to operate in the autonomous mode, where the shore based AIS transmitter will reserve a number of ‘slots’ to broadcast position messages only. In this situation it has to be discussed if also ‘ship static and voyage related data’ messages will be constructed and broadcast, as far as the required information is available on the shore-based station. That can be the situation in VTS centres, supported by any information system e.g. Informatie Verwerkende Systeem 90 (IVS90) or MIB. In unmanned radar stations, which can operate to generate radar targets in situations where the normal onboard radar is not sufficient to oversee the traffic situation, the ship and voyage related information would normally not be available. In that case just position messages will be broadcast to inform the vessels about the existence of traffic. If repeater stations are in use, they re-broadcast only all received messages.
If a shore based facility broadcast AIS messages from non-AIS vessels, there will be some quality uncertainties. This will be caused by the knowledge that the radar tracker on the shore sometimes loses a track or delays the automatic initiation of tracks. Also ‘ghost’ tracks, label swap, loss or change of identification labels, etc. are known imperfections of sophisticated radar systems reflecting in uncertainties of the generated AIS messages. Proposed is to display such reports in a different colour on ECDIS, indicating that the accuracy, availability, reliability and integrity are not fully supported.

DGPS information is required to obtain certain level position accuracy. Recommended is the use of DGPS service from so called ‘radio beacon’ transmitters.

This requires a DGPS receiver on board of each vessel. This kind of systems, when integrated in the transponder, an on-board solution will be suitable, is cheap and direct connectable to the GPS receiver. Translation or processing of data is not required in this solution because of the universal Radio Technical Commission for Maritime services (RTCM) format. This solution does not require any shore based facility, besides the radio-beacon transmitter (large range), and will not overload the AIS communication and reserves the maximum number of slots for position messages. However, AIS has build-in facilities to transmit DGPS messages. In certain limited areas, where the traffic density is not too high, one can decide to use the AIS-DGPS messages. This requires shore based AIS stations, with DGPS reference receivers in each VHF range, which can transmit the differential corrections in AIS format. It will make the onboard AIS receiver or a processor system connected to the AIS more complicated because the system has to make the choice between available DGPS services. It is not recommended in this case to skip the DGPS receiver aboard because of compatibility.

Safety related messages, can be broadcasted. Proposed for inland navigation is to limit the first two items to shore based stations only.

In some situations a VTS station can interrogate a vessel to transmit required information. This can happen if a vessel is entering the VTS controlled area and no ship static and voyage-related data message is received yet. This can cost up to six minutes before that particular vessel will send this data as scheduled. Then the operator can decide to interrogate that vessel to get the information immediate. Also in the situation that the first contact between two vessels is on a very small distance, interrogation can be used to get the required data on board.

5.1.3 Ship - ship operation

All vessels carrying AIS are able to receive the signals of all other vessels with AIS within the range of their transmitters (VHF range). For this type of operation, an external DGPS service will be required if high position accuracy is needed. No shore based AIS stations are needed. On the TTI the AIS vessels will be identified, while other additional information will be available. The rest of the traffic must be obtained from the own onboard radar system. This operational mode is recommended for long stretches of river, etc.

5.1.4 Ship - shore (and shore - ship) reporting operation

If a manned shore based station is available on certain points, near locks, bridges, VTS stations, etc. automatic reporting and identification of the vessels will be possible. In this mode also automatic updating of ETA, etc. is possible if the shore-based station is connected to the entire network. A traffic image of all vessels with AIS in the area can be constructed on the shore for tactical and/or strategic applications. Recommended for lock- and bridge operators, etc.

5.1.5 Ship - shore ‘traffic image on board’ operation

One can decide to bring additional traffic information from the shore to the vessel. This may happen at certain locations of the river (junctions, crossings, curves in the river, etc.). In these cases the board radar system, together with AIS, is not sufficient to monitor the entire traffic situation. The reason may be that not all vessels are equipped with AIS, and consequently the skipper will not have all the required information. In a VTS environment, the information will be visible in the form of tracks; positions of vessels obtained by a shore based radar station, identified with labels, etc. For vessels not carrying AIS, the VTS station can generate AIS-like messages based on the VTS information. Positions of all non-AIS vessels can be broadcast as AIS messages by the VTS station. In this way, virtually all vessels will be available in the tactical traffic image. This method can be used with manned VTS stations where VTS operators will assist skippers in a heavy traffic situation but also on unmanned locations where only a radar system on the shore with tracking device will generate AIS-like messages to complete the traffic image on board. If the VTS centre only transmits the detected radar tracks of ships (position, length, identification, speed, course etc.), the increase in amount of data-exchange is rather limited to obtain a proper overview of traffic in an area. A less sophisticated base station can be used. If it is sure that all ships are equipped with AIS transponders, repeater stations can be used to collect and re-transmit messages to all users in order to extend the facilities of the on-board equipment in topographically critical regions ('looking round the bend').

Advantage of the proposed method is that only on points of interest (VTS, locks, curves, etc.) shore based stations will be required, while on the long stretches of the rivers only ship to ship AIS communication will be sufficient. The ship-shore reporting operation and ship-shore 'traffic image on board' operation modes of the AIS should preferably be performed in the autonomous mode to reduce costs of equipment ashore.
The deviations are:

- During the Rhine Scheldt Demonstration the AIS network was operated with *fixed time slot* for all participating AIS (mobiles and shore based) and for all messages. In the AIS standards for inland navigation it is defined to operated the mobile units in self-organising mode.
- Using binary broadcast message for communication of Non-AIS targets from shore to ship instead of AIS position report messages 1, 2 and 3 with indication of source of origin. Incorporating the non-AIS tracks in the inland AIS standards wasn't been defined in detail in 1999 in WP 3 in and in the Technical Characteristics for a Universal Ship-borne Automatic Identification System.
- Enhancements of binary broadcast message in order to accommodate the sub-message VTS Surveillance Footprint [6] for information of third-source targets. Two different applications has been developed, these are for:
  - International use, providing for each target: target id, target id type (MMSI, IMO, or call sign), latitude, longitude, and speed over ground Course over ground and time stamp. This leads to the accommodation of 8 targets per message.
  - European Inland Waterway uses, providing for each target: target id, target id type (MMSI or IMO), Call Sign, latitude, longitude, SOG, COG, Heading, Draught, Length, Breadth and time stamp. This leads to the accommodation of 5 targets per message. *(Implemented in the Rhine-Scheldt demonstrator).*

[6] VTS footprint allocated for the transmission of VTS radar-tracks or non-AIS tracks.

5.2 Inland ECDIS

5.2.1 Introduction

The Inland ECDIS activities in INDRIS are closely related to the activities of a similar project that runs in Germany, ARGO.

The ARGO project is an initiative of the German Federal Administration of Waterways and Navigation. This agency plans to introduce electronic chart systems on the river Rhine. After evaluation the seagoing ECDIS S-57 and S-52 standards, it was decided that these provided a promising starting point for an electronic chart application for use on inland waterways. In this way, both duplication of work might be prevented whilst at the same time sea-river traffic would be served.
In the pilot project ARGO, the „minimum performance standards“ for an Inland ECDIS have been developed and tested. The system contains the components Electronic Navigation Chart, radar imaging and GPS. The position of the vessel is presented into the chart with the help of “radar map matching”. The electronic chart is overlaid to the radar picture in a way, that the navigator gets all tactical information in one single screen.

In the first stage (1998) of the pilot project, the University of Stuttgart developed a prototype of ARGO. The prototype was installed on the motor ship „Mainz“, owned by the Wasser und Schiffahrt Dienst Süd-West (WSD-SW). Electronic charts (ENC) are produced. In 1999, the prototype of ARGO has technically and operationally improved, using trials with accuracy measurements.

5.2.2 Inland ECDIS origin

Contrary to the use of ECDIS at sea on inland waterways, the primary aim of ECDIS is not to assist position finding. Rather the primary objective is to provide geographical information that can be used for an active also nevertheless assist monitoring the location and progress along the river. However, under conditions of limited visibility including darkness, the own ship’s radar has become a primary aid to navigation even more so than at sea. Especially under these conditions, ECDIS may assist with route monitoring.

On the other hand, also under good visibility conditions there are examples on the Rhine and elsewhere on inland waterways, where skippers nowadays have limited information and sometimes even a false impression of the position of the riverbanks. Provided the ECDIS is fed with accurate and up-to-date depth data, it could also be of help in these situations and thereby optimising the use of the infrastructure.
In the ARGO project as well as in INDRIS, the choice is made to follow the maritime S-57 and S-52 standards. In this way, use is made of the work that has been done in the maritime world. It seems that by adding a limited number of objects to those that are already were defined, the needs of inland navigation can be properly met. An example of additional objects are the traffic signs that can be found along the Rhine indicating for example allowed berths, prohibitions, etc. An example is given below.

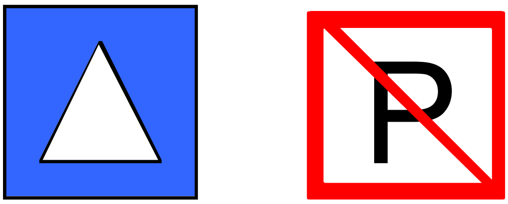

Figure 5.1: Traffic Signs

Another example is the kilometre signs that indicate the distance along the river from its source.

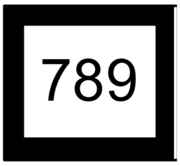

Figure 5.2: Kilometre sign

However the most important role of Inland ECDIS is on a more strategic, a more long term level, i.e. with voyage planning, ETA calculation and as a 'database' of all geographical related data. This is recognised in INDRIS by its efforts to provide accurate and up-to-date data for the depth critical parts of the river. The depth contours are combined with actual or predicted water levels, the ship's draft and a user definable under keel clearance to a presentation of the actual navigable fairway on the display. However voyage-planning software may use the same data, without presenting it graphically, to calculate the maximum allowable draft or an accurate ETA.

Further steps that has been taken in this area are to provide the depth information and the resulting fairway width accessible for voyage planning software and with the same purpose to include information like:

- berths
- prohibited berths
- accessible dimensions of bridges and locks
- regulations with implications for the voyage planning
- etc.

5.2.3 Updating

To use ECDIS for the navigation, but also for voyage planning and ETA calculation, the information needs to be up-to-date. Although there are large parts of the inland waterways where the ECDIS data will change rarely, there are parts of especially the rivers where for example the daily water-depth change is significant to shipping. It is therefore vital to provide an easily accessible updating service for ECDIS from the very beginning.

From the review of the present situation and the availability of data it becomes clear that the present organisation of surveys of the inland waterways will need to be adapted in order to be able to provide the necessary updates. For example in the Netherlands at present the critical parts of the river Rhine (Waal) are surveyed daily and the least recorded depths are disseminated. However, these surveys do not include (accurate) position information. At low water situations, also the buoy positions are

changed daily in the Netherlands to indicate the actual fairway. At present also these buoy positions are not recorded (accurately) and are therefore not published.
With regard to the depth information, this need for up-to-date information is recognised by the ARGO project and it is intended to provide regular updates of depth contours for the critical parts of the German Rhine. In the Netherlands as well as in Austria, this is still under discussion.

To be able to use the ECDIS information for voyage planning and monitoring and for ETA calculations also further steps need to be made with regard to updating. Both in Germany and in the Netherlands are presently undertaking to make the 'nautical information for skippers' available in digital form using the Internet (the Electronic Waterway Information System (ELWIS) respectively BerichtenCentrum 2000 (BC2000) projects). However the presently chosen format of information that affects voyage planning like information on a – temporary - fairway obstruction, still closely follows the nowadays paper format. In order to allow voyage-planning software to use this information inclusion of software accessible geographical references and standardisation of these messages will be necessary. This would allow at the same time the ECDIS to visualise for example a partial obstruction of the fairway during navigation (the TTI), and also allow ECDIS based voyage planning software to take this information into account when planning and monitoring voyages.

The authorities of especially Austria and the Netherlands have expressed their interest in so-called dynamic objects, like lock and bridge signals, as well as the use of inland ECDIS during calamity abatement. The latter was demonstrated during the calamity abatement demonstration near Millingen. Such use however put special demands on the updating organisation, administration and infrastructure and needs further research and development.

5.2.4 ENC data

During the River-based Information, Navigation And Communication (RINAC) project, a first inventory turned out that actually in the Netherlands, Belgium, France, Germany, and Austria there are no S-57 compliant data for inland waterways issued by official authorities available.

Nevertheless, especially the administrations of inland waterways in the Netherlands, Austria and Germany realised that the meanwhile internationally adopted ECDIS standards for seagoing shipping would be an appropriate basis for future data standards in the inland waterway shipping. Independent of the intention to provide S-57 data sets to be used in various applications, most of the authorities had started previously projects to introduce digital cartography or GIS based management of geo-referenced information. The purpose of these activities was mainly to rationalise the data administration, maintenance, and production of 'paper products' such as inland waterway charts. In majority, this led to digital databases that are presentation oriented, having neither data model nor data coding scheme as basis.

It is understood that the provision of S-57 complaint data was never intended to be an isolated activity. It has to be incorporated in the overall maintenance and production line of an official body. In this content, S-57 defines a separate product line that is in turn based on the already digital data. The discussion with various representatives of inland waterway authorities led to this important conclusion.

Starting in 1997, the Austrian ‘Bundesministerium für Wissenschaft und Verkehr (BMWV)’ specified the goals and functions of an inland waterway traffic management system (“Sicherheitsanforderungen and ein Schiffahrts-Leitsystem”). The activities in various demonstrations approved the need and applicability of ECDIS data.

Within the activities of the INDRIS project, for the Danube demonstrator test site at Grein an inland ECDIS test data set was required. SevenCs produced and maintained this ECDIS test data set according to the international Hydrographic Organisation (IHO) standards S-57 and S-52.

In Germany, by end of 1997 the ARGO project was started by the Federal Waterway Administration (WSD-SW, WSD-S and WSD-W). This project focuses on the production of an Inland ECDIS database that covers parts of the Rhine. Additionally, this data were integrated in an Inland ECDIS prototype application.
Presently Inland ECDIS compatible data is being produced for most of the German Rhine, the German Danube and in a later stage the Main.

In the Netherlands, the discussion about implementation of ‘River Information Services’ (RIS) with components such as a ‘Fairway Information System’ (FIS) in the framework of the INDRIS project led to decisions concerning S-57 compliant data. Based on digital data e.g. of ‘Rijkswaterstaat Meetkundige Dienst’ a first coverage of S-57 data is available for Dutch inland waterways. SevenCs is involved in activities to implement the production of S-57 data.

In summary, the mentioned projects and activities draw a very optimistic picture for the future availability of S-57 data sets of European inland waterways. Nevertheless, important aspects like constant maintenance for new editions and update data, distribution, prices and commercial services have often been touched yet for a first time.

So far all activities take place on the main waterways, the ‘high ways’. However to allow strategic use of Inland ECDIS in for example voyage planning and to keep the momentum caused by ARGO and INDRIS, it is of utmost importance that ECDIS coverage from origin to destination is realised on short notice. Similar to route planning software for roads based on small units such as postal numbers, a skipper will only be interested to do the necessary investments if also the smaller waterways, the ‘local and regional roads’ are included.

5.3 Data standards

The data in RIS are divided in three categories:
- Transport data, such as cargo data, ship characteristics and voyage-records
- Geographic related data, such as water depths, bridge data, lock data and meteorological information
- Navigation related data and dynamic data such as the actual ship’s position and speed

5.3.1 Transport data

There is an urgent need to use the same data throughout the entire transport chain. This has led to international developments and agreements on standard data and standards for Electronic Data Interchange. These are used in inter-modal transport areas, customs, and trade.

UN/EDIFACT[7]) should be considered in any application were values can be generated in character format for data exchange purposes.
The UN/EDIFACT Standard is:

- application independent
- communication medium independent
- machine independent

EDI, and more concretely UN/EDIFACT, provides overall greater accuracy in ordering goods. EDI leads to improved logistics, particularly resulting in lower storage/warehousing costs.
EDI is applied most predominantly in Europe, Asia and Australia/New Zealand, and plays an increasingly important role in the US, where it is applied in administrative exchanges.
The use of standards that are in line with the already available solutions used, will be preferable for all data-interchange concerning the same kind of information.
As a consequence the UN/EDIFACT standards will be recommended for transport- and logistics-related information.

In report on Work Package 4, a description is given of those data items in RIS for which an UN/EDIFACT standard is available.

5.3.2 Geographic data

The development of electronic charts for inland navigation is making progress in Austria, Germany, and the Netherlands. ECDIS makes use of the S-57 data standard. This standard was developed to allow transfer of chart related data. The standard describes entities that are in close association with hydrographic objects that are important for safe navigation.

In inland navigation the standard was adopted for Inland ECDIS and amended for all special objects that are related to river navigation, whilst preserving the compatibility with sea ECDIS. In first instance, static objects were drafted, such as riverbanks and land related conspicuous points. It was considered that other dynamically related information issues such as the position of a vessel, specific information on bridges and locks (dimensions of the chambers and opening times) and similar information should be included. This was done and agreed by the management and the standard for use in the project was composed of the following categories

- the objects that are available in the S-57 standard for sea ECDIS
- new defined objects related to static objects as well as dynamic objects
- meteorological information

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[7] Is the user application protocol for use within user application systems for data interchange to facilitate transactions in the public and the private sectors.

5.3.3 Navigation related data

For safety of navigation information, use will be made of AIS to interchange pertinent safety information. Again, this is a Sea AIS standard and some of the standards have been changes and amended to suit inland use. The standard should be compatible with Sea AIS. The standard is still under discussion. In order to have a reference point, the management decided to freeze the standard as developed in INDRIS as per 1st. January 1999.

In the AIS system, different types of information are defined (as described in the ITU standard):

1. Static information. This information will be updated every 6 minutes and on request and contains information about call sign, dimensions of the vessel, location of the GPS antenna, type of ship, etc.
2. Voyage related information. This information will be updated every 6 minutes, when data has been amended, and on request and contains information about actual draught, hazardous cargo, destination, ETA, etc.
3. Dynamic information. This information will be updated according to speed and course alterations and contains information about position, time, course and speed, heading, rate of turn, etc.
4. Safety related messages. Very important navigational or meteorological warnings can be broadcast.

All information can also be transferred on request.

Looking to the updates of information, it can be concluded that for inland navigation, the update rates must be considered for the modes of operation as described before. In particular in the situation that the first contact of vessels is on a very small distance, say within 10 km., an automatic interrogation from one vessel to the other, to obtain the relevant static and voyage related information, must be considered.

5.4 RIS guidelines

RIS guidelines were thought to be necessary by the project management. This was due to the need for harmonisation and the use of standards that could be used in information exchange for traffic and transport management purposes. Another objective was that the intended demonstrators should at least use the same guidelines when the demonstrators and associated software and hardware were developed. The new concept of regional Vessel Traffic Management also required a clear description of its role and its elements. It was decided to use the guidelines for Vessel Traffic Services as a starting point.

It was also decided to develop guidelines apart from INDRIS on a voluntary basis. A special working group was started to draft the guidelines. The development work on the three demonstrators was assigned the work package numbers 7, 8 and 9. Consequently the working group to draft the RIS guidelines was called Working Group 789 (WG 789). The result of the drafting group was accepted for use during the INDRIS project. It was recommended to the work package leaders of the demonstrators work packages to use these guidelines in their preparatory work.

Since the RIS guidelines also were the first attempt to describe the essential components of VTMIS, the RIS guidelines were also introduced in PIANC and International Association of Lighthouse Authorities (IALA) to provide these organisations with a starting point for further development of VTMIS and RIS guidelines that is accepted by a wider community.

6 DANUBE DEMONSTRATOR

6.1 Introduction

The river Danube was defined as a Pan-European Transport Corridor VII by the 3rd Pan-European Transport Conference of Helsinki, June 1997, and is expected to be one of the most important links between the Western European waterway network and the middle and South Eastern area of Europe. Studies initiated by the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT) show that this inland waterway will become more important since the road and rail infrastructure will not have sufficient capacity to take the charge of the forecasted increase of transport. This is particularly true for the time frame 2000-2020.

Traffic on the Danube is expected to increase significantly during the next years. It is a clearly stated political task to shift cargo from road and rail transport to inland navigation to cope with future transportation needs in order to cut down CO2 emissions and their follow-up costs significantly.

The expected significant increase of inland navigation traffic on the Danube requires River Information Services (RIS). It is a high priority target of the Austrian BMVIT to use the RIS tools for integration of inland navigation into inter-modal transport chains.

The construction of this chapter is as follows:

- At first the technical and operational background for this demonstrator will be described.
- Then the preparation concerning the set- up and other essential preparatory work of the demonstrator is described.
- Finally, the framework and work carried out are described during the execution of the demonstrator in Nov. 1999.

6.2 Demonstrator System

The Danube Demonstrator is set up as a RIS in a non-VTS environment. The system is a transponder system that has interfaces to the Inland ECDIS on board a vessel. The Ships Identification Unit (SID) is an intelligent transponder that can be fitted to any fixed or moving objects and will transmit its position, identity and call sign. DGPS corrections are integrated. Consequently, the demonstrator is focussing on a Tactical Traffic Image supported by a FIS.

The vessel's location is displayed with its name accurately positioned on the Inland ECDIS display, according to Inland ECDIS standards. Vessels equipped with PCs, monitors and transponders are, on a predefined segment of the river able to see their own position and that of all other vessels equipped with a transponder on board.

The RIS control centre had the same picture and information as all vessels and in addition the position to draw hazard zones on the river or disseminates any other information to be shown on the vessels' displays. This is called a Tactical Traffic Image on shore. The display brings up the relevant chart of the river and the vessel.

As far as necessary a Strategic Traffic Image is made available at the control centre. The locations of the relay stations are such that complete coverage of the stretch is achieved.

The system uses the latest transponder technologies and the computers provide fault diagnostics to enable easy maintenance.

A pre-demonstrator trial in Sept. 1998, as one of the elements of the feasibility study from Work Package 2), has shown that the system could be implemented. Due to the fact that scanned river charts were used, another (commercial) demonstrator was held in April 99 in Hainburg to prove the feasibility of electronic charts (ECDIS). The results of this demonstration convinced the Austrian authorities (BMWV/OSB) and the INDRIS Project Management to continue the project, resulting in the hereafter described INDRIS Danube Demonstrator. In this commercial demonstrator again a proprietary ECDIS was used. The main difference with the pre-demonstrator trial was the usage of an ECDIS kernel and display instead of scanned charts on top of basic AIS equipment.

6.3 Demonstrator Infrastructure

6.3.1 Specific objectives of the Danube demonstrator

The objectives of the Danube demonstrator are as follows:

- To test a TTI on board and to shore stations
- To use a STI to shore monitoring stations
- Provide fairway information on board (using the FIS software)
- Use the provisional agreed communication standards
- Use the provisional agreed electronic reporting formats
- Use the provisional agreed Inland ECDIS standards for traffic images

6.3.2 Introduction

A communication network was installed on the demonstration stretch between the lock of Wallsee, the shipping police station Grein and the island of Wörth. The network consists of fixed computer-equipped relay station on the lock of Wallsee and the shipping police station Grein, one-fixed relay stations along the river. The transponder relay stations had power and telephone connections and communicate among themselves and the control centre either via Integrated Services Digital Network (ISDN), GSM or local cabling. The communication to the vessels and between the vessels was performed via transponder and radio. Three vessels of the Shipping Police and one vessel of a local shipping company had on board a permanent fixed installation with different levels of equipment.

It was one of the challenges, the geographical situation in Grein, has show that this system is a useful complement to the traditional RADAR system. With the island Wörth dividing the river Danube into two small arms, it was possible to display vessels on the river which could not previously be seen via RADAR system.

6.3.3 Concepts

Due to the geographical profile of the Danube stretch the following concept was made:

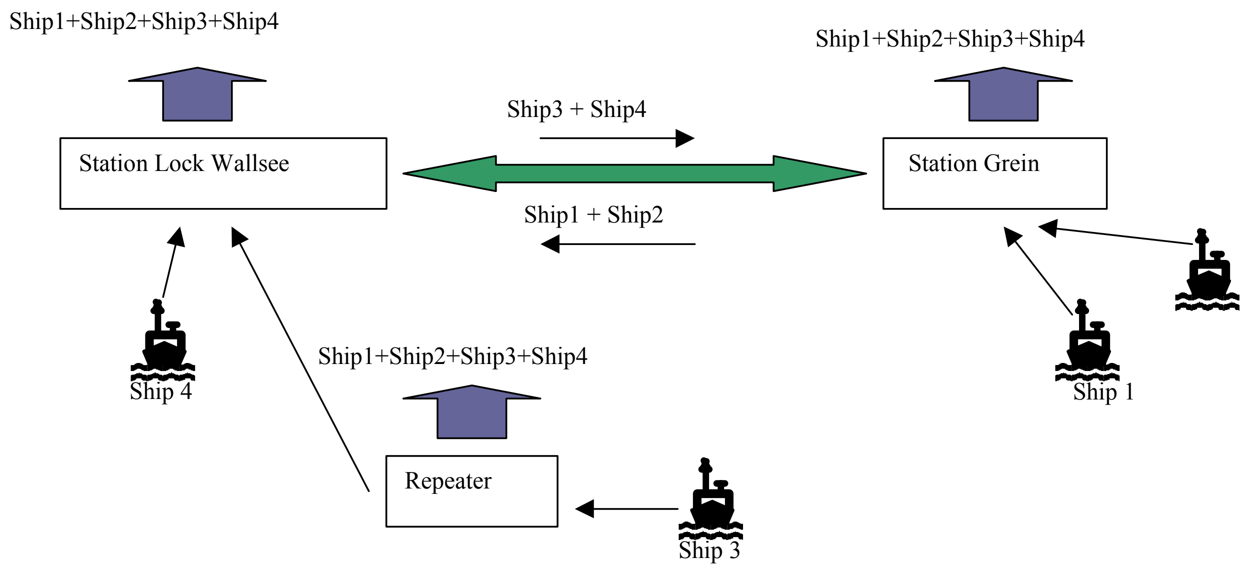

Figure 6.1: Danube demonstrator concept

In this diagram, the interchange of ship position data between the stations Grein, Wallsee and the repeater is depicted. The station in Grein receives the positions of the ships 1 and 2 directly and the positions of the ships 3 and 4 via the leased land line from the station Wallsee, so the traffic image contains all ships. The lock Wallsee receives the data from ship 4 directly, the data from ship 3 is received via the repeater and the position information of ship 1 and 2 are received from Grein over the leased landline. Please note that by this way all stations (mobile or fixed) are able to receive the positions of all stations.

The system components have been tested for several weeks to guarantee their proper operation.

6.3.5 Coverage

Another important point of interest was the evaluation of installation sites in the existing infrastructure.

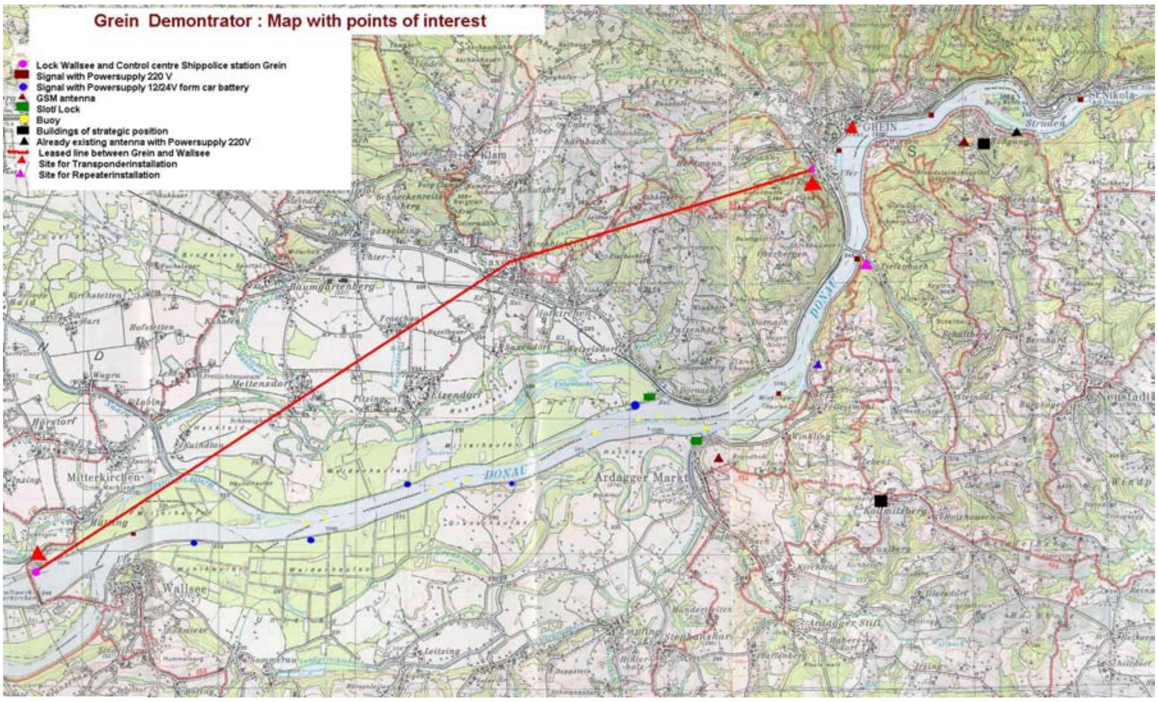

Figure 6.2: Grein Demonstrator – Map with points of interest

The results that are displayed in the chart above show the possible sites for the fixed stations as well as the site for the repeater. In this display the ISDN landline between Grein and Wallsee is drawn, because of the already existing ISDN boxes in both stations. Furthermore, the ships have been examined to ensure the installation the GPS and VHF antennas and the existing power supply facilities. At this stage of the project, the bridge of Tiefenbach near Grein was seen as biggest problem concerning the radio coverage. As a result of this, it was decided to mount the repeater onto the signal facilities at the bridge.

The next step was the evaluation of the radio coverage in this area. Test trials with handheld radios in the frequency band of 162.025 and 0 dB antennas have been held.

The results of these radio coverage tests in the Danube demonstrator area are:

- An area of high quality reception from the station Grein between St. Nicola and 200 metres in front of the harbour of Ardagger Markt (orange circle),
- An area of high quality coverage from the station Wallsee down to Mitterhaufen (orange circle)
- An area of high quality coverage from the Repeater at the bridge Tiefenbach near Grein between Grein and Ardagger Markt. (blue circle),
- An area of medium or less radio coverage between Ardagger Markt and Mitterhaufen,
- Due to this result it was decided to move the Repeater site from the bridge Tiefenbach to the slot at Winklinger Haufen (Green square at the southern shore in the red circle).

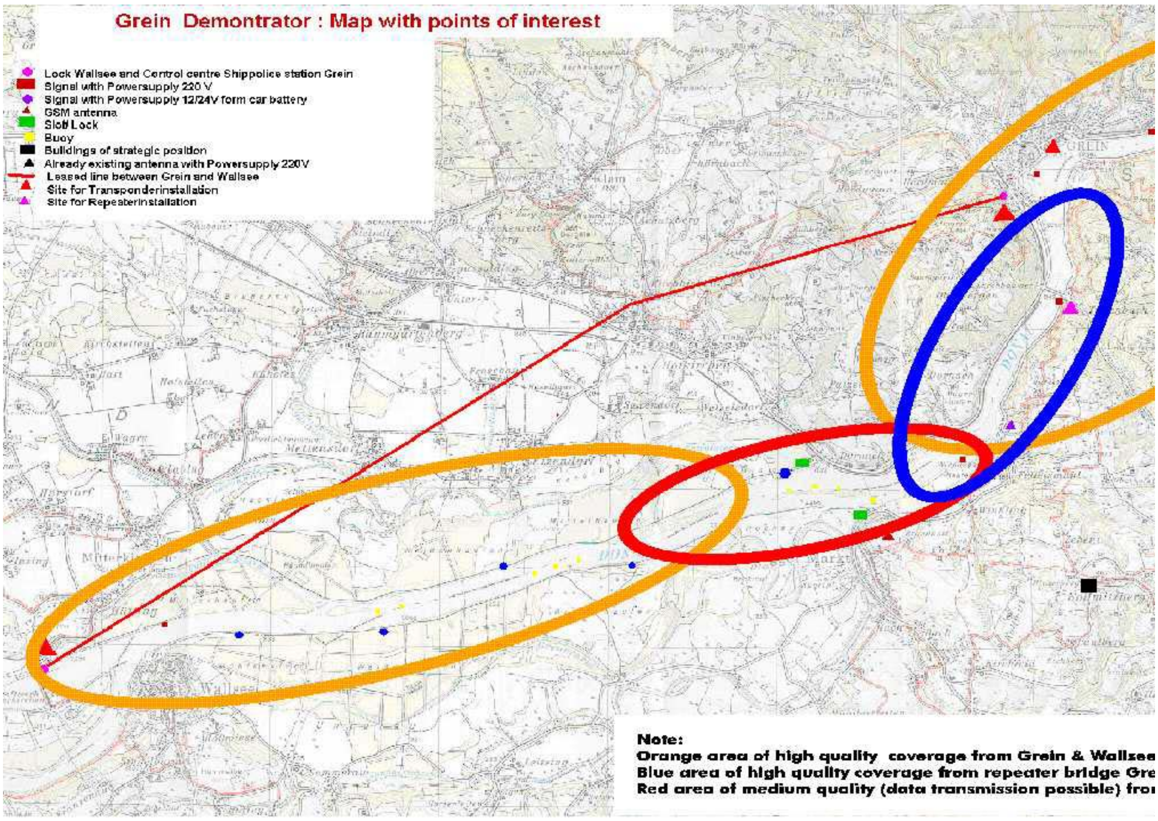

Figure 6.3: Grein Demonstrator – Map with points of interest II

6.3.6 Software development

By using an open system, in contrast to a proprietary system, it was necessary to design the interface of the Traffic Image software to the transponder network. It was required to build conversion software, which reads the data from a COM port and changes the data structure so the objects could be displayed by the Traffic Image software. This conversion software runs in the background and provides the ECDIS display over a TCP/IP connection (sockets) with the needed data. By using TCP/IP sockets it is possible not only to run one Display with one transponder, but also to run other displays with the conversion software. This implies that the Regional Centres could control the aspired National Control Centre. This procedure is expected to bring about the benefit of saving resources and budgets.

6.4 Preparation of the demonstrator concept

6.4.1 Overview

This work package defines the technical specifications of the hardware to be used on ship and on shore. This includes transponders, DGPS receivers, computers (servers, clients), network components, printers, antennas and all other hardware necessary to run the Danube demonstrator.

The vessels were equipped with different levels of equipment such as:

- Transponder (DGPS receiver included)
- PC / Laptop, transponder, VHS and GPS antennas
- Communication software

The Danube demonstrator is set up as a transponder based communication network that is hierarchically integrated in a wire based communication network on shore. The system will perform communication on five levels:

- ship to ship
- ship to shore
- shore to ship
- shore to regional office
- regional office to National Info Centre

The communication network is designed to support the following principles in data communication:

- ship-to-ship communication via transponders to exchange ships' ID and position
- ship-to-shore communication via transponders to exchange ships' ID and position
- ship-to-shore-to-ship communication via transponders to achieve short distance communication even without direct visibility
- ship-to-shore-to-control station to generate a tactical traffic image within the river segment
- shore-to-ship (emergency)

The system is configured as follows:

- Transponders (ship based and shore based)
- Ship based Display and data processing equipment
- Shore based display and data processing equipment
- Inland ECDIS of the segment of the Danube demonstrator

The following figure will give an overview of this concept for the Danube demonstrator.

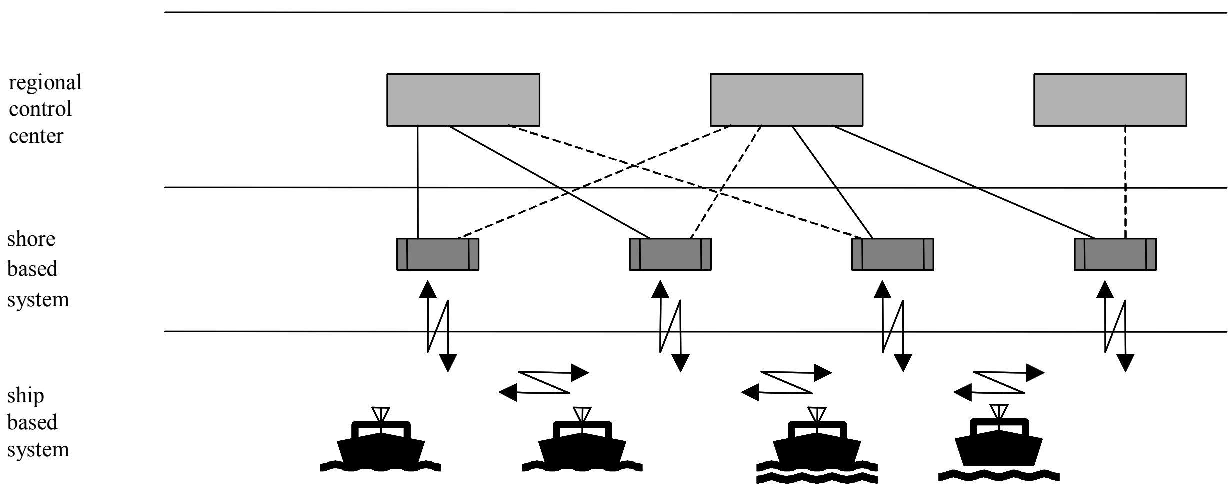

Figure 6.4: Danube demonstrator concept

6.5 Software

6.5.1 ECDIS

The preparation of an electronic chart of the river Danube is of vital interest for the whole project. Due to the safety relevant function of this information, it is necessary to provide a chart in standardised format that is maintained under the responsibility of the national administration. As far as Austria is concerned, two different authorities are involved: the Ministry of Economic Affairs (responsible for the maintenance of the fairway) and the Federal Ministry of Transport, Innovation and Technology (responsible for traffic management and safety of navigation).

The Danube demonstrator used the latest version of Inland ECDIS. The necessary work to incorporate Inland ECDIS into the system was performed as follows:

- Conversion of the existing digitised graphical charts to S57 files.
- Amendments with respect to Austrian shipping police regulations, particularly the specific rules for the 'Struden' section.
- Down loading of the Inland ECDIS software into the system with interfaces to on board and shore based systems.
- Definition of procedures for maintaining and updating of Inland ECDIS data of the Austrian Danube.

The publication 'Inland ECDIS Data and Presentation Standard' describes the standard to be used for the exchange of digital hydrographic data between national inland waterway authorities and users. This standard is intended to be used for the supply of Inland ECDIS data. The Inland ECDIS Harmonisation Group of the European Commission, DG VII, and Concerted Action on Inland Navigation prepared the 'Inland ECDIS Data and Presentation Standard'.

The standard was adopted by the national inland waterway administrations of the Netherlands, Germany and Austria. This standard describes the necessary amendments to S-57 and S-52 and the application of both standards for the purpose of use in Inland ECDIS applications.

SevenCs was successful to develop a first prototype version of conversion software that imports source data in Intergraph-format and converts this data into 'raw' Inland ECDIS data. The Wasser- und Schiffahrtsdirektion (WSD), Vienna and Oberste Schiffahrtsbehörde (OSB) in Vienna have supplied the source data. Using this converter software together with existing Inland ECDIS production and maintenance tools (SevenCs ENC Tools) SevenCs produced Inland ECDIS data covering the demonstrator areas.

Additionally, SevenCs supplied software to display AIS-targets together with Inland ECDIS data. This software was used for testing/ demonstration purposes and to simulate the communication between AIS fitted vessels and shore based systems. SevenC's supported Alcatel to integrate this software.

6.5.2 BICS

The BICS software enables a skipper to define and notify all vessel-related data like vessel's name, cargo, starting and arrival point of his voyage etc. These data sets were stored in a database in a central mail server. The communication uses EDI messages, e- mail messages and for the physical layer a connection over GSM modems.

The most recent BICS software release needed to be adapted to the Austrian requirements. This procedure implies a close co-operation with the Dutch and Austrian authorities. The BMVIT will be responsible for this issue. Alcatel has performed the system integration to the Danube demonstrator.
The electronic reporting is based on the present operation of BICS. The following amendments will be made and added:

- Fairway information (BMVIT)
- Inclusion of the navigation plan
- Inclusion of a translation module that changes the input screens to the chosen language
- Check if the reporting standards are in line with the provisional European standard.

6.6 Execution of the demonstrator

6.6.1 Objectives

The objectives of the Danube Demonstrator are as follows:

- Demonstrate the use of a TTI on board and in shore stations
- Demonstrate the use of a STI to shore stations
- Demonstrate the use of a FIS on board
- Demonstrate the use of agreed standards for all kind of communication
- Demonstrate the use of provisional agreed electronic reporting formats
- Demonstrate the provisional agreed inland ECDIS standards for all kind of traffic images

6.6.2 Test site

The test area was situated on the Danube stretch between the lock of Wallsee / Mitterkirchen downstream, through the Strudengau, passing Grein and the island of Wörth, to St. Nikola.
The decision to build up the demonstrator in this stretch was mainly affected by the ambition to prove the feasibility of the system in a very demanding geographical environment with narrow riverbanks, accompanied by high hills on both sides of the river, a bridge and an island. Especially the section between Ardagger and St. Nikola shows difficult navigable water given the look-ahead conditions, which requires an excellent performance of the communication system. The technical challenge there is the reach of the radio waves as well as the accuracy of the DGPS positioning within the TTI.

6.6.3 Site preparation.

The demonstration was held on board of the passenger ship Ostarrichi. The other vessels (mainly the water police patrol vessels) had the order to manoeuvre around the

Ostarrichi to demonstrate the operability and feasibility of the system. Presentations were held on board to describe the features and particulars of the concept.

Figure 6.5: Overview of the demonstrator vessel “Ostarrichi”

6.6.4 Overview of demonstrations

The following user groups were invited to the demonstrations:
- Project management
- INDRIS consortium
- European Commission representatives
- Austrian authorities
- Representatives of skippers, ports, fire brigades, lock operators, calamity abatement organisation, expert of transport organisation, ecology groups and shippers of several Danube countries
- National and international policy makers

The following activities were included:
- Presentations to national and international authorities and bodies,
- Information and press releases to national and international press and news agencies,
- National and international interviews in TV and radio stations.

Besides these activities it is worth mentioning that the APA (Austrian Press Agency) and the ORF (Austrian Broadcast) attended the demonstration.

6.7 Discussion and Conclusions

6.7.1 Discussion

The predefined goals of the demonstration have been fully achieved and led to a successful demonstrator.

The presentations highlighted the following successful issues:
- The introduction of Inland ECDIS on the Danube as well as the details of the Inland ECDIS standards.

- The introduction of the overall electronic reporting and the electronic Notices to Skippers on the Danube.
- The benefits of supplying information to other inland navigation bodies and institutions.

The Danube RIS demonstrator provided convincing evidence that to a large, extent a system like this can fully meet the needs of inland navigation and related fields of business. The role of the AIS transponders appears to be essential, as a state of the art technological device for high technological communication systems. It could also be concluded that TTI's and a STI and the indispensable connection to the Danube power plant and lock companies played a large role in the successful completion of the demonstrator. A system like this, when enhanced with future modifications and extensions, is the beginning of a new, prosperous and effective development in inland navigation, using all exciting possibilities of modern technology and offering chances for good profit making. The demonstrated system implies environment-protecting modes of application.

6.7.2 Conclusions

The following conclusions are drawn:

- The Danube demonstrator had shown that it is possible to implement a system with the required accuracy and is not based to a single system supplier. This is one step into the right direction in-line with the basic ideas of the INDRIS project to define and build up a system that can be employed in every country of the European Community.
- The operational benefits of RIS for authorities and private users are proven. Example is the broad interest and enthusiasm to use the system from the commercial side (Logistic service providers, skippers and shippers) and from the shipping authorities.
- Approximately 200 persons attended the two days demonstration. Most of the attendees expressed appreciation to the high technical quality of the Danube demonstrator.
- The nautical demonstration, together with technical papers proved that future installations of River Information Services on the European inland waterway would help to increase nautical safety to a large extent.
- Beside nautical aspects, the commercial advantages of a River Information Service, such as time and fuel saving together with improved management of all kind of resources related to inland navigation, were highly appreciated.

7 FLEMISH DEMONSTRATOR

7.1 Introduction

The creation of an inland platform in Flanders is based on the desire to stimulate inland navigation in Flanders as a competitive alternative to road transport. The IBIS platform is designed to create safety on the inland fairway network by providing information to skippers, whilst in a central place the traffic flows will be monitored.
The tour de role has disappeared as a result of a European directive. BIVAS, a platform where parties can exchange information regarding supply and demand for the transportation of goods using the inland waterway net was created. On an Internet web site, announcements of cargo to be transported can be inserted in a central database. Using mobile communication facilities skippers are informed about these business opportunities. By means of mobile communication skippers can also announce ship capacity in a central database, which can be consulted on-line by the industry or loading companies on the web site. In this way an information system about supply and demand of cargo transport capacity is established.

Because the skippers are obliged to use mobile communication, the application on board is based on JAVA technology. Hence the communication costs are minimised. By using JAVA technology, a copy of the information from ship and skipper available on the central database is also stored on board. To avoid synchronisation problems the skipper has to send the information to the server, every time he makes changes. The changed information is saved on board as well as on the server. The skipper is also able to mark his interests in certain cargo-offers. He will get a Short Message Service (SMS) message on his mobile telephone, if the status of the marked cargo-offers is changed by the industry. The JAVA applet, developed for the industry on the Internet, guarantees an up-to-date and on-line information system without any investments or subscription-costs. The cargo-offer applet on the Internet can be used in different ways such as: between industry and skipper, between co-operations and skippers or between industry and stevedoring companies. When parties are brought together by this pre-contract system, they might negotiate about the price of the transport facilities rendered.

In short, BIVAS is meant to become a platform where information on the demand of ship capacity is stored and depicted on request of skippers. BIVAS is an information system regarding commercial aspects of inland navigation, without being a commercial system itself. This is similar to the measures being taken by the French Administration, such as the electronic bourse. This application is seen as part of the STI.
IBIS can be seen according to the RIS definitions as a Strategic Traffic Image on shore. The focal point of the system is the database with the co-ordinates of the vessels. Their destinations and cargoes are also known from information provided by the locks. Especially dangerous cargo can be followed in the fairway network. A GIS application is made to show the positions of the vessels in the network. For vessels not equipped with GPS, ETA's may be calculated on the basis of the information of the locks.
The infrastructure between shore and the ships is used to provide fairway and water level information. This is, in RIS terms, a FIS application.

It is of importance that standards that are developed in RIS are maintained. Consequently, the GSM standards and data exchange standards as well as the RIS guidelines are important.

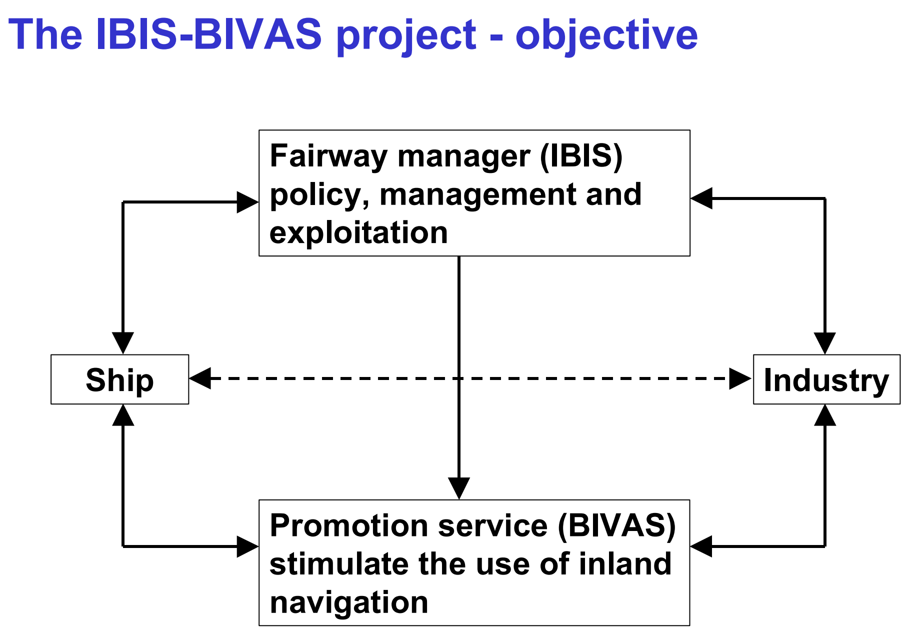

Figure 7.1: Overview of the relations between IBIS and BIVAS.

7.2 IBIS

The IBIS system was a result of an initiative of the Federal Ministry of Public Works. This initiative was to improve the use of the waterway network in Belgium and to start improved competition with road haulage. A system that was developed according to this initiative should collect data on traffic, it should issue permits to use the canals and fairways and the canal dues need to be paid. Another issue addressed should be statistics in order to provide numerical material for policymaking.
The Flemish Administration developed IBIS. The Wallonian Administration developed GINA (Gestion Informatisée de la Navigation). The functionality of IBIS was expanded by the inclusion of a follow-up system for ships.
The IBIS system has a number of interesting features:

1. Pre-notification
2. Creation of a new voyage
3. Calculation of the tariff connected to the permit
4. Summaries
5. Permits

1. The pre notification is a message from the central server to a lock. Such a pre notification indicates which vessels are expected according to the lists made by the central database. An example is shown below.

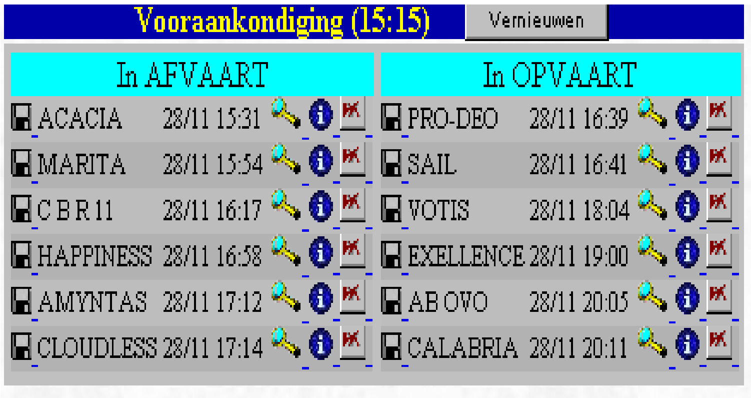

Figure 7.2: Pre-notification list

2. Filling in an electronic form creates a new voyage. It uses the standard ship information such as ID, name and certificate number. The berth of departure and the berth of arrival are also inserted as well as particulars of the cargo according to the manifest. Using the information of the voyage the optimal route will be shown. This document will be send to the central database using GSM.

3. The canal dues are calculated as a function of covered distance the tonnage of the vessel and the weight of the cargo transported. The way of payment is also indicated. An example of such a calculation is given in the following figure.

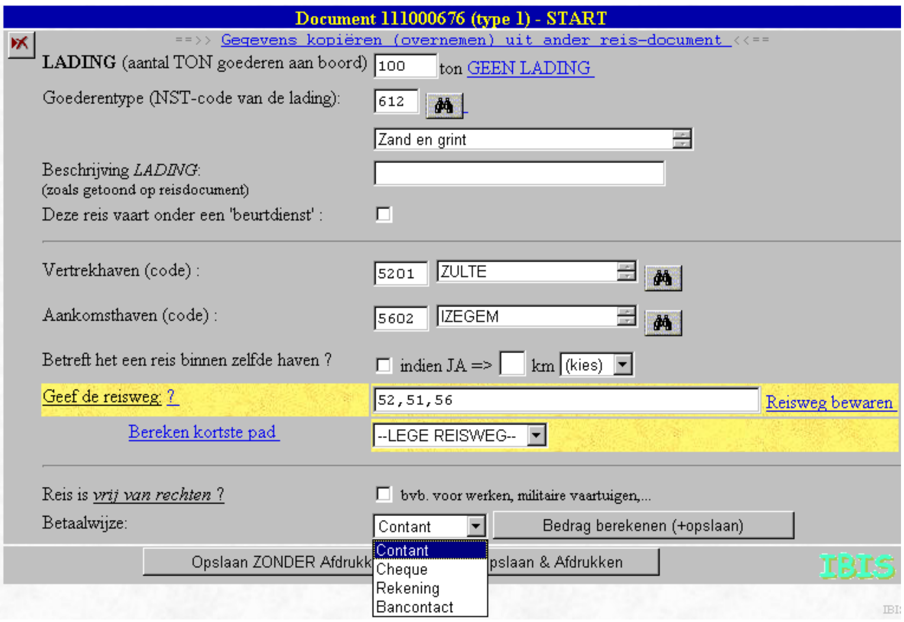

Figure 7.3: Calculation sheet

4. A summary is made of the calculations and the optimal route to be followed. The summary contains the name of the vessel and shows the name of the skipper. It summarises the cargo and the route to be followed. The distance covered is also shown as well as the part of the route where no canal dues are applicable. The distance where canal dues are applicable is shown as well as the berth of departure and the berth of destination. The canal dues are also indicated.

5. A permit is send to the skipper. This permit also indicates the amount due. Since law demands this permit the appearance of the permit is as the law prescribes.

The central database has facilities to provide an overview of the traffic densities on the different parts of the Flemish Waterway network. Displays are available for:

- total number of vessels,
- number of vessels carrying dangerous goods
- number of empty vessels
- total tonnage of cargo in transit
- total tonnage of dangerous cargo in transit

It is also possible to produce statistical overviews over defined intervals of time. These overviews indicate the importance of the different fairways and their use. They will enable policymakers to initiate new infra-structural plans, improvements of the fairways.

IBIS is also able to show static information regarding opening times of bridges and service times of locks.
Overviews of locks are also provided; these overviews contain the number of vessels passed as well as the tonnage transported by these vessels. Those overviews also contain the canal dues that have been paid. The same overviews can be made for canals, but also intensities at a given point in time can be provided.
Skippers need data on water levels. Depths of rivers are also important to determine water levels. Overviews can be provided with water levels and depths. They are measured using a sensor system with central database where all data are stored. They can be retrieved using Internet technology. On request water levels can be depicted as Time graphs over the last period of time.

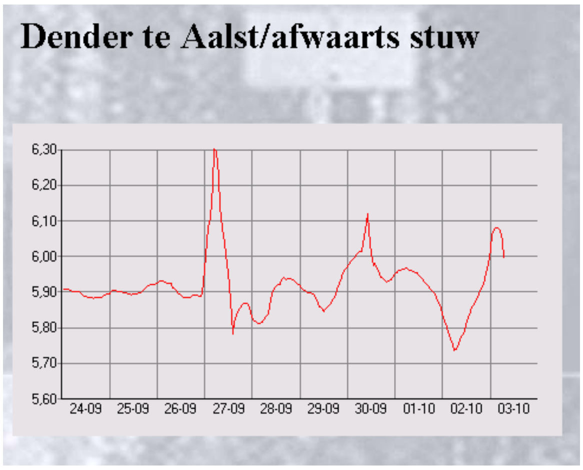

Figure 7.4: Overview of water levels

Notices to Skippers are also fed into the central database for easy retrieval by skippers. The Notices have geographical pointers. It is now possible to find Notices to Skippers for a specific area or fairway. It is also possible to prescribe to an E-mail service that produces Notices to Skippers for the entire area or for a specified part.

7.3 BIVAS

BIVAS may be seen as a turning point in inland navigation. The tour de role has been phased out and another approach was badly needed. Modern telecommunication and electronic data provided a solution to replace the tour de role. BIVAS will match demand and supply of cargo. As a result it is expected that more traffic using the inland fairway network will be generated. BIVAS doesn't replace the tour de role. Negotiations regarding the price to be paid for the services are not a part of BIVAS. These negotiations will take place between the cargo owner and the transport company i.e. the skipper of the vessel. The BIVAS-system was introduced in 1997 and in 1999 a new release was put in the market with a number of improvements. The essential parts of the BIVAS system are:

- Communication between skipper and database uses the IP protocol of Internet.
- The on board application is written in Java. This reduces communication costs since the application is down loaded in the computer's memory.
- The skipper can access cargo proposals on the server. This improves the first release where GSM reception was bad and data disappeared.
- The cargo owner will have an overview of all vessels that are able to transport the cargo. In the first release only suitable vessels obtained the request but the cargo owner was not aware of all vessels that were suitable.
- The input of cargo by the cargo owners is fast since the application also uses Java.

7.4 Execution of demonstrator

On 2nd December 1999, the representation of the Flemish demonstrator in "the Harbour house" in Antwerp took place.

The Government spokesman of the Minister Vice President, Flemish Minister of Mobility, Public Works and Energy indicated the importance of the Flemish inland navigation and stated that the Flemish Government took initiatives to attract new transports to the waterway, like for instance ships transporting waste.

The different functions of IBIS and BIVAS were also demonstrated.

Great interest is generated. All sectors related to the inland navigation were present, among them: administrations, port industries, skippers, lock keepers, ship owners, shippers, promotion services for inland navigation, suppliers (software and hardware) and the press.

7.5 Conclusions

The Flemish Demonstrator showed clearly the possibilities of River Information Services.

Furthermore, the developments met the assumed European standards. The introduction of telematics is an expression of the recovered dynamics of inland navigation.
In combination with the wireless communication, the switch to electronic data and information has created the opportunity for a real change to take place.
A very important result of INDRIS is the fact that for the first time, so many different countries have positively worked together in the field of inland navigation services and INDRIS has inspired a further future co-operation.

8 SEINE DEMONSTRATOR

8.1 Introduction

This chapter describes the prototype of a Fairway Information System that VNF, within the frame of the INDRIS project, has implemented.

The objectives of the RIS demonstrator in France are twofold:
- Demonstrate the feasibility of the VNF 2000 system and related applications,
- Assess the usefulness and quality of services rendered by the system.

8.1.1 River Seine main characteristics

The stretch of the River Seine the project actually addresses runs from the port of Le Havre to Montereau a port located 100 km upstream Paris. This stretch has a length of approximately 460 km.

It is accessible to vessels up to 4500 T. The traffic density is in average 35 vessels per day between Rouen and Paris with peaks reaching up to 60 vessels per day. Gennevilliers near Paris is the main port on the river. It handles annually a flow of goods exceeding 20 Mtons.

8.1.2 VNF and RIS

In the 1990 VNF took the initiative to implement a kind of Fairway Information Service called VNF Minitel. Through the French dedicated telephone network, the so-called Minitel, users could receive relevant information extracted from a VNF central database. Users are able to retrieve the following information:

- Freight offer
- Commercial conditions of the transport contract
- Status of the inland waterway network, including waiting times and opening hours of locks
- Regulations including those applicable to dangerous goods
- Critical events

On the 1st of January 2000 the "tour de rôle" has completely disappeared in France as a result of a European directive. Furthermore, it appears that the Minitel service is not easily accessible to foreign users.
This combined with internal motivations, VNF has decided to completely re-structure the existing database that was used. The new system is known as VNF 2000.

Therefore, VNF considers the INDRIS project as an opportunity to promote new information services enabling any European inland waterway user to retrieve via Internet pertinent information from the new structured database.

Furthermore the new VNF 2000 database is capable to receive and store the information provided by users. Additionally the system is interfaced to the BICS[8] reporting system.

8.2 Demonstrator System

8.2.1 Information Content

The information that the VNF prototype will display to users by means of an adequate number of windows and screens, is divided into two categories:

- Status of the inland waterway network,
- Transport capacity and supply.

The information exchange in the VNF 2000 is categorised as defined in the functional specification of RIS (see WP 6).

The following conclusions are drawn:

- VNF 2000 is restricted to information supply on the level of FIS.
- The project has not considered the possibility to make use of standardised ECDIS information.
- Finally, even if the Seine may be navigated by a number of seagoing, it is not yet envisaged to introduce AIS (Automatic Identification Systems) on French inland waterways.

8.2.2 Information quality

The national authorities provide the information related to the status of the inland waterway network. These authorities are in charge of the exploitation of the inland waterway infrastructure. Such information is currently distributed by the administration in the form of Notices to Skippers (avis à la batellerie). The information is checked and verified under the responsibility of the administration. Therefore the information items referred back hereto will be validated and should be considered as certified.

The data items related to the transport demand and supply include:

- Data related to the ships' descriptions. They are in principle stored in ships' directory. The corresponding data items are those prescribed by the Central Commission for the Navigation on the River Rhine. They will be coded according to the BICS system format. The BICS ships directory is managed at national level by inland waterway authorities. Corresponding data are to be considered as certified. The system will allow the exchange of information on vessels between national authorities.
- Other data related to transport offer and data related to transport demand. Such data are commercial in nature. As soon as the system "tour de rôle" has disappeared (as per 1st January 2000), the administration will not control such type of information. Transport demand information will therefore not be certified. They may be subject to errors. However, in most cases the inland waterway authorities are informed through the voyage declaration of the date when the voyage terminates. This date indicates the moment that the ship is in principle available for a new transport operation, so that very often the inland waterway authority can verify the information on ships' availability.

According to the French regulations, every skipper undertaking a voyage in the French inland waterways has to fill in a voyage declaration. The information contained in the declaration serves as a basis for levying the fees corresponding to the

use of the rivers/canals. The skipper prior to the departure must fill in the declaration. It must be delivered to the authorities. In practice, the authorities are the lock operators who are entitled to receive the declaration and to check the correctness of the information contained herein.
The on-board equipment provided by VNF in the frame of the demonstration will allow the skipper to fill in and print the declaration using his computer on board.

8.3 Demonstrator Infrastructure

The system tested during the demonstration is composed of three elements:

- a server owned and managed by VNF,
- a telecommunication network,
- pieces of equipment on board vessels.

For the purpose of the demonstration a prototype of a VNF web site has been developed and implemented.

It is VNF's intention to link the server in its current configuration to the new database.

Information to be fed into the server web site will come from various sources and in different ways depending on the type of data items concerned:

- With regard to the status of the inland waterway network data, items are those established by the inland waterway authorities and stored in the currently operational database.
- With respect to cargo transport and when appropriate the transport costs and conditions, data will be simulated taking into account data stored in the existing VNF database or in the freight offices. Users will also be able to input simulated or real data in the web site when connected through Internet to the server.
- With respect to data related to ships use: they will be made of data extracted from the VNF ship directory updated as the case will be by the data received from the Netherlands. To this end a BICS translator has been installed.

Technically, two points deserve to be mentioned:

- Experience is lacking concerning delays in establishing connections with the server. The demonstration will aim in particular to gather data on this issue.
- The demonstration will provide the opportunity to extend to France the use of the BICS system[9]. BICS is based on EDIFACT standards. Although in the case of the Seine demonstration there will be no difficulty to process the BICS EDIFACT messages, the demonstration may lead to analyse how to meet in the future further requirements for interoperability of applications and confidentiality protection.

Ships willing to use the VNF 2000 system should be equipped on-board with the following minimum configuration:

- standard PC computer with a standard screen,
- modem including a GSM card,
- printer.

The on-board equipment are able to display the information in the three languages used within Europe, i.e. Dutch, German and French.

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[9] A description of BICS is given in paragraph 8 in the final report of INDRIS Work Package 1.

8.4 Organisation of the demonstrator

From a general point of view, VNF considers the demonstration as an opportunity to provide users of the French inland waterway system with evidence of its willingness to promote information services through INTERNET.

On the other hand and as far as the INDRIS project, VNF thinks it is essential to obtain users reactions on the services provided by the prototype presented even if:

- Only a part of INDRIS functions will be present in the prototype
- Data handled by the demonstrator are partly simulated.

In addition the representative of DG VII, and of all members of the INDRIS consortium the following were invited.

- French Ministry for Transport : Inland Transport Direction (Direction des Transports Terrestres), Sea Ports and Transport Direction (Direction des Transports Maritimes, des Ports et du Littoral),
- French inland shipping companies: national federation (Comité des Armateurs Fluviaux) and main shipping companies (C.F.T., Touax, C.F.N.R, Morillon-Corvol and Compagnie des Sablières de la Seine),
- French barge owners: national federation (Chambre Nationale de la Batellerie Artisanale),
- French inland ports: national federation (Association Française des Ports Intérieurs),
- Freight forwarders : national federation (Chambre Syndicale Nationale des Courtiers de Fret Fluviaux),
- Shippers: national federation (Association des Usagers de Transport de Fret) and important shippers; users and non-users of inland waterways,
- VNF: head office and V.N.F. local services mainly concerned with transportation (Lille, Lyon, Nancy, Paris, Rouen and Strasbourg).

The number of potential participants was 70.

8.5 Conclusions

8.5.1 VNF conclusions

In VNF views, the demonstration on the River Seine of a prototype of a client-server system providing information on:

- the status of the inland waterway network and,
- the transport demand and offer have

positively contributed to the promotion over Europe of information services enabling a better use of the inland waterway infrastructure.

The Seine demonstration project covers a subset of functions that from a general standpoint would respond to demands expressed by the users of the River Seine.

8.5.2 Conclusions from the transport industry and potential users

VNF received a significant number of comments. These comments originated from shippers, ship owners, skippers and local authorities. The port of Lille indicated their interest in information of vessel positions in real time, including ETA's and ATD's at locks. A shipping company places emphasis on the general concern that Internet communication may not guarantee the confidentiality of the information exchanged. This issue should be addressed with more depth.

Representatives of the powerful French shippers organisation AUTF have stated that they have a keen interest in:

- Strategic information on shore
- Vessels directories
- Navigation plans
- Transport declarations

However the shipper's organisation raised their concern regarding the relationship between public agencies and private companies in setting up commercial services aiming at:

- Electronic bourse and,
- Support of barge planning

It is believed that French users, based on their encouraging responses, are in favour of RIS developments. Basic issues such as protection of confidentiality of commercial information and the organisation of the co-operation between public and private parties should be carefully addressed when RIS will be further developed and implemented to form a successful system.

9 RHINE-SCHELDT DEMONSTRATOR

9.1 Introduction

9.1.1 RIS functions embedded in the Rhine-Scheldt demonstrator

The Rhine-Scheldt demonstrator objective is to show a number of applications in order to present a fairly complete overview of the RIS concept and its standards.

As defined in work package 6 the following functions will be demonstrated:

- Vessel traffic management
- Lock planning
- Navigation (Tactical Traffic Image)
- Voyage-planning and monitoring
- Logistic applications
- Incident abatement

The interrelation between the different functions is given in the following process diagram:

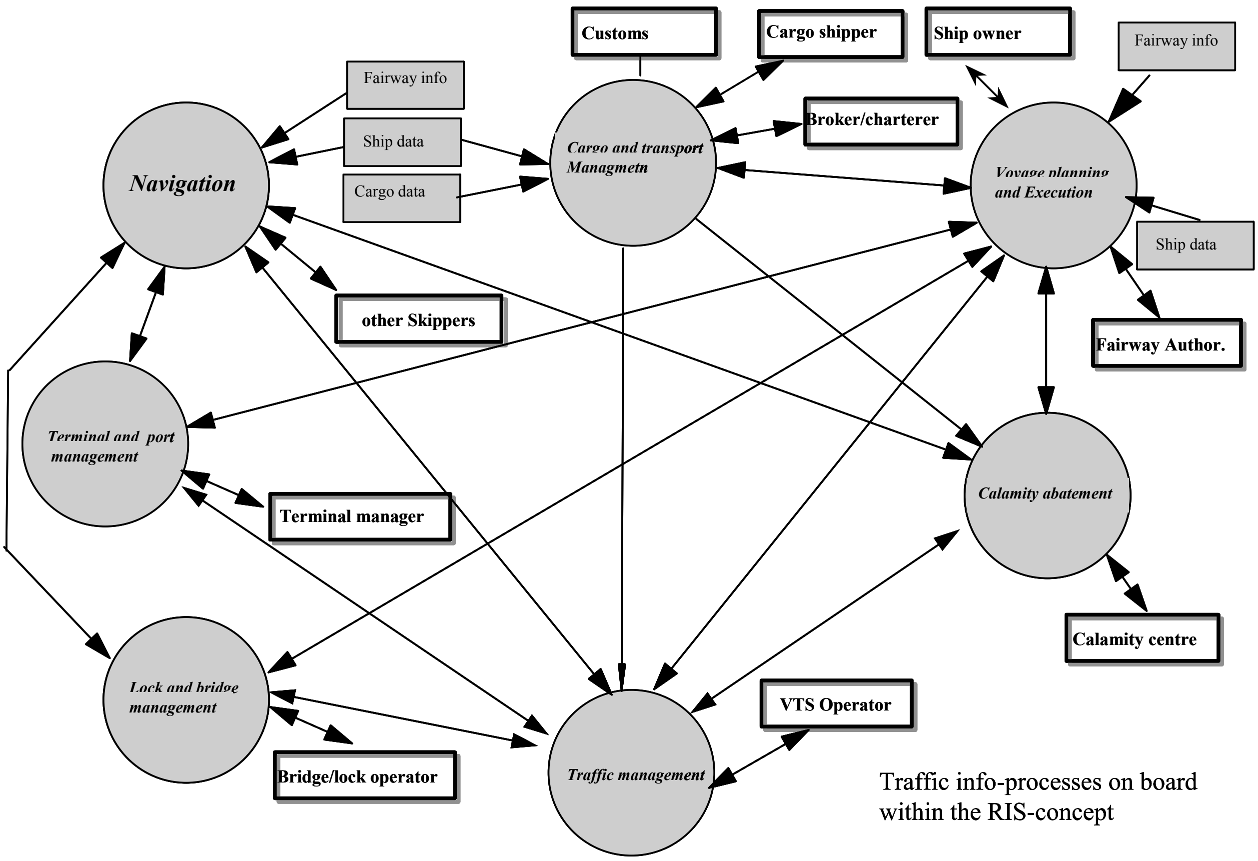


Figure 9.1: Overview of to be demonstrated functions

The Rhine-Scheldt Demonstrator will address example applications to be demonstrated and assessed.

9.2 Demonstration System and Applications

9.2.1 Inland ECDIS

As one of the main elements in the Rhine-Scheldt demonstrator, ENC's have been developed for parts of the river Rhine in the Netherlands and in Germany[10]. This also applies for the connections from the Rhine to the Scheldt at Hansweert and near Antwerp.
The ENC's are used during the demonstrator for tactical purposes (small scale ENC) and for strategic purposes (large scale ENC). The (large and small scale) ENC's meant here is the presentation of the underlying database that describes the geography as well as the different objects along the inland waterways.

The following criteria have been taken into account:

- A data model should be developed that contains all information required for safe navigation. The data model should include and encompass descriptions of the fairway characteristics.
- The data structure should be according the Inland ECDIS object describing and information exchanging formats standard. This is required for easy updating of data in the database.

The following activities have been carried out:

- An investigation of the required data in the database based on the catalogue of desired objects and their attributes.
- An investigation of the availability of these data using the existing databases.
- Development of conversion routines to translate existing formats to the required formats
- The delivery of ENC's for the different applications.
- An investigation into the organisation of automatic updates to the database both on board and on shore

9.2.1.1 Geographic data

DTF (Digital Topographic Format) files are available for the river Waal and some other parts of the main fairway routes. The accuracy of this information is much better than needed: about 0.2 metres. The data is provided in ARCINFO format. Because of coverage restrictions in the Netherlands, these data have not converted to ENC format.
Topographic files (1:10000) are available for the whole Dutch RIS area in ARCINFO.

9.2.1.2 Object Information

The following remarks are important to understand the difficulties involved in the transition of existing data to ECDIS data.

[10] The latter ENC's have been produced under the umbrella of the project ARGO. Between the project ARGO and INDRIS a co-operation on the level of the Ministries of Tranport in both countries is established. This co-operation led to the use of ENC's in the test phases of both projects.

1. The Dutch VIN (database of inland fairway characteristics in the Netherlands) contains most of the object information that needs to be converted in to the ENC. Part of the information however, has been converted manually. In addition inconsistencies with regard to the positioning (especially on an ENC network level) of the information into ENC format has to be solved.
2. The Vaarweg Markerings Dienst (Marine Marking Service) of the Directorate General of Freight of the Ministry of Transport delivered data for the maritime areas of Rotterdam-Dordrecht and Zeeland.
3. The port of Rotterdam has delivered fairway data of the Rotterdam basins and the Nieuwe Waterweg (New Waterway). The data are stored in AutoCAD 14 format.
4. Local directorates of the Ministry of Transport in the Netherlands have provided additional information on fairway characteristics. This information is obtained by visual observation. This was due to the lack of database-information and/or accuracy-problems.
5. For strategic applications the UN-location-codes (harmonised codes for harbours, terminals and other relevant waypoints) has been added to the ENC's as well as information on lock-details and bridges.
6. Water levels and depth contours, to present the available fairway-width, have been restricted to a local demonstration in the area of Dordrecht. This is due to the division of responsibility of depth information and the dissemination of this information among the Districts of Rijkswaterstaat in the Netherlands. In the German ENC's of the Rhine, depth contours are included.

9.2.1.3 Resulting ENC's

The German authorities delivered ENC's of the project ARGO, for parts of the German Rhine to be used by this demonstrator. During the INDRIS project there has been a strong co-operation between both projects with regard to the definition of inland ECDIS standardisation.

In the following figure the available ENC-areas are presented with a blown up example of the ENC of the Millingen area.

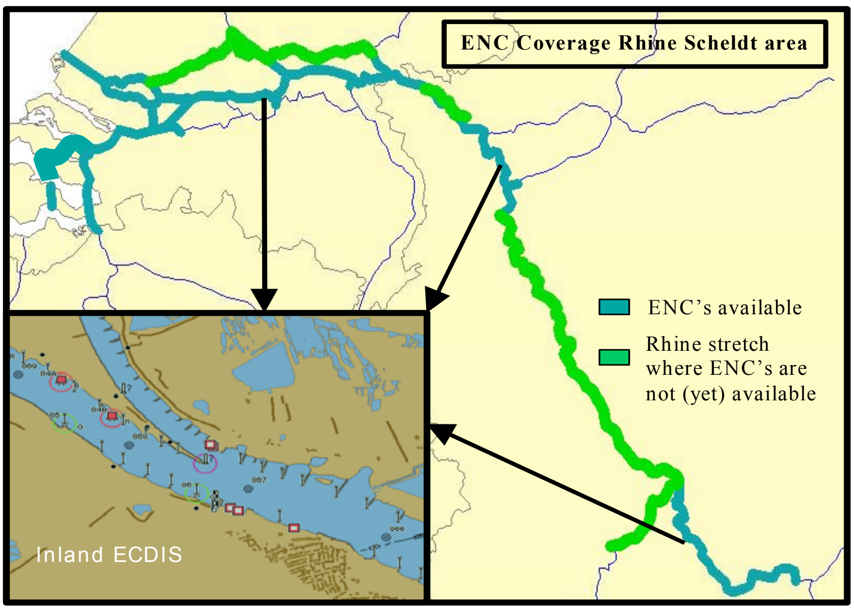


Figure 9.2: Overview of areas with ENC coverage

9.2.1.4 Responsibilities

In the preparation phase, discussions started with regard to the question of the Governmental-responsibility for supplying data to private users. The supply of data (e.g. on depth-contours and water levels) in the near future requires the establishment of a maintenance organisation. The required accuracy of the data and update frequencies of data as well as a clear definition on the responsibility on the use of that data needs to be agreed upon between users and data-suppliers.

9.2.1.5 Update mechanisms

In the Rhine-Scheldt demonstrator the update mechanism using GSM as a communication means, has been successfully shown during the month of May 2000 in Dordrecht as well as during the calamity demonstrator in Millingen.

9.2.2 Inland AIS

The RIS-AIS network is defined as an integrated network of AIS Base stations and mobile stations.

The AIS network for the INDRIS Rhine Scheldt demonstrator consist of:

- Two base stations, situated at the VTS centres in Dordrecht and Nijmegen, with
    - INDRIS Vessel Traffic Management system in VTS centre Nijmegen for a local view of the traffic area of Millingen[11]
    - INDRIS Vessel Traffic Management system in Dordrecht creating a local overview of the traffic
- Transmission link between Nijmegen and Dordrecht for the presentation of the traffic area between Millingen and Dordrecht. This is presented in the VTS Dordrecht creating a combined overview of the traffic areas. This VTS serves as a RIS centre.
- Nine (9) Base stations at different places along the Rhine on the route Rotterdam-Germany. This creates a Strategic Traffic Image, from the Rhine at the German border up to Rotterdam and Hook of Holland
- AIS mobile units integrated with on board INDRIS-applications[12].

9.2.2.1 Primary Functional Specifications

The requirements were set up as follows:

1. All AISs of the RIS AIS network have to comply fully with the “Standards for Tactical Data Exchange, Communication and Messages”
2. The AISs have to operate in autonomous mode
3. DGPS corrections have to be integrated in ship’s based AIS.
4. In the area of Millingen of VTS Nijmegen and at VTS Dordrecht the radar tracks of non AIS-vessels shall be transmitted via AIS by the shore station in the autonomous mode (as a part of the VTM application)

[11] radar tracks and AIS tracks are presented on an ECDIS overlay

[12] The AIS is interfaced with the traffic image on board presentation of ECDIS, radar and AIS information and with a voyage planning module (restricted to own ship’s position)

5. Presentation of the AIS information must be possible in different ways:
    - Presentation of the actual traffic situation on network level as well as on local level. The information has to be presented geographically on an ENC of the waterway-network.
    - Presentation of historical traffic information (vessels and cargo characteristics included) must be possible on the basis of:
        - the voyage of an individual AIS-vessel
        - time interval for all or a part of the AIS-vessels

In the next figure a schematic overview is given for the RIS-AIS network coverage along the river Rhine in the Netherlands

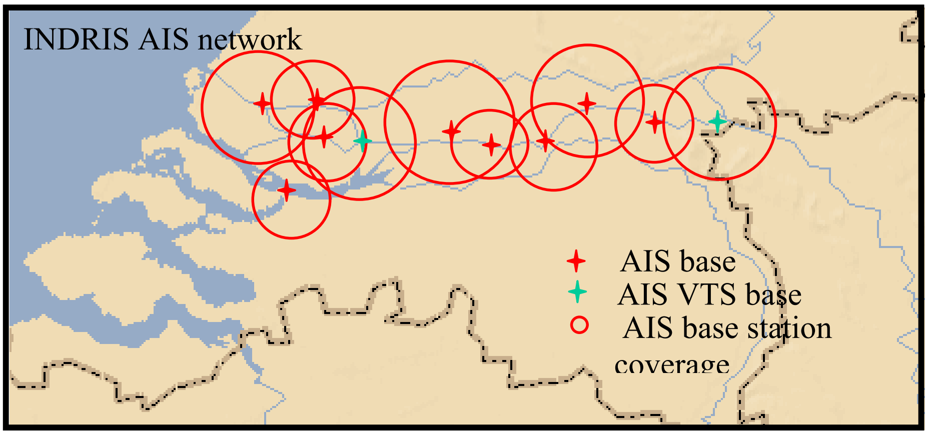


Figure 9.3: Overview of the AIS network coverage.

9.2.2.2 Inland AIS standards

During the preparation phase of the INDRIS demonstrator the following deviations from specification of the inland AIS standard as defined in WP 3 has been identified.

- The chosen solutions are as close as possible to the WP 3 standard and the preliminary AIS standard described ITU-R M.1371 Technical Characteristics for a Universal Ship-borne Automatic Identification System.
- The additionally required functionality for use of AIS in Inland Waterway applications were identified as application specific and therefore included in the presentation part of AIS.

The deviations are:

- Using binary broadcast message for communication of Non-AIS targets from shore to ship instead of AIS position report messages 1, 2 and 3 with indication of source of origin. Incorporating the non-AIS tracks in the inland AIS standards has not been defined in details, in 1999 in WP 3 and in the Technical Characteristics for a Universal Ship-borne Automatic Identification System.
  Enhancements of binary broadcast message in order to accommodate the sub-message VTS Surveillance Footprint [13] for information of third source targets*)*.

[13] VTS footprint allocated for the transmission of VTS radar tracks or non-AIS tracks.

- On the presentation side, the ship static and voyage related message has been divided due to it's length into two sub-messages representing the application for maritime use and regional use, European inland waterway

9.2.3 Vessel Traffic Management

The VTM workstation used in the demonstrator is capable to display the traffic image for the entire VTS area. The VTM workstations, for use by the VTS operator, are located in the operational room of VTS Drechtsteden and in the operational room of the VTS centre Nijmegen. This can be seen as a RIS centre during the demonstrator. For the calamity abatement trial, an additional VTM workstation will be placed in the provisional Calamity Centre at Millingen.

The basis of the VTM display consists of the 7Cs' ECDIS kernel. The traffic image, from the VTS radar and the AIS is displayed on top of ECDIS. The identification of track data will be automatic for vessels that are equipped with AIS.
The ID of the vessel and the particulars of the vessel and its cargo are displayed in the track label in VTM display.
The following diagrams depict schematic overviews of the technical infrastructure of the VTM traffic display on tactical and strategic levels.

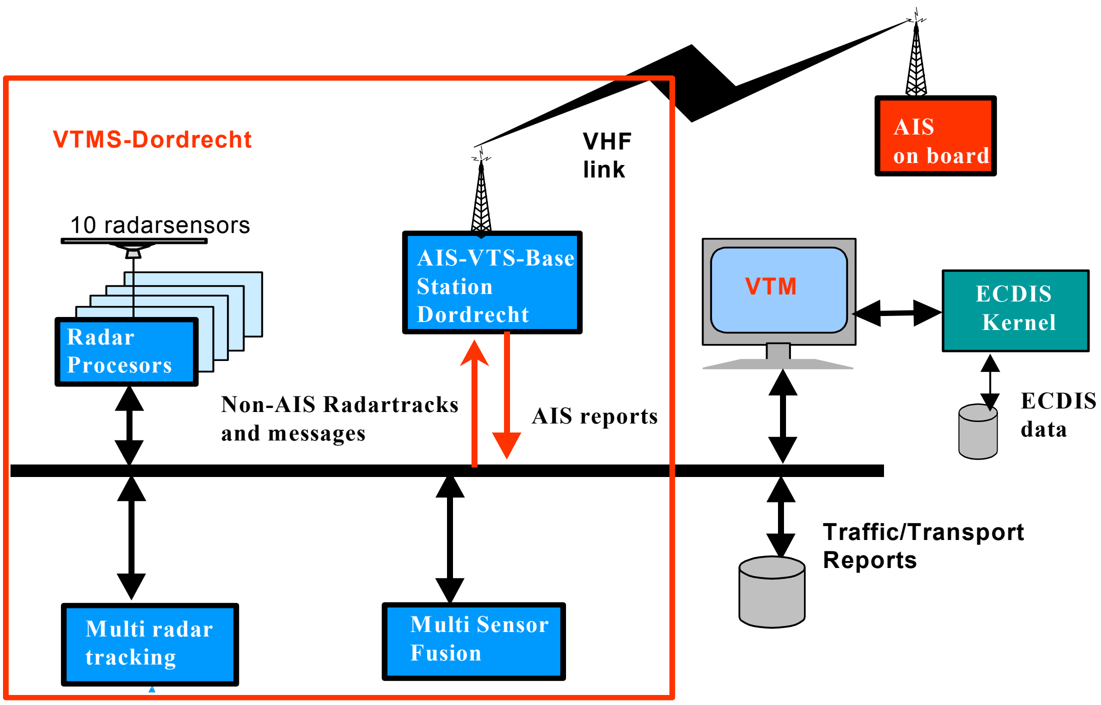


Figure 9.4: VTM traffic image on a tactical level – Schematic overview

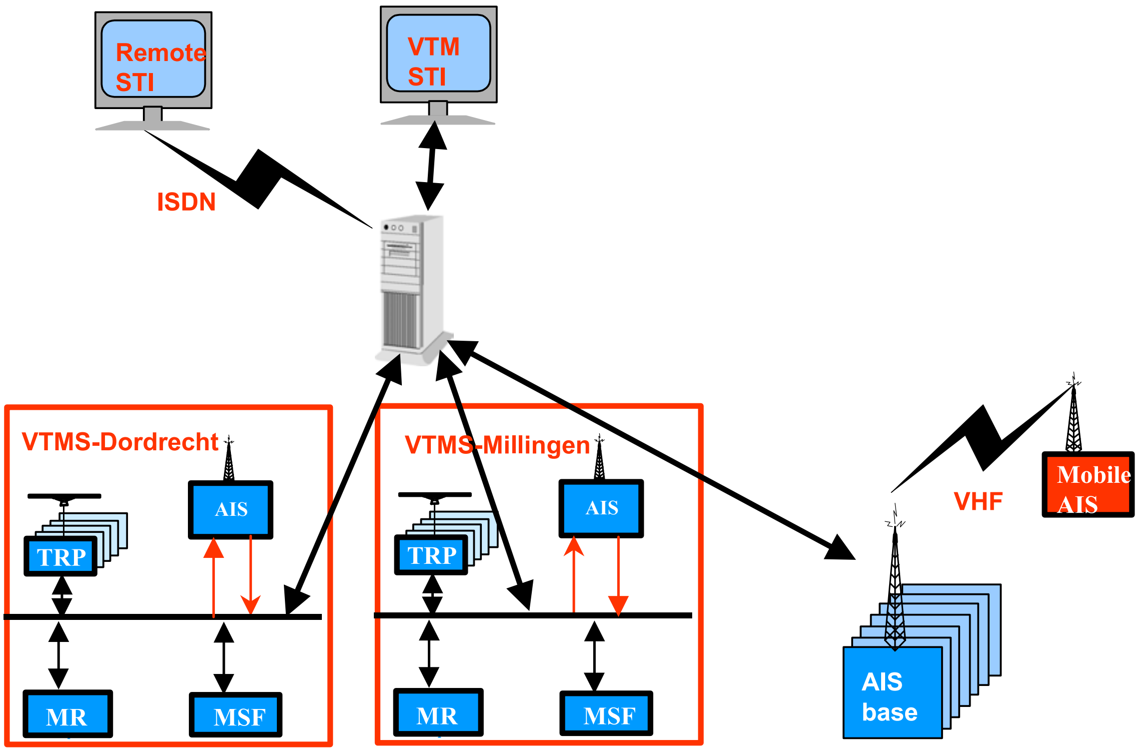


Figure 9.5: Strategic Traffic Image in a RIS centre – Schematic overview

9.2.4 Barge Information Server

In order to facilitate on-board RIS applications to be demonstrated in the Rhine-Scheldt demonstrator, a so-called Barge Information Server (BIS) software module has been developed. This BIS facilitates the applications in providing data and communication facilities. BIS provides the project with the possibility to prove the use of standardised data and communication means and procedures. BIS prevents the use of non-standardised data and communication by forcing the application suppliers to make use of the standardised BIS data and communication.

To facilitate the integration of applications encompassing functions, a client /server architecture is used for the Barge Information Server. The applications in this context act as clients.
The architecture is based around a central server acting as a data collector and distributor. Both the server and the clients are implemented on board the vessel. The server is able to perform functions on the data available and return the requested result. If within the mission of the vessel, cargo data contents are received or at least a reference to the data is stored in the server. The electronic reporting function then can retrieve the data to perform its own specific functions, or the BAS module[14] can use

[14] This module calculates the signs that the vessel has to carry when it transports dangerous goods.

the data to assess if it is allowed to transport the cargo. Similarly the intended route is stored through the server to be used by BICS.
The server as such is more than a database server. The idea is to implement functions in the barge information server, which can be used by other applications. Also it is possible to let the barge information server trigger other applications to perform sub-functions.
In the following general diagram the main functions for voyage planning are depicted within the proposed architecture.

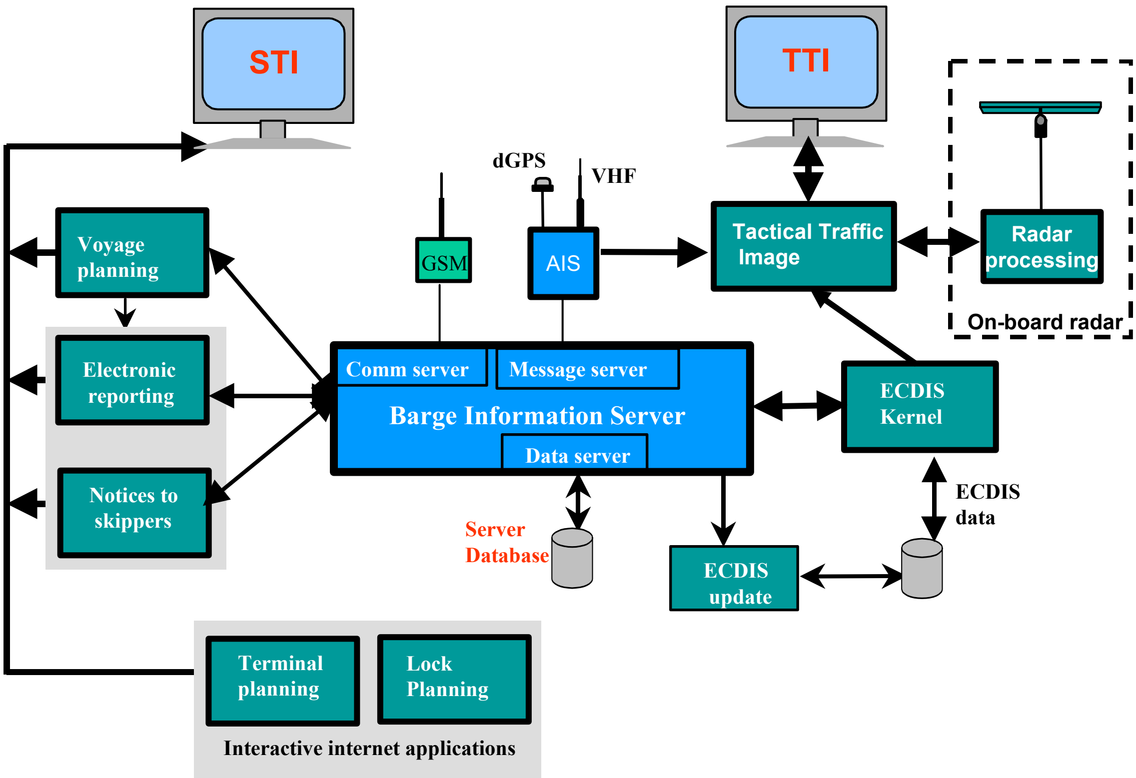


Figure 9.6: Overview of the BARGE Information Server configuration

The applications using the Barge Information Server are:

- Voyage planning consisting of the following:
  - BCB, for voyage planning and other on-board functions
  - Voyage monitoring
- BICS, for electronic reporting of a voyage to the authorities
- BASWIN, for calculating the number of cones in case of transport of dangerous goods
- Mail / HTML application, for exchanging e-mail (to be used among others by Notices to Skippers and ENC updates) and HTML messages.
- AIS data/message interface
- Cargo information application, for exchanging cargo data and making reservations for transporting cargo (not applicable for the demonstrator)
- Stowage application, for exchanging stowage plans and loading lists. (not applicable for the demonstrator)

9.2.5 Tactical Traffic Image on Board

The TTI will be presented on a PC on-board of inland vessels. The basis of the TTI consists of the ECDIS kernel. The traffic image originates from AIS in autonomous mode and is displayed on top of the ECDIS. The traffic image consists of an indication of the position and identification of other vessels fitted with AIS within the selected range. In the area of the VTS Drechtsteden as well as in a sector of the VTS-Nijmegen, this is enhanced by the positions of vessels detected by the VTS radar that are transmitted as AIS data. For each vessel, the traffic image is integrated with the own ship's radar image. Ship's own position input of the TTI will be derived from GPS and Differential GPS.
Additionally, the TTI is able to receive and process standardised urgent navigation messages via AIS. The demonstrator included an AIS-message of a temporary blockage of the fairway.
The ECDIS is fed with the S-57 data of the demonstrator area that is supplied by the Dutch and German authorities.
The ECDIS updates are received automatically. The selection of the vessels to be updated is based on the administration in the RIS (ship database).

The main technical functions of the TTI are:

- Fusion of radar tracks from the involved VTS systems Drechtsteden and Nijmegen and AIS tracks
- Display of actual traffic image on board of vessels based on AIS tracks or the fusion of radar tracks and AIS tracks

9.2.6 Voyage planning and monitoring

9.2.6.1 Voyage planning

The vessels are fitted with voyage planning and monitoring software. Based on input like destination, ship's dimensions ship's power and desired throttle positions etc. and using the fairway information from the ECDIS, the voyage planning software calculates possible routes, ETA's, etc. The software also allows inputting a provisional schedule consisting of a sequence of destinations, RTA's and RTD's for example from the barge operator.

If the ship's operation schedule is not continuous and the trip is interrupted overnight, the software can amend the ETA and ETD. If the software concludes that either RTA or required ship's draft or air draft is not feasible, it will suggest values that are possible. On request of the user, it will show why the requirements cannot be met. In the case of vertical or horizontal limitations, it will indicate if the problem can be solved. The software will also facilitate looking up the bottleneck locations using the chart display of the ECDIS.

9.2.6.2 Voyage monitoring

Even the best planning cannot take into account every aspect. Traffic may cause more than normal delays. A fairway may become temporary blocked by an incident. Therefore, the voyage planning/ monitoring software needs to be 'alive' during the entire voyage. It uses the transponder GPS positions to monitor the vessel's progress and polls the ECDIS for updates that may affect the progress during the remaining part of the voyage. It advises the skipper on the preferred speed, taking into account the RTA at waypoints.

9.2.6.3 Voyage planning software

There were two versions of the voyage planning software: one is based on the BCB software of STN-ATLAS and the company Noordersoft (PC Navigo) develops the other. Noordersoft has amended this commercially available application to accommodate the INDRIS standards on electronic reporting of voyage and cargo. Noordersoft was not a member of the INDRIS consortium but joined the project on a voluntary base.

9.2.7 Electronic Reporting

The final result of the planning is an enhanced schedule consisting of a sequence of destinations, RTA's and ETD's. This schedule and the relevant ship's data - including dangerous goods that may be carried, is communicated to interested parties via the RIS before starting the voyage.

In the Rhine-Scheldt, Seine and Danube demonstrators, the basic elements of the BICS application are used. BICS is an electronic reporting application operational in the Netherlands and Germany. During the INDRIS project, the application is extended and enhanced with different functions.

9.2.8 Notices to Skippers

As a first attempt to standardise the Notices to Skippers the message formats has been amended and made available via e-mail, a service available via the barge information server. Notices to Skippers became a separate application in the INDRIS Rhine-Scheldt demonstrator.
The Notices to Skippers can process the following messages:

- Shipping messages
- Water level related messages
- Nautical Information
- (Unstructured) Text messages.

The standardisation of Notices to Skippers started in the INDRIS project. However, a lot of effort is required to standardise the content of the messages on a European scale, convert the Notices to Skippers into S57 inland ECDIS standards and have the notices to skippers available under the control of the inland ECDIS related applications. In the Rhine-Scheldt demonstrator only the first step has been undertaken.

9.2.9 Contribution of Lock Planning to Voyage planning and Voyage execution

Enhanced lock planning requires vessels to be equipped with accurate position finding equipment, ECDIS, voyage planning and monitoring software and data communication. In the demonstrator, the position finding will be taken care of by the AIS (transponder). Based on the geographical information from ECDIS, the voyage planning/monitoring software calculates an ETA for the final destination and subsequent ETA's at the locks that are part of the initial voyage plan.

At a given moment the ETA/RTA negotiating module of the voyage planning/ monitoring software polls the lock planning software for available time-slots. Triggered by this request, the lock calculates the expected waiting time based on an extrapolation of its present and future lock conditions. Based on the expected waiting time the lock communicates a tentative RTA. In order to make the ETA/RTA negotiating process transparent the planning is made available via Internet.

9.2.10 Contribution to Terminal Planning

The BPS - the Barge Planning Support - intends to make the planning of container terminals and route planning of container vessels available online to terminal planners, barge operators and skippers.
The objective of this application was to develop and demonstrate a prototype for a Barge Planning Support (BPS) system with which planning and realisation of the terminal process is visualised. Terminals can supply vessels and barge operators with their RTA's. The purpose of the pilot was to demonstrate that BPS could improve time management of inland container vessels and communication with the terminals.

During the demonstration of the BPS-system, three different groups participated: container terminals, barge operators and container vessels. The container terminals entered their intended schedule for loading and unloading of inland container vessels and the occupancy of their cranes and associated berths in the BPS-system. The barge operators and container vessels were able to consult the system to see if there were possibilities to adjust their own voyage plan.

9.2.11 Calamity Abatement

During the demonstrator in Millingen, a serious accident with two ships involving dangerous cargo is simulated.

RIS provided the involved parties, patrol boat, fire brigade, VTS operators and the other demonstrator vessels with the relevant information such as the position of the incident and the cargos. In addition, the RWS-liaison officer, being member of the calamity-team on location, and the RWS-calamity-centre in Arnhem were provided with this information.

An incident co-ordination centre is set up consisting of:

1. A traffic image providing the location and routes off all ships in the vicinity. with special attention tot the location (label) of patrol and fire fighting vessels. (using ECDIS).
2. A prediction of the traffic at a specified time in the future (using ECDIS).
3. AQUABEL.
4. Information to all relevant parties.
5. The possibility of automatic processing of data and information send in by the patrol vessel on location, the RWS-liaison-officer or the RWS calamity centre in Arnhem.

Following the simulated incident the demonstrator allowed either the co-ordination centre or the patrol vessel to communicate the status of the calamity abatement to RIS. This status is shown on the TTI of the vessels involved in the project. On the traffic image of the co-ordination centre, the patrol vessel and the calamity centre in Arnhem, this status is also shown.

Following the simulated incident, a partial and temporary blockage of the fairway has been communicated to the ECDIS of the INDRIS vessels.

9.3 Demonstrator Infrastructure

The demonstrator infrastructure is depicted in the figure below:

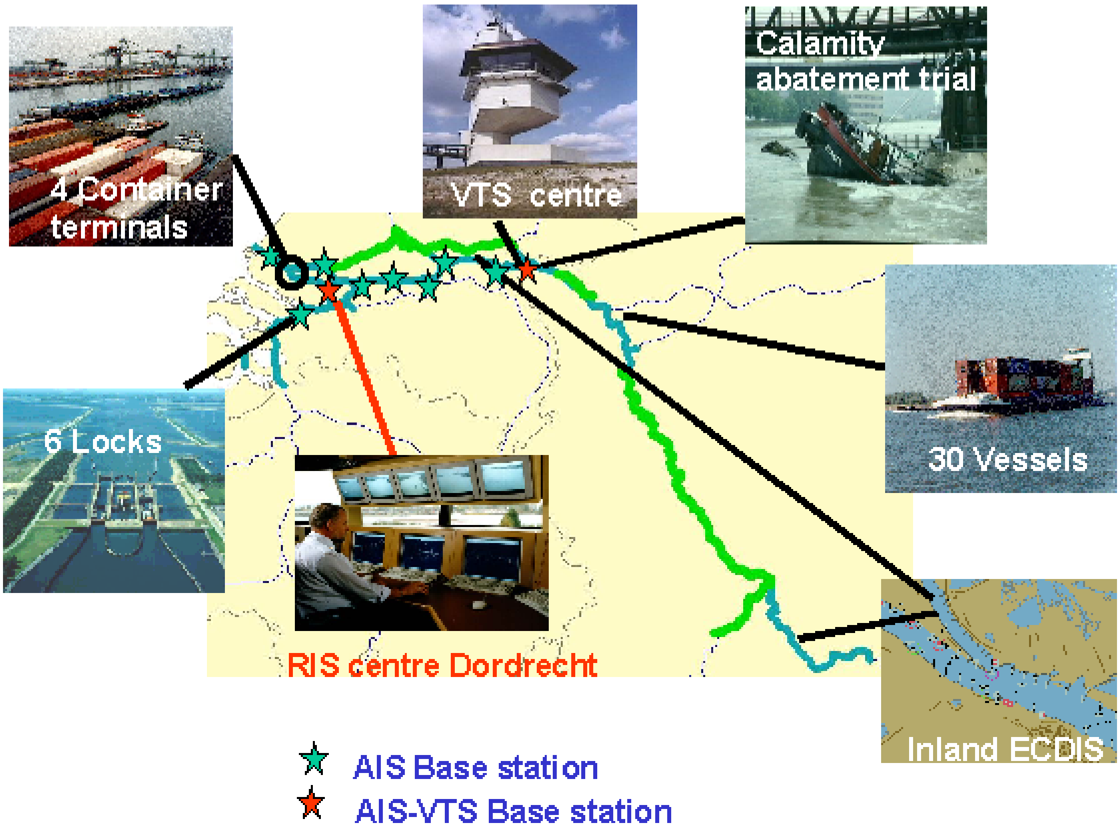


Figure 9.7: Overview of the Rhine-Scheldt demonstrator

The following parties contributed to this demonstrator:

9.3.1 Vessels

Patrol vessels and commercial vessels participated in the demonstrator. Most of these vessels are using/testing the INDRIS applications on board. All vessels have the following infrastructure on board:

1. PC with two flat screen displays, roller ball and keyboard (one display for tactical information and one for strategic information) with the following applications:

- TTI (the coastal vessel “Zwerver”, the on-board radar is integrated with the TTI) based on inland ECDIS and AIS
- Barge Information Server (BIS)
- BCB voyage planning and voyage monitoring
- Electronic reporting BICS

- PC Navigo route planner
- Notices to Skippers "on line"
- GSM connection and telephone
- AIS box with GPS/DGPS receiver
- UPS (Uninterrupted Power Supply)
- Applications manual

9.3.2 RIS- AND VTS CENTRES

The VTS centre Dordrecht participated in the VTM demonstrator as a RIS centre. In this centre the Tactical Traffic Image is situated in the Control Room and is tested by the RIS (VTS) operators. The VTM display is also used for displaying the Strategic Traffic Image based on information of the AIS network
.
The second VTS centre co-operating in the demonstrator is the VTS centre Nijmegen. On one hand, this centre tests the Tactical Traffic image of the VTS sector Millingen and on the other this centre plays an important role in the Calamity Abatement trials in the Millingen area.

9.3.3 Lock control centres

The local Directorates Zeeland and Utrecht participated in the lock planning trials with the following locks:

- Kreekrak locks in the Schelde Rijnkanaal
- Hansweert locks in the "Kanaal door Zuid Beveland"
- Krammer locks in the Oosterschelde
- Irenesluizen at Wijk bij Duurstede in the Amsterdam-Rijnkanaal,
- Beatrixsluizen in the Lekkanaal en
- Prins Bernhard-sluizen located in Tiel in the Amsterdam-Rijnkanaal

9.3.4 Terminal control centres

In the Rotterdam harbour 4 terminals with different cranes took part in the demonstrator. 44 container vessels and 9 barge operators participated in the Terminal planning trials (BPS-application)
At the terminals, the barge operators and the vessels PC's were available with access to the Internet application BPS.

9.3.5 Calamity Abatement centre

In the calamity abatement trial the following organisations took part:

- Calamity vessels:
  - Zwerver
  - Synthese
- Fire fighting vessel
- Patrol vessels of:
  - Water Police
  - Local Directorate Ministry of Transport, Oost-Nederland
- Local co-ordination team (representatives of the relevant organisations) with local incident co-ordinator (head of the fire brigade, deputy Mayor of Millingen)
- Local fire brigade Millingen
- Regional fire brigade Nijmegen
- Calamity Reporting Centre Oost-Nederland – communication - co-ordinator

- VTS Centre Nijmegen/Millingen
- Calamity co-ordinator Wijgula

9.4 Demonstrator execution

9.4.1 Introduction

The official start of the demonstrations of the Rhine Scheldt demonstrator of INDRIS took place on Monday 8th. of May 2000. The demonstrations can be differentiated in four categories:

- Presentation of the results of the project with focus on the applications, prepared for the Rhine-Scheldt demonstrator to policymakers, potential users (authorities and transport sector) and general interested invitees.
- Presentations for specific user groups.
- Operational test of the terminal planning in a restricted period.
- Calamity abatement trial.

Apart from these demonstration categories it is worth mentioning that the tests of the on-board equipment will be continued till the end of 2000 enabling skippers experimenting with the INDRIS applications. The final evaluation of their experiences shall take place after that period.

9.4.2 General Demonstration

For the central demonstrations representatives of the following (international and national) organisations were invited:

- Ministries of Transport of Austria, Germany, Belgium and France (central and local directorates)
- DG-TREN,
- Central Rhine Commission,
- Danube Commission,
- PIANC,
- Members of the Concerted Actions on inland navigation and VTMIS,
- IMO/IALA,
- Coast guards,
- NNVO (National Organisation Traffic Management-education),
- Fairway authorities,
- Port-authorities,
- Fire brigades,
- Search and rescue organisations,
- Branch organisations Inland Navigation,
- Ship owners, shipping companies and skippers,
- VTS operators and VTS authorities,
- VTS suppliers, IT companies, Electronic chart suppliers and Service providers
- Police,
- Press,
- Customs and Statistical offices,
- Pilots ,
- Hydrographic offices,

- Shipping inspection.

The general demonstrations have taken place from 8–12 May 2000.
During the 5 presentation days, a total of 330 visitors were welcomed on board.

9.4.3 Demonstrations for specific user groups

Mainly during the months May and June specialists have been invited to visit the INDRIS demonstrators in Dordrecht and discuss the results of the project and the benefits of future ICT developments for their specific user group/branch.

The following specialist groups have attended:

Date	Specialists/group	Focus on:
09-05-2000	KIVI (Royal Institute of Engineers)	General ICT development in inland navigation
15-05-2000	Electronic chart suppliers	Benefits of standardisation and ECDIS
16-05-2000	SICS (Governmental platform for research on Information and Communication systems in waterborne transport)	INDRIS and future ICT research in inland navigation
17-06-2000	VTS operators (2 sessions)	RIS and Vessel Traffic Management in the future. From traffic operator on a local level to Strategic Vessel Traffic Management
24-05-2000	Harbour authorities	Traffic and Transport Information systems, the development of a national database (STIS)
29-05-2000	Local operational shipping and patrol departments. Nautical educational institutes	RIS – FIS and traffic services - on the national fairways
29-05-2000	Lock Keepers	Voyage and lock planning; just in time principles
30-05-2000	Skippers	Navigation and voyage planning
10-06-2000	NNVO - National organisation for traffic operator training	ICT in inland navigation. Future Traffic Management
05-07-2000	Thematic Network: WATERMAN	Meeting with INDRIS demonstration
18-09-2000	Terminal operators	RIS and terminal planning
13-10-2000	CBRB (Skippers branch organisation)	Traffic and transport management Information systems STIS, the national development of RIS in the Netherlands

More than 200 specialists participated in these demonstrators.

9.4.4 Operational Pilot for optimising arrivals of vessels at terminals

Operational tests on the terminal planning application BPS have been executed in May 2000. For 5 days (24 hours a day) the BPS system was used and tested under full operational conditions.

The principal conclusions were:

- Considering the experience with terminal planning (BPS) during the pilot and the opinion of individual container terminals, it can be concluded that there is obviously a need for an application such as BPS.
- BPS should be connected, through software interfaces, with systems used at the different terminals. Only then, BPS can be used in an efficient way.
- In the event that the BPS system undergoes a further development and becoming a user-friendly and efficient Internet application, it can evolve to become a useful tool to optimise the handling of inland container shipping.

- To successfully implement a system such as BPS, it is essential that all container terminals participate in the implementation. If not the optimal effect will not be achieved and time and financial resources are duly wasted.

9.4.5 Demonstrator of Calamity Abatement

The calamity abatement trial was executed near the Dutch German border on the river Rhine at Millingen. Around 40 specialists on calamity abatement, policymakers and press visited the demonstrator at Millingen or co-operated in the trial.

The main results of this calamity abatement demo were:

- Information regarding ship locations, damage sustained and casualties on board was quickly and efficiently relayed to the RIS centre and in turn to the appropriate authorities. Quick response time, reliable and actual information was achieved.
- Information regarding traffic in the area was immediately available to the skippers of the incident, vessels in the area and to the RIS-operator thus providing a direct overview of the problem and risk possibilities to other ships and their cargo.
- The use of the RIS system will increase communication efficiency by decreasing the verbal information exchange between the participating organisations and vessels.
- The use of a standardised information system appears to have a positive effect on emergency response and crisis management, particularly in a highly populated area along a congested waterway.

Figure 9.8: Overview of calamity demonstrations on the river Rhine

9.5 Conclusions

The following conclusions are drawn:

- The Rhine-Scheldt demonstrator was a great success. In total 330 visitors attended the general demonstrations in Dordrecht and 200 people attended the special demonstrator sessions in Dordrecht and the calamity demonstrator in Millingen at the Rhine.
- Apart from partners and sub-contractors involved in the preparation of the demonstrator, several parties contributed to the INDRIS trials. In total 30 vessels, 6 locks, 4 terminals, 2 VTSs, the fire brigades of Nijmegen and Millingen, police authorities and several barge operators participated in these Rhine-Scheldt trials.
- Electronic reporting based on the BICS application has been a great success during the INDRIS project. BICS is operational in the Netherlands, Germany and Austria and will shortly become operational in France.
- Inland ECDIS electronic charts are available for the Rhine from Rotterdam to the German border, for parts of the river Rhine in Germany and for the link between Rotterdam to Antwerp. The extension of the electronic nautical charts for the remaining parts of the Rhine in Germany and other fairways in the Netherlands is under preparation. The added values of inland ECDIS for inland navigation on tactical and strategic levels have been convincingly demonstrated in the INDRIS project.
- Several aspects related to the practical implementation of Inland ECDIS need to be solved and agreed upon on a European scale in the future. These issues are;
    - ENC update mechanisms.
    - The integration of dynamic data such as water levels/depth contours and Notices to Skippers.
- It has been shown in the preparation phase, that for the implementation and maintenance of Inland ECDIS a public-private co-operation is advisable. The collection and maintenance of data has to be addressed by the relevant decision-makers of the different European Authorities. This is viewed as a cornerstone for the success of River Information services throughout Europe.
- During the Rhine-Scheldt demonstrator, the first steps towards standardisation of Notices to Skippers were undertaken. The interfacings of Notices to Skippers with applications like BICS have been demonstrated. The standardisation of the content of messages and integration of the Notices to Skippers is, however, an issue for the years to come and an important pre-condition to implement Notices to Skippers on a European level and make these Notices language-independent.
- Operational exercises with the interactive lock planning failed for a number reasons. The number of vessels with on board INDRIS applications (30) was too small and has required ETA calculation methods for the entire fleet. These were not available. The lock planning communication application on the locks was not integrated with the lock planning working methods on the locks.
- The integration of VTS radar targets in the AIS message structure causes capacity problems in the demonstrated area of high traffic density. This leads to an important operational restriction of AIS in a VTS environment.
- Integration of AIS, Inland ECDIS and shore based radar in a navigation display for tactical use on board as well as for tactical and strategic use in RIS proved to be successful.
- The preparation phase of the route and voyage planning application was partly a success. The demonstrator indicated that ETA planning might be very beneficial for different processes in Inland Navigation.

- When considering the experience gained with terminal planning (BPS) it can be concluded that there is an obvious need for an application such as BPS.
- The use of the RIS systems in case of calamities will reduce the negative effects of an accident, while the relevant information can be made available at the right time and at the right place in an unambiguous format. The RIS systems will increase communication efficiency by decreasing the verbal information exchange between the participating organisations. The integration of decision support functions and calamity alerting functions in RIS can be seen to form the major calamity abatement tools of the future.
- Although an excellent result has been achieved as a result of an intense co-operation between partners and subcontractors, it became clear that co-operation in a project/process like INDRIS is very difficult. In the preparation process of the Rhine-Scheldt demonstrator, it became apparent that co-operation between industrial partners is not always evident.
- In future, the objectives and progress of projects like INDRIS needs to be intensively communicated towards the potential users of systems and applications at every phase of the project. This is viewed as necessary in order to gain a wider commitment from the transport sector.

10 ASSESSMENT OF DEMONSTRATORS

10.1 Introduction

The main objectives of the assessment of the demonstrators are to:

- Assess the RIS through the results of the three demonstrators on the Rhine, Danube and Seine; the assessment will consist primarily in users' satisfaction assessment as well as C/B analysis.
- Draft the policy recommendations to DG VII and to the national administrations on the desirability and usability of RIS.

Eventually, in case of an expected satisfactory acceptance and positive assessment of the mentioned standards, the RIS concepts and standards would be forwarded for international approval and introduction.

The first step for to the assessment procedure of a RIS is to:

- Define the different geographical (navigation) areas of interest and target groups,
- List all functions of RIS and types of information provided by each function,
- List target groups (or user groups) to whom the above information is provided.

10.1.1 GEOGRAPHICAL (NAVIGATION) AREAS

Navigational, technical, political and organisational criteria are used to define and divide the European Inland Waterway Network into homogenous areas. For instance, by using criteria based on the navigation conditions, it will become clear that the Rhine constitutes an area different from the Seine and Danube areas.

It is assumed that each area requires a specific set of RIS services.

10.1.2 Target Groups (User Groups)

In a similar manner as above, the number and types of Target Groups in each Geographical Area are defined by clustering all actors involved in river navigation activity in this area into homogenous groups. These Target Groups are in fact the "destinations" of the information provided by RIS. These Target Groups can also be clustered into the following categories: Skipper, Owner; Equipment Supplier, "Infrastructure", Authority, Service orientated (traffic), Service orientated (transport), etc…

The following table illustrates the used Target Groups.

Target Groups
Skippers
Ship owners
Suppliers of navigation systems
Bridge operators
VTS operators
VTS authorities
VTS suppliers
Hydrographic Offices
Electronic chart suppliers
Fairway authorities
Customs

Statistical offices
Pilots
Shipping company
Port authorities
Lock operators
Search and rescue organisations
Fire brigades
Police
Terminal operators
Charterers
Freight forwarders
Short sea operators
Barge operators

Table 10.1: Target (Users) Groups

10.1.3 RIS Functions and types of information provided within each function

First of all the assumption are made that a RIS system provides different types of information to the above Target Groups which can be grouped into homogenous clusters named services, in the context of this assessment called functions. These functions can also be grouped into categories.

The table below illustrates RIS categories and functions:

CATEGORY	FUNCTION
Tactical Traffic Image on shore	
	Local Vessel Traffic Management
Tactical Traffic Image on board	
	Navigation (collision & grounding avoidance, path optimisation), Voyage monitoring on board (*local, short-term*)
Strategic Information on shore	
	FIS (water levels, obstacles, currents, ice, …)
	Electronic Bourse
	Incident abatement in a VTS area
	Lock / Bridge management
	Barge planning support
	Regional Vessel Traffic Management (Strategic Traffic Image based on AIS Monitor Stations)
Strategic Information on board	
	Ship based FIS (Long term predictions for *long term* voyage monitoring and on board planning)
RIS Navigation plans	
	Traffic predictions

Table 10.2: RIS categories of functions

10.2 Users' Satisfaction Analysis

10.2.1 Introduction

For each geographical area, the aim of this activity is to check what each potential users (Target Groups) think about RIS as defined theoretically in comparison with habitual conventional procedures: opinion about RIS, what is to be added, what is to be removed, what is to be improved. A large population within each target group is surveyed via questionnaires. This general survey made it possible to assess the acceptance of RIS by different actors involved in river navigation.

This type of assessment is a kind of users' satisfaction assessment applied only on the population of invitees that attended the demonstration. It has the property that the results of the demonstrators are used to assess the demonstrated individual RIS elements in comparison with habitual conventional ratings: e.g. much better, better, equal, worse. The population to be surveyed is composed by those who attend the demonstrations.

10.2.2 Set up of the users' satisfaction assessment

The number of Qualitative Assessment Questionnaires that were received (per target group) from the Danube and the Rhine-Scheldt demonstrators are given in the Table below.

	Danube demonstrator	Rhine-Scheldt demonstrator
Skippers/Ship Owners	2	20
Equipment Suppliers	1	
Infrastructure	1	1
Authorities		82
Service (Traffic)		29
Service (Transport)	1	14
Other[15]	15	
	20	146

Table 10.3: Number of responses received

The respondents were requested to evaluate the information provided within the demonstrator with respect to various functions. For each set of information provided the current method of provision of information (habitual way) was stated alongside the method as proposed within the RIS framework (RIS way). For this the respondents should chose how they rated the RIS way in comparison to the habitual way, indicating whether they considered it: much better; better; equal; or worse. In addition they were requested to indicate the influencing factors in their response from the following: ease of use, accuracy and response time.

[15] Most of the attendees of the Danube demonstrator elected not to provide information regarding their user group

Each demonstrator had its own characteristic with respect to requirements and functionality. By considering the responses from each geographical area one can determine the considered improvement to be gained from the implementation of a RIS. When combining these, it is possible to indicate the overall perception for the whole European inland waterway network.

The functions assessed within the various demonstrators are indicated in the table below:

	Danube	**Rhine-Scheldt**
Local Vessel Traffic Management	**X**	**X**
Tactical Traffic Image on-board: Navigation	**X**	**X**
Tactical Traffic Image on-board: Voyage Monitoring	**X**	
Fairway Information Service	**X**	**X**
Incident abatement in a VTS area		**X**
Lock/Bridge Management	**X**	**X**
Barge Planning Support		**X**
Regional Vessel Traffic Management		**X**
Ship-based Fairway Information Service	**X**	**X**
Traffic predictions		**X**

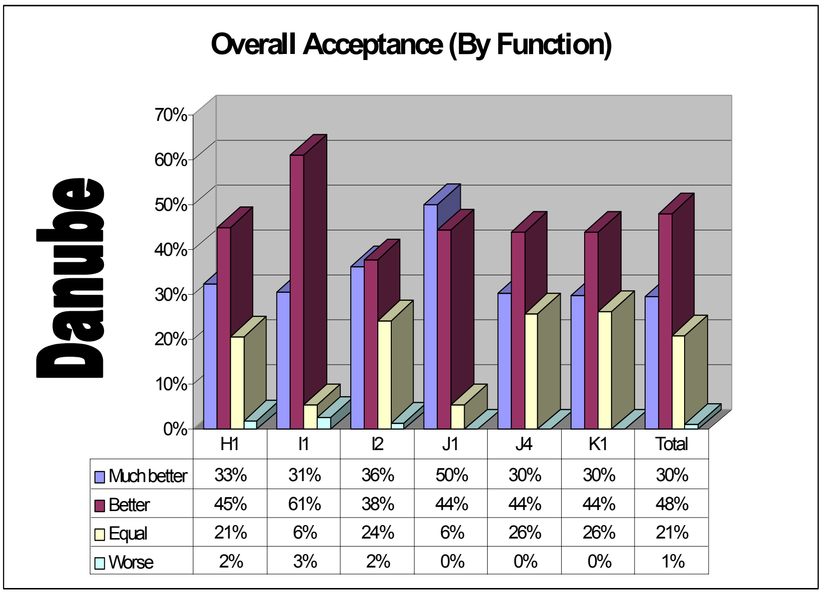
Table 10.4: Demonstrated Functions

10.2.3 Results of the Assessments

In this section the overall results for each demonstrator are presented, indicating overall acceptance and determining parameter by category (where available) and by demonstrated function. The results of the individual target groups are presented following the respective questionnaire within the relevant Annex.

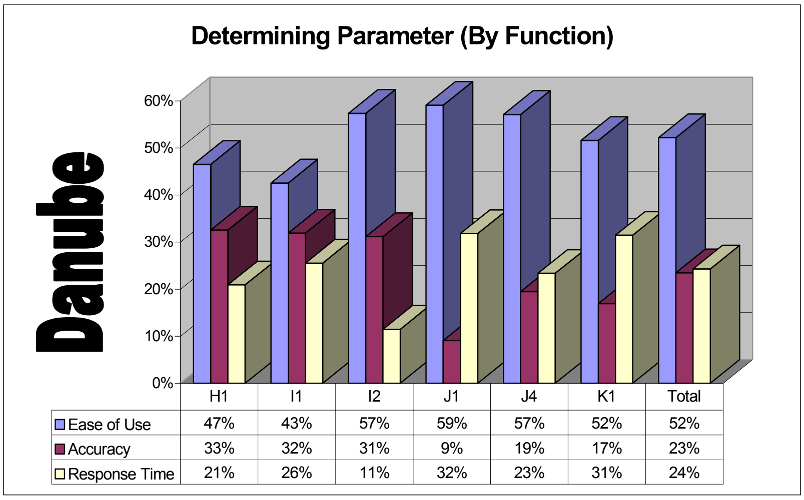
10.2.3.1 Danube

Individual target groups were not identified prior to the demonstration held on $9^{th.}$ and $10^{th.}$ November 1999. Due to the limited number of functions to be demonstrated, the decision was made to request all invitees to complete one questionnaire.



	H1	I1	I2	J1	J4	K1	Total
Much better	33%	31%	36%	50%	30%	30%	30%
Better	45%	61%	38%	44%	44%	44%	48%
Equal	21%	6%	24%	6%	26%	26%	21%
Worse	2%	3%	2%	0%	0%	0%	1%

Figure 10.5: Results of the overall assessment of the Danube demonstrator



	H1	I1	I2	J1	J4	K1	Total
Ease of Use	47%	43%	57%	59%	57%	52%	52%
Accuracy	33%	32%	31%	9%	19%	17%	23%
Response Time	21%	26%	11%	32%	23%	31%	24%

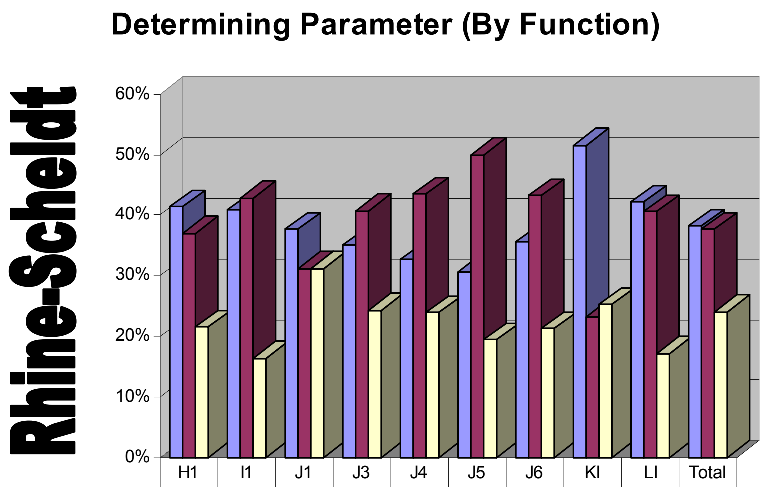
Figure 10.6: Overall acceptance of the Danube demonstrator functions

Of the various functions demonstrated the Fairway Information Service received the most positive response, with 50% stating that RIS was much better and 44% stating that it was better.

Only 1% stated that the RIS version was worse. The RIS was indicated as worse within the functions Local VTM, TTI Navigation and TTI Voyage Monitoring. It was reported that there was non-compliance of the target representation on the traffic display.
For each function demonstrated, the determining response parameter was dominated by “Ease of Use”. “Accuracy” and “Response Time” were also seen to be of greater importance in the Tactical Traffic Image.

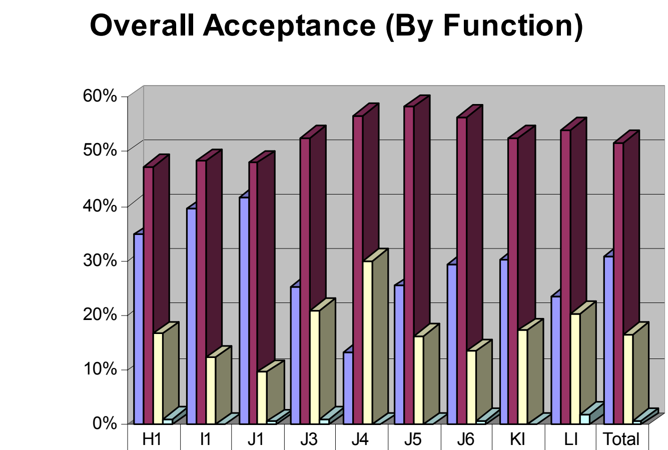
10.2.3.2 Rhine-Scheldt

The results are evaluated by category but also by function of the RIS.



	H1	I1	J1	J3	J4	J5	J6	KI	LI	Total
Ease of Use	41%	41%	38%	35%	33%	31%	35%	52%	42%	38%
Accuracy	37%	43%	31%	41%	43%	50%	43%	23%	41%	38%
Response Time	22%	16%	31%	24%	24%	19%	21%	25%	17%	24%

Figure 10.7: Determining parameter of the functions of the Rhine-Scheldt demonstrator



	H1	I1	J1	J3	J4	J5	J6	KI	LI	Total
Much better	35%	39%	42%	25%	13%	25%	29%	30%	24%	31%
Better	47%	48%	48%	53%	57%	58%	56%	52%	54%	52%
Equal	17%	12%	10%	21%	30%	16%	14%	17%	20%	17%
Worse	1%	0%	1%	1%	0%	0%	1%	0%	2%	1%

Figure 10.8: Overall acceptance of the functions of the Rhine-Scheldt demonstrator

For the Rhine-Scheldt demonstrator the response rate of the attendees was good. This allowed a detailed analysis of the results by both category and function.

The overall acceptance by function indicated a combined improvement of 83% (31% Much Better and 52% Better). The functions that were considered above average were the Tactical Traffic Image on-board, Fairway Information Service, Barge Planning Support and Regional Vessel Traffic Management. Lock/Bridge Management and Traffic Predictions were slightly below average.

Overall the determining parameters “Ease of Use” and “Accuracy” were evenly matched. Through analysing per category it can be seen that the ‘practical’ users, such as skippers, rate “Ease of Use” higher, compared to the Authorities, for example, who look towards accuracy.

By Category:

Skippers and Ship Owners showed a very positive response to the functionality of RIS as demonstrated. Overall they expressed an improvement of 84%. The most improvement was noted in the Tactical Traffic Image On-board and the Barge Planning Support functions, both scored above average. “Ease of Use” dominated their choice. However, it should be noted that “Accuracy” was noted as most influential for the on-board Tactical Traffic Image and for FIS.

Again the *Authorities* were positive, giving an overall improvement rating of 82%. Their opinion of the demonstrated functions was consistent, although the Fairway Information Service was seen as the biggest improvement. “Accuracy” was the leading determining parameter, although by only a small margin.

The *Service (Traffic)* target group indicated an overall improvement of 88%, with the Fairway Information Service once again showing the largest improvement. “Ease of Use” was most important.

The *Service (Transport)* target group indicated an overall improvement of 68%, with Barge Planning Support being the key functionality. It should be noted that this target group was only asked for their opinion on the Lock/Bridge Management and Barge Planning Support functions.

10.3 C/B Analysis

10.3.1 Objectives of the C/B analysis

The INDRIS SWP 13.1 Technical Report "Framework of INDRIS Demonstrators' Assessment" provides the general guidelines in terms of what should be assessed and to provide the basic indicative methodology.
The specific objective assigned to SWP 13.4 is to undertake a C/B analysis, e.g. assessing the costs and the benefits of a particular RIS implementation. This C/B analysis should not be seen as the final answer on the desirability to implement RIS, but should provide a framework with which other RIS implementations could be assessed.

Ideally, a complete C/B analysis should therefore consider each Target Group & Geographical Area separately. Different approaches could be applicable.

One approach consists in assessing, for each Target Group, the costs of acquiring a given type of RIS information and the benefits that different Target Groups would obtain from the use of such a type of information.

Another approach consists in assessing the costs necessary to purchase and operate the necessary RIS equipment (hardware, software, communication cost, etc…), not considering the type of information provided and the benefit (as a whole) that Target Group might expect from the use of RIS.

Taking account of the huge set of different information RIS can provide, it appears that the above specific objective is a wide and complex one. In order to achieve it, an original approach is required. This is due to the different possible combinations (geographical area/target group versus type of information), the difficulties linked with data availability and the determination of the absolute benefits to be expected from the application of an IT system.

10.3.2 Problem Solving Approach

From the definition of RIS the following relations are derived:

1) The first basic relation to be highlighted is between RIS and safety and capacity of the waterway traffic. In other terms, the relation are studied between the level of information and knowledge provided to the waterway users and the reduction of the risk and of the number of accidents as well as the reduction of the time delays and the use of optimum drafts. This should be independent of whatever geographical area is considered.
2) The second basic relation is a medium/long term effect of RIS: by improving the reliability[16] of inland navigation, RIS would allow a modal shift, what would induce effects benefiting communities larger than the sole waterway users. These effects concern less gas exhaust, less congestion, less atmospheric pollution and related societal costs, less road infrastructure heavy maintenance fees, etc.
3) The third basic relation is the saving of costs in dredging and infrastructure that is the result of implementation of RIS. This means that if an ECDIS is available with precise depth data areas with excess sedimentation can be located which may save general dredging activities. Many locks have large deceleration works that are necessary for mooring inland vessels that have to wait for a lock cycle. By precise planning of the RTA's, based on ETA's send by skippers the number of waiting vessels can be reduced and hence the length of the deceleration works can be reduced. The planning messages that are a part of RIS might help this process. Furthermore by positively affecting the traffic flows through locks it is possible to make the traffic supply through a lock more uniform over the day, implying a better usage of the locks. This would imply that the lock might be operated for a longer period without renewal or replacement of the lock. The investment costs may be reduced.

These three relations induce the following hypotheses:

[16] Reliability in this context should be seen as a large degree of predictability of the ETAs and ATAs as well as sufficient high frequency of sailing.

a) The different target groups that are benefiting from RIS could be broadly grouped into three:

- A first group benefiting from the direct short-term positive effects of RIS. In reality they are the skippers, the shippers, the commercial parties, etc. We will name this set of target groups: the private parties. This Group is the core beneficiary of the direct effects due to an improvement of safety and capacity (efficiency) of inland navigation;
- A second group that is composed by the beneficiaries of the infra-structural effects of RIS; the competent authorities;
- A third group that is composed by the core beneficiaries of the medium/long term positive effects of RIS: the community as a whole. The public authorities may represent this Group. We will name this Group: the Community. Of course, it is really the beneficiary of the wide range positive effects a modal shift would induce.

b) Three types of RIS benefits exist:

- Direct short-term positive effects of RIS. They are derived from the enhancement of safety and capacity and can be approached by calculating the reduction of costs, due to time delays, optimal loading and accidents, when a RIS system is implemented.
- Medium/long term positive effects of RIS that are derived from the positive effects a modal shift could induce. If one can approximate the number of "*trucks equivalent units to be shifted*", effects can be approached by calculating the potential community savings due to less exhaust of gas, less atmospheric pollution and related effects as well as less road infrastructure maintenance fees.
- Medium/long term positive effects of RIS that are derived from the positive effects of dredging and delay of infrastructure investments.

c) Two types of RIS costs exist:

- Costs that will be borne by private parties (private costs). They consist of all costs related to the purchase and operation of on-board equipment. In addition, the training costs (training of private parties to the use of RIS system) should be taken into account as well. These costs are included in the software costs, since the software includes training modules.
- Costs that will be supported by the Community. They consist of all costs related to the installation and operation of necessary shore based RIS equipment (radar stations, ECDIS data collection and dissemination costs, Lock planning and communication software costs, data collection stations, etc.). These costs will affect the existing costs of the systems that are in place in the area. These systems are local VTSs at different places along the river Waal. If a central RIS is being established, the local VTS centres can be integrated in the RIS centre. This would reduce the number of VTS operators. The use of RIS also implies savings on some infra structural works such as deceleration works in front of locks and less dredging costs as well as savings due to the delay of new investments in locks.

d) Above hypotheses imply a full calculation of the benefits and costs of RIS. They include the costs for a RIS and equipment on board, and the benefits for the users, the competent authority as well as the benefits for the community as a whole.

10.3.3 Execution of the C/B analysis

It was impossible to make a detailed C/B analysis for all geographic areas. As an example the area of the river Waal (Rhine) between Zaltbommel and Lobith (Dutch and German border) is chosen to make an example C/B analysis.

Taking account of the remarks that have been made in the preceding part, we will proceed as follows.

1) We will consider situations without RIS at the years 2005, 2010, and 2015, for a given geographical area. It is determined that 5 years are necessary for the built –up of RIS. In addition a period of 5 years is considered where the full benefits are developed.
2) For these basic situations without RIS we will derive an estimation of traffic volumes, traffic density, traffic delays and accidents from data available (statistics at 1995 and projections at 2015 given by a state forecasting model and a traffic simulation model).
3) Considering each of the above situations with a given level of RIS implementation we will derive an estimation of the RIS contributions to the reduction of traffic delays and accidents. We will assume a 0% RIS implementation at 2005, 100% at 2010. For the period from 2010 to 2015 we assume full RIS implementation.
4) By using statistics and estimations related to the costs of a unit traffic delay and of accidents for 1995 and 2015, we will estimate the costs of traffic delay in situations with and without RIS
5) We also will make estimations for the dredging and infra-structural savings due to RIS. Dredging can be improved due to the improved depth information. Infra structural savings are based on reduction of deceleration works at both sides of the three locks and a delay of investments in locks. This is due to an improved management of the traffic flow through the locks.
6) In order to have an estimation of the costs and benefits of RIS implementation *for what we called the Community*, we will consider that for the 'with 100% RIS' situation at 2010, a justified percentage of the traffic growth is due to a shift from road to inland navigation. Using estimations regarding the societal cost of truck transportation, we are able to derive benefits/costs of RIS implementation for the Community.
7) The costs of RIS will be determined. In the first place we will determine the equipment costs for RIS including ECDIS. In addition the costs of equipment in the three locks adjacent to the stretch will be estimated. We will deduct the costs that are already being made for the local VTSs in the area.
8) The horizon of the B/C analysis is 5 years from start to full implementation and 5 years of operation.
9) We will try to derive a B/C ratio for the community, a B/C ratio for the competent authority and a B/C ratio for a user such as a skipper of inland vessel. This reflects the win-win situation that is associated with RIS. The society will benefit through less social costs of transportation and the competent authority is able to reduce its costs to maintain an orderly flow of traffic and reduce the infra-structural costs. The skipper is able to reduce his operational costs due to RIS.

10.3.4 Input parameters of the C/B analysis

10.3.4.1 Traffic volumes

The traffic volume figures that will be used are derived from transport statistics at 1995 and from the traffic projections in the area at the horizon 2015. These projections are based on Rotterdam projections of the number of containers that are handled in the port. An algorithm is used to determine the modal shift. This shift is foremost the result of a tendency that is already observed before any RIS system was implemented. The traffic density on the Dutch road system implies so many delays that many shippers select the waterway mode. RIS might enforce a certain percentage of modal split, but this is believed to be not a large proportion.

For the year 1995, the volume of transported goods in the selected waterway, the Waal, is 160 Mtons. For 2015, the volume of transported goods is 190 Mtons. The underlying assumption is that the increase in transport comes from container transport to Germany, Belgium as well as to national destinations. Bulk transport of coal, ore, sand and gravel is assumed to decrease slowly as compared to the level of 1995.

10.3.4.2 Accidents

INCARNATION has determined the number of expected accidents on the river Waal. This is done on the basis of an analysis of an accident database over an 8 years period. A simulation model is used that calculates the casualty rates such as collision rates, grounding rates and contact rates in different traffic situations according to fairway characteristics and the number of encounters. These rates are translated afterwards in a total number of accidents for each traffic situation.

The costs of accidents were determined in INCARNATION by the assessment of the following:

- Collisions are defined as damage costs to vessels including loss of earning capacity, cargo damage, other parties' economic damage and suspension costs.
- Contacts are defined as owners' damage, damage costs to vessels including loss of earning capacity and other parties economic damage.
- Groundings are defined as damage costs to vessels including loss of earning capacity, cargo damage costs and lightening costs; other parties' economic damage and suspension costs.
- Strandings are defined damage costs to vessels including loss of earning capacity; and third party costs.

10.3.4.3 Time delays

The INCARNATION study[17] has determined for each relevant combination of traffic scenario/fleet composition and navigable width/depths /currents, the time delays to be expected as a result of the number of encounters. It has resulted that for 1995, the total time delays, queuing and waiting times amounts to 1584 minutes per day for all passing ships or an average of 2.2 seconds per ship over a kilometre fairway.

[17] "Safety and Capacity", Work package 1 - report of the INCARNATION project.

For the selected cargo flow scenario at 2015 (without RIS), the values would be 2701 minutes per day for all passing ships or an average of 4.3 seconds per ship over one kilometre fairway.

A more important aspect is the delay of vessels when they are using the three locks adjacent to the river Waal in the area considered. Three locks are present. It is assumed that the number of vessels passing these locks in both directions will increase from 450 ships per day to 550 per day in 2015. It is assumed based on data provided by Rijkswaterstaat that the average waiting time is about 20 minutes increasing to 35 minutes in 2015.

10.3.4.4 Fuel consumption

The fuel consumption of all vessels that regularly use the river Waal is calculated on the basis of the average power, the average speed and a value of the specific fuel consumption. The mean speed is thought to be constant. This is based that extra speed can only be achieved at the expense of high powers, given the mean depths of the river. The improvement in diesel technology is indicated by a slowly decreasing specific consumption. It is assumed that fuel prices will continue to rise.

10.3.4.5 Costs of existing VTS centres

In the area of the Waal that is considered in this report, 4 VTS centres are present. One centre is in St Andries, one in Tiel one in the Waal bends and one in Weurt. The capital costs based on equipment and housing and the operational costs are being determined for these four centres. It is assumed that the capital costs are about 10 M Euro. The lifecycle is assumed to be 12 years. The amortisation rate is thought to be 4%. It is also assumed that 21 persons are required to run one VTS.

10.3.4.6 Dredging

The annual costs of dredging depend on the volume of silt that has to be removed. The calculation is based on an annual increase of sedimentation of 5 cm over the entire stretch whilst for the width a value of 200 m was taken. Dredging costs are taken as 5 Euro per cubic meter.

10.3.4.7 Deceleration works

The annual costs of the deceleration costs are based on the assumption that each lock has four works positioned on each side on both sides of the fairway. Each deceleration work is thought to have a length of 200 m. The investment costs are given as 25,000 Euro per m. length. The lifecycle is thought to be 15 year. The capital costs are based on an amortisation rate of 4% about 5,400,000 Euro per year. Maintenance costs are thought to be about 3,000,000 Euro per year.

10.3.5 Impacts of RIS

10.3.5.1 Accident reduction

The reduction of accident costs is based on a consideration of the new equipment that is available on board and on shore. It was assumed that AIS and ECDIS were available on board and that the whole area was under constant monitoring. The reduction rates were in the order of 25% with a positive exception for grounding when

ECDIS has the faculty of depth contours. In that case the reduction was thought to be 45%. Third party damage was assumed to be dependent on manoeuvring skills rather than on AIS and ECDIS. These cases contain damage due to manoeuvring mishaps near a berth. Stranding is defined as to hit moles and these very often depend on suction phenomenon or wrong assessment of the navigational situation rather than anything else.

10.3.5.2 Reduction of delays

On the river Waal

The reduction of traffic delays is thought to be dependent on traffic organisation functions of RIS and further also depend on the use of all navigable space available, due to the ECDIS information on depths. In cases where skippers don't dare to use all the navigable space available to them because they don't have sufficient information.

Near the locks

The reduction of delays for locks is a product of improved planning on the part of the skipper. When lock cycles really offer opportunities to pass the locks this is now known and a skipper can act accordingly. This indication will probably reduce the traffic at peak times and more use will be made of lock cycles that have sufficient room. More information is assumed to change the behaviour of skippers in such a way that they will choose for an uninterrupted voyage rather than waiting for the availability. It is worth noting that a message to a skipper to reduce speed in order not to use the deceleration works for waiting is not comprised under this heading. The waiting time is in fact not changed. The waiting time is used to reduce speed and to save fuel.

10.3.5.3 Increased efficiency of management on board of RIS vessels

The use of ECDIS and voyage planning software provides the opportunity to select the optimum draft and speed in order to maximise profit. Often this is not possible, since cargo cannot always refused if a contract exists between forwarder and skipper. In the latter case he may be able to select a speed in such a way that he minimises fuel consumption by reducing power at stretches with small under keel clearances and increases speed in parts with more under keel clearances. It is noted that when sailing on a river many of these advantages will not play a large role in times of high water. In times of low water considerable benefits are possible. It all depends on voyage planning software with the right modules for optimisation.

It is also stressed that reducing speed in order to arrive exactly in time at a lock as discussed in the preceding section is also contained in this section. It is necessary to make simulations under realistic conditions to arrive at more precise values for reduction of fuel or improvements in the management on board. For this calculation we have argued that if a reduction in fuel costs is made of 5 percent we may have a conservative estimation of the benefits.

10.3.5.4 Phasing out of VTSs

As RIS encompasses Vessel Traffic Management over an entire stretch of a river rather than local Vessel Traffic Management it seems to be logical that local VTSs are dismantled and integrated in the RIS centre. In some cases radar will help to complete a shore based Tactical Traffic image and the radar sensors and auxiliary equipment can continue to provide additional information on non-AIS vessels.

10.3.5.5 Reduction of dredging costs

ECDIS is able to determine the voyage of vessel and indicate for a given draft the minimum depth that is required. This might sometimes mean that it is not necessary to dredge the entire stretch, but only the parts that are essential for a safe voyage of the vessel with maximum draft. In the Port of Rotterdam positive experience has been gained with a similar approach. It appears to be possible with only small dredging activities to enlarge tidal windows for some docks. Although it is not expected that the same spectacular results are possible it has been assumed that a full exploitation of ECDIS type of depths might decrease the dredging costs to about 75 % of the present costs. However, a more detailed study should be launched to get more accurate figures.

10.3.5.6 Reduction of decelerations works

Voyage planning and communication with the lockmasters might provide the skipper with a precise time of arrival at the lock. The skippers that use this opportunity will not use the deceleration works to wait for their turn to sail into the lock. Extensive use of ECDIS and digital communication may lead to a reduction of the length of the deceleration works. However they should not be discontinued, since these deceleration works also provide a possibility to stop for the night for those vessels that are allowed to sail 15 hours a day. Most private skippers fall under this regime and they should have a possibility to use the deceleration works as a safe haven for resting and sleeping. As a first assumption it is thought that a reduction with 25% might be the best compromise.

10.3.5.7 Reduction of capital costs of locks

The savings in the investment of locks are not very easy to calculate. It is expected that using RIS functions, such as reservation and the supply of RTA's to vessels will flatten the supply curve and reduce the waiting times. This may lead to a postponement of investments since the present capacity of a lock can be better utilised.

In the following, some estimation has been made. The investment of the three locks with 4 lock chambers is estimated as 320 Meuro. The lifecycle is assumed to be 32 years. The annuity will be nearly 17.9 Meuro. This is based on an amortisation rate of 4%. It is assumed that the traffic patterns will be made more uniform so that the total lifecycle time of the locks will become 37.5 years. The annuity, belonging to this new life cycle is about 16.6 Meuro by postponing new investments an annual benefit can be created of about 1.3 Meuro.

The introduction of some sort of regional Vessel Traffic Management requires a study of the new principles of RIS between the competent authority and the many users. The results of these studies will provide a more accurate description of the benefits of RIS to the competent authorities in terms of postponement of investments and in terms of reduction of waiting times and increase of the predictability of the ETA's for inland vessels.

10.3.5.8 Savings due to the modal split

In order to have an estimation of the costs and benefits of RIS implementation *for what we called the Community*, we will consider that for the 'with 100% RIS' situation at 2010, a justified percentage of the traffic growth is due to a shift from road to inland navigation. Using estimations that are related to the societal cost of truck transportation, we might derive the indicative benefits of RIS for the Community. We will consider the situation before full implementation of RIS is completed in 2005, but we expect that the RIS will only slightly affect the modal shift. We believe that a substantial shift could come really true when RIS will be 100% implemented and is fully operational. The estimations of tonnage transferred from road to inland waters are given in the next table.

From a study carried out by ANAST[18], it appears that on the highway A15 (which is almost parallel to the river) in the period 2000-2010 each additional ton transported by truck would cost an average of 11 Euro to the Community (or about 287 Euro per additional truck passage). This externality value includes:

- Atmospheric pollution costs (including effects on health, buildings and vegetation),
- Noise pollution cost,
- Damages to the road infrastructure and maintenance costs,
- Casualty (killed, injured) costs.

10.3.6 Costs of system components

10.3.6.1 RIS and ECDIS centre

The shore-based equipment is the equipment that is used for regional Vessel Traffic Management in the stretch of the river Waal considered. The first remark is that one RIS centre will replace the existing local VTS centres. AIS are seen as the major tool to build a Strategic Traffic Image of the entire stretch. It has been remarked in INCARNATION that full coverage very much depends on the traffic intensity of the area under consideration[19]. This coverage has to do with the two major aspects where Vessel Traffic Management can provide benefits:

- Increase the safety level (reducing the number of accidents through information).
- Improve the efficiency of the traffic flows.

The total equipment is based on AIS equipment supported by a large database that provides the backbone for electronic reporting and the dissemination of additional information. Large reductions have been made in personnel costs. 21 persons can run a RIS centre. The equipment comprises sufficient displays for a constant monitoring of the entire stretch, the Strategic Traffic Image.
Apart from the Vessel Traffic Management, it is required to have a constant monitoring of the depth contours in the river. This requires ECDIS charts and regular

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[18] "Estimation des externalités additionnelles dues à l'accroissement cumulé du transport par camions sur l'autoroute néerlandaise A15 sur la période 2000-2010" *Internal ANAST Working Paper, June 2000*, pp1 to pp7.

[19] If traffic intensity is a governing factor in the extend and functions of a RIS, RIS centres will be adapted to the regional needs. These centres can be more simple than the one envisaged for the river Waal.

updates. The ECDIS centre associated with the RIS centre also monitors the required dredging in the river to enable vessels to use optimum draughts.

It is envisaged that the RIS centre closely co-operates with the adjacent locks. These locks do have a controlling centre to control lock transits and to operate the essential equipment of the locks. This equipment will not change. However the lock control centres are playing a role in the traffic flow scheduling using planning tools and an overview of the relevant part of the Strategic Traffic Image. This STI can be borrowed from the RIS centre by simple means.

10.3.6.2 On board equipment

The determination of the ship borne costs is based on the following equipment:

- AIS. Present AIS for seagoing applications cost about 8000 Euro. However, it is doubted whether all performance standards as required by IMO for seagoing vessels are necessary for inland vessels.
- ECDIS software might not very costly when the same schemes that will be used in the marine world will also apply to the inland navigation world.
- One computer two screens to depict the TTI and STI on board. Software to map the ship's radar image on top of the ECDIS.
- Investment in communication equipment. This includes modems to be connected to UMTS.

The following table indicates the estimated costs of the equipment.

Costs of equipment on board	
Capital costs in Euro	
AIS	3,500
Computer	3,000
ECDIS software	2,000
Communication infrastructure	800
Radar mapping	12,000
Total fixed costs	21,300
Amortisation rate	4%
Life cycle	3
Annuity	7,969
Operating costs in Euro	
Communication costs	1,000
Total annual costs	8,969

Table 10.9: Overview of ship borne costs

A major consideration is the number of vessels that will use or are using ship borne RIS equipment. The following factor is important: The costs of the equipment and the time that is for the benefits required equalising the costs. This is in general a rather short period that will not exceed 3 years. If we assume that everywhere RIS infrastructure is available one may visualise the benefits in terms of reduction of fuel costs for sailing on a river. In canals and canalised rivers, the reduction of waiting times is also an important factor.

The question of sufficient profits is becoming the question of the times that a vessel may benefit from the RIS infrastructure. It is assumed that the river Waal and Rhine in Germany as well as the connection between Rotterdam and Antwerp will have extensive RIS shore infrastructure. In those cases the vessel may benefit form the advantages of RIS in terms of a better management of the cargo carrying capacity of the vessel and minimisation of delays. If we sum the river stretches on the Rhine, and Danube weighted with the traffic intensity the conclusion is that about 10 % of the vessel kilometres made will have extensive RIS equipment allowing the vessels under coverage to benefit from the advantages offered by RIS.

It is believed that about 10,000 vessels are regulars on the European waterway net. Many of these vessels will not sail under RIS coverage and when they do the benefits are too small to warrant the acquisition of ship borne RIS equipment. It is assumed that 10 % of all potential vessels will frequently use RIS covered waters sufficiently to consider the acquisition of ship borne equipment

As can be seen the costs of ship borne RIS equipment are more or less independent of the size of the vessel. The size of the vessel is important for the cost reduction that can be made. Consequently there should be a tonnage limit for vessels that will not voluntarily acquire the RIS equipment. This limit is not taken into account.

The benefits for the river Waal should be calculated taking into account the specific benefits for that area. This is done as follows: The total amount of fuel for all inland vessels is calculated using average values. It appears that the fleet of 10,000 vessels will use something of 7,000,000 tons of Marine Diesel Fuel. In the Waal area about 20,000 tons of fuel is used. They are based on 998 vessels equipped with RIS equipment.

10.3.7 B/C ratios

10.3.7.1 C/B Private parties

The private parties benefit from the direct short-term positive effects of RIS. These can be derived from the enhancement of safety and capacity and can be approached by calculating the reduction of costs, due to time delays and accidents, when a RIS system is implemented.
We have calculated average values of the costs that the private parties would support in three particular situations and for two cases: 'without-RIS' and 'with-RIS'. If we compare the results of the situations 'with-RIS' to those of the 'without-RIS', we will obtain for the private parties the following benefits resulting from RIS implementation.

The implementation of RIS will necessarily imply costs for the private parties. These costs will mainly consist of all costs related to the purchase and operation of on-board equipment. In addition to these, the training costs (training of private parties to the use of RIS system) should be accounted as well. What will be the value of these costs? We will answer indirectly this question.

For an investment to be justified on the point of view of economical evaluation theory, the value of the Benefits/Costs (or Advantages/Costs) ratio should be equal or greater than 1 (B/C ≥ 1).
The following table provides the B/C ratio as calculated for the private parties. Benefits consist of reduction of accident costs (It is unimportant whether these costs are borne by the skipper or the insurance companies), reduction of delays due to traffic congestion and waiting for locks as well fuel reduction by selecting optimal speeds and draughts. The costs are a proportional to the use of this equipment in the stretch that is under consideration.

C/B Private Parties		
(B1)+(B2)+(B3)	*Total Benefits Private Parties*	*20,104,275*
(C3)	*Total Costs Private Parties*	*4,310,996*
(RatioPP)	***Benefit/Cost Ratio***	***4.66***

Table 10.10: B/C ratio for private parties.

10.3.7.2 C/B of competent authorities

The following table provides the B/C ratio as calculated for the competent authority. Benefits consist of reduction of the costs of VTSs. These VTSs will be phased out. On top of that a reduction of dredging may be expected. It is also expected that reduction will occur of the costs associated with deceleration works. A postponement of investments for new locks replacing the present locks may also lead to reductions of costs. They are seen as benefits in the present calculation. The costs are the costs of a new RIS centre and an ECDIS centre, as well as the extra costs to equip the locks with adequate planning programmes including communication modules. The following table displays the B/C ratio.

C/B Operational Authorities		
(B4)+(B5)+(B6)+(B7)	*Total Benefits Operational Authorities*	*72,332,652*
(C1)+(C2)	*Total Costs Operational Authorities*	*70,359,596*
(RatioOP)	***Benefit/Cost Ratio***	***1.03***

Table 10.10: B/C ratio for competent authorities

10.4.7.3 C/B for the Society as a whole

A societal C/B analysis takes all benefits and costs into consideration irrespective of the beneficiaries. This means that all benefits are summed and compared with all costs. The following table indicates the results.

C/B Societal		
All Benefits	*Total Benefits Societal*	*409,263,934*
All costs	*Total Costs Societal*	*69,884,659*
(Ratio S)	***Benefit/Cost Ratio***	***5.86***

Table 10.11: B/C ratio for the society as a whole.

10.3.8 Conclusions

The following conclusions are drawn from this preliminary study:

- The results of the B/C ratios as calculated in this report need to be interpreted with care. This is due to the fact that many components of the calculation cannot be calculated with a high degree of precision.
- However the template of the B/C ratios may be used as starting point for more precise calculations and estimations.
- RIS as a VTM system provides the parties involved with positive B/C ratios.
  - The private users on the stretch of the Waal, that is considered, will have a large return for any investment that they are prepared to make.
  - The competent authorities may also have a positive B/C ratio but the application of RIS will not bring them many benefits. However, as manager of the inland navigation infrastructure it may be expected that they will co-operate with a change that is clearly in the interest of the users.
  - The society will have a very positive B/C ratio. The main factor is the enhancement of a modal split that provides a more equal load on the available transport networks. By taking away some of the transport loads of the road system and put that
- A RIS can be seen as valuable tool in the hands of the policymakers to promote inland navigation transport. The benefits of a modal shift seem to be the most important parameter when considering the desirability of a RIS.
- The efficiency of vessel traffic is more important than the safety of inland vessels. By providing more accurate information regarding the waterway and the management of the locks in the waterway network large benefits are expected for the skippers and owners of inland vessels. This in turn will make ETA's of inland vessels more accurate. On top of that it will increase the reliability of inland transport, reduce the costs of transportation and increase the predictability of the time that goods will arrive at the consumers. This will positively affect the modal split.
- It is a requirement for future work on RIS, to use discrete simulation programmes to study the waiting times and the effects of advanced reservation of locks. It is also necessary to simulate voyages of a large number of vessels and confront them with cargo requirements to study the effect of the ship borne equipment in more detail.
- Although the safety level is high on European waters it might be useful to determine the effects of spill of dangerous substances on the environment and the people living near waterways. The effects of alternative regulations of the transport of dangerous goods and the benefits and costs that these rules may provide should be determined. This would lead to the use of FSA[20] in an inland environment.

[20] FSA is Formal Safety Assessment. This risk methodology is recommended for use in rule making by the IMO.

11 EXPLOITATION

11.1 Inland ECDIS

In the INDRIS project, Inland ECDIS has become an important basis for a number of applications. Not only does it consist of a chart, but also it forms a geographical database where all kinds of information can be linked. Thus it is a basis for the Fairway Information System because almost all information has a reference towards geography. It is also used for tactical purposes because electronically you can represent your own position and the traffic in your immediate surroundings in this Inland ECDIS.

It became clear very soon that to develop this type of chart it was useful to develop the ECDIS standard designed for maritime navigation into a special Inland ECDIS form because there is a need for additional information. At the same time as the INDRIS project, the ARGO project in Germany was developing an Inland ECDIS along the same rules. Therefore both projects joined their effort into one starting an Inland ECDIS platform in the EU to develop a standard. This standard has now been used in INDRIS and ARGO. As a result, there is now an experimental Inland ECDIS available for the Rhine between Mannheim and Rotterdam and for larger parts of the Austrian Danube. 30 vessels use this Inland ECDIS. These vessels are also equipped with transponders as a part of the INDRIS project and by 12 vessels equipped with the ARGO system that are taking part in the ARGO test.

A further application of inland ECDIS on the inland waterway network in Europe is being studied. However it can be expected that this standard is adopted and that for more waterways an inland ECDIS database will become available.

11.2 Electronic reporting

For a number of functions electronic reporting has been used in INDRIS. These are mainly related to voyage data, e.g. a report from a vessel to the waterway authority stating the information about origin and destination, information about cargo and especially detailed information about dangerous goods. Another example of the use of electronic reporting is the EDI message send to several parties active in the inland navigation logistics. The main tool that is used in INDRIS is the BICS system that has been developed primarily for reporting the transport of dangerous goods by skippers to the waterway authorities. That tool has been further developed in a more general tool available for traffic-related messages and logistics related messages. The standard for data transfer is EDI. This system is operational after INDRIS in Austria, Switzerland, Germany, France and the Netherlands and is at least being used by the waterway authorities. The Netherlands can receive messages in the IVS90 system, Germany receives these messages in the ELWIS system and Belgium uses IBIS.

During the various demonstrations it has been shown that also the Austrian and French authorities use experimental systems that can receive BICS messages.

A separate international working group is maintaining the EDI standard messages for the purpose of the use in BICS.

11.3 IBIS/BIVAS

The combination of these systems in Belgium is the beginning of a RIS in Flanders combined with an electronic bourse system for inland navigation. IBIS acts as a special RIS and BIVAS is the electronic bourse. These systems have been demonstrated during the INDRIS projects and proved to be able to communicate with the RIS systems designed in conformity with the INDRIS standards. The BIVAS system is operational.

11.4 Electronic Bourse and FIS in France

Before the beginning of the INDRIS project VNF had designed and tested an electronic bourse system in France based on the Minitel technology, which is available in France only. To be a part of INDRIS, this system had to be adapted to a technology available throughout Europe. In this fashion this Electronic Bourse system could become part of the INDRIS recommendations. At the same time VNF developed a FIS system according to the INDRIS standards for data exchange and demonstrated the functionality and actual operation in the Paris demonstrator. During that demonstration, it has been proven that this FIS operates in an INDRIS environment. On top of that, the waterway authorities can receive BICS-messages. These developments led to the VNF 2000 project where both FIS and the Electronic Bourse systems are operational.

11.5 Notices to Skippers

The ambition of INDRIS at the beginning has been to develop a FIS system, which also included a European notices to mariners. Although a lot has been achieved to further harmonise the data being used in a FIS we have not succeeded in implementing a common user interface for FIS. This is certainly possible, but some national waterway authorities are not yet capable of adapting towards such a standard. We do see, however, some very interesting FIS systems that can be reached by navigation on the Internet, such as the German ELWIS and the French VNF 2000 systems. The Dutch BC2000 system needs to be mentioned, that provides Notices to Skippers on the basis of a free e-mail subscription.
The future objective is to integrate Notices to Skippers in Inland ECDIS and to make it language independent.

11.6 PC Navigo

A development that already exists is the route and voyage planner of PC Navigo. This software has been adapted to the Inland ECDIS standard and offers now compatibility with RIS software.

11.7 Barge Planning Support System

One of the INDRIS products demonstrated in the Rhine-Scheldt demonstrator was the BPS system. BPS was designed to exchange information between inland vessels, terminal planning departments and ship owners. This would improve planning of voyages of barges in the terminal area, since they are now able to see the occupancy of cranes and berths. The system was found so interesting that a follow-up is now being considered.

11.8 “Vaarplan” a Dutch initiative for promoting RIS

The Ministry of Transport and public Works has conceived a plan for implementing RIS in Dutch inland waterway network. It is based on the RIS guidelines and was a direct result of INDRIS. It is thought that waterway management can be improved for traffic and transport goals.

11.9 National Traffic and transport plan in the Netherlands

The Ministry of Transport has recently issued their new policy document (NVVP: Nationaal Verkeers– en Vervoersplan (National Traffic and Transport Plan) that covers the next decade. It is interesting to note that the furtherance of the development and the realisation of RIS are now an integral part of this plan and set the course for developing a policy for Inland Navigation.

11.10 Test centre of the Danube

As a result of the successful demonstrations on the Danube the Austrian authorities decided to establish a RIS test centre on the Danube. This centre will be used to test applications on RIS and convince potential users of the benefits. A major point is the STI of the Danube, starting in Austria.

11.11 PIANC and IALA involvement in RIS

During the execution of INDRIS, PIANC decided to start a working group on Inland VTS and RIS. This working group is now preparing a set of worldwide guidelines for RIS based on the recommendations of INDRIS. PIANC is co-operating with IALA. IALA is working on Inland VTS guidelines. The objective is now to draft one common version of RIS and Inland VTS guidelines that is accepted and approved by both PIANC and IALA.

11.12 EADINS

The establishment of EADINS (European Association of Developers of Information and Navigation Systems) is an indirect result of INDRIS. Commercial parties joined this association to supply software that satisfies the standards that were developed. They also have indicated that the supply of ECDIS data is a necessary condition for the development of advanced products.

11.13 STIS and RIS Flanders

The Netherlands plan to implement RIS, have started in the definition of a national Shipping and Transport Information Services, STIS. Flanders plans to replace IBIS by a new system. This system is in the quotation phase and it is expected that the existing system will be replaced in 2 years.

12 DISCUSSION AND CONCLUSIONS

12.1 Introduction of the discussion

A large variety of issues have been discussed in INDRIS. A major point was the question of a more architectural approach to INDRIS. Although this approach was outside the work specified in the Technical Annex of INDRIS, the management team felt that a closer scrutiny of architectural aspects might be of great value for the furtherance of RIS. The approach chosen however deviates from the original intentions of RIS. RIS was originally seen as a concept that provides information on Vessel Traffic Management in its widest context. It was appreciated that the information in a VTMIS could be used for a large number of stakeholders. RIS was seen as a VTMIS for a river environment. Vessel Traffic Management suggests that the main purpose is safe navigation under the pre-condition that the available infrastructure is optimally used. Vessel Traffic Management also reaches out to other stakeholders. Hence, RIS can be seen as a concept for inland navigation providing a number of services or, at the other hand, it can be seen as Vessel Traffic Management Information concept that provides information in the widest context for waterborne users.
The discussion in INDRIS led to the following definition of River Information Services:

> **River Information Services (RIS) is a concept for *harmonised information services* to support traffic and transport management in inland navigation. It includes interfaces to other transport modes**

12.2 The RIS Architectural Framework

12.2.1 Introduction

There is an increasing need for information exchange between parties in the transport world. The exchange of traffic related information dealing with safety and efficiency of the traffic, transport related information in order to improve the efficiency of transport-processes and there is an increasing urge for sharing information in the different traffic and transport processes. During the last decades a significant amount of systems and concepts dealing with Vessel Traffic and Transport Management are developed and some are in operation. The waterborne transport sector might now be faced with the challenge of integrating these ‘building blocks’ into a pan-European system architecture that would offer some degree of consistency and synergy across applications. The use of (system) architecture leads to better interaction between systems and applications; this will result in improved efficiency in business/ transport and safety processes. Finally inter-modal information sharing will be the issue for the next decade.

The challenge for a new architectural approach and a discussion on the status of RIS is to require all stakeholders to adhere to an agreed framework. This framework must

accommodate national plans and support the various efforts in research, standardisation, deployment and investment.
The idea behind the development of architecture for River Information Services or in general IT-systems for traffic and transport is to have a framework to translate policy goals into specifications for system design. The framework has to be defined in such a way that a RIS system will be produced that are efficient, expandable and that can interact with other systems. Architecture development might lead to an integrated ICT environment of a RIS system for traffic and transport management, or to a system that focuses on Vessel Traffic Management in its widest sense with information usable to logistic providers. In the first notion individual systems linked together should create an integrated environment of IT systems for traffic and transport management in a way that their performance, usefulness and efficiency of these systems will be enhanced. Each individual system provides one or more functions[21]. By creating a framework, functions can be linked and combined to create a very large multi-functional, multi-service system.

Architecture supports the development of systems by providing tools for a proper arrangement of co-operation between people and between systems. Architecture provides information about what should be uniform in systems in order to make interaction and co-operation between systems possible. The objective of (system) architecture is to provide a stable basis for a working and workable system; flexible systems must be built upon stable architectures.

A systems architecture is not a design, nor is it a system, it is a description which forms the basis for a class of systems and hence a set of designs.

12.2.2 Architecture on different stakeholder levels

There are many different aspects, many different views of architecture. The stakeholders range from policymakers to system manufacturers. They all need a view of the complex world of RIS, an insight in the overall structure of RIS, an understanding of RIS architecture at their level. That is why “architecture” which should give this insight, offers such a multitude of descriptions.
Different stakeholders have different interests, for policymaker the main issue might be how to achieve policy goals, while system manufacturers could be more interested in the way a function is implemented. To get some structure we can distinguish three groups of stakeholders. They are namely policy makers, competent authorities and operators (public and private) and system engineers. The idea of this three-layer stakeholder-architecture is that the right sort of people with the right information can make the right decisions. Interaction between neighbouring layers is foreseen and needed to check the validity of any decision. The stakeholder-architecture has to create a right balance between user needs and technology push.

12.2.2.1Policy makers

These stakeholders want the system to solve (or diminish) general transport and traffic problems. They are responsible for policy measures that will imply a shift from road transport to inland water transport or short sea shipping. They also might promote

21 Functions combined to meet a user need are known as *services*

measures such as ICT structures to make transport more efficient and reliable. These policy makers also define the conditions that are needed to safely use the inland water infrastructure by providing rules and when necessary budgets to implement safety and efficiency along the waterway net. Stakeholders are also the decision-makers in the transport business that may view the opportunities of the inland waterway net as a part of inter-modal transport chains.

Each of these groups has its own policy goals, in addition to the more general objectives of improving safety, efficiency, environmental quality, etc. Each group will also have its own tasks in the transport process and will have its own ideas about the required services – the "*User needs*" - to achieve its goals. Once the services have been selected, the functionality and their interactions for providing these services must be determined. The choice of services, the interrelation between these services and the agreement about responsibilities for the implementation and operation of (parts of) these services form important elements of architecture on the policy level.
An "*organisational architecture*" as part of the architecture on the policy level is used to expand and explain the responsibilities and functional interactions between multiple organisations, which may be public, private, or public/private partnerships.

12.2.2.2Competent Authorities and Operators - Business level

This group of stakeholders will control (a part of) the system and provide the main input. These stakeholders are traffic operators, lock operators, search and rescue and calamity abatement operators. They belong to the services officially appointed to do this type of work such as the competent authority to monitor safety and the fire squad as the authority for calamity abatement and terminal operators. The architecture has to be worked out in more detail at the operational level. At this level the services selected are split up in applications, more detailed and accurate descriptions of the services. An application will state in which way the service will be provided and applications will be broken down into functions or processes.
Directly related to the processes at the operational level the sort of information exchanged between the functions is defined. Internal relationships as well as relationships with actors outside the system need to be described.
Finally on this level it is required to define aspects like reliability and quality.

At the operational level the "*functional architecture*" – with the possibility to define this in different sub-architectures or related architectures – has to be defined.

12.2.2.3System engineers

Component suppliers will deliver hardware and software components for the system. System engineers will combine the components into complete systems, e.g., VTS-suppliers, system integrators, telecommunication operators, etc. The architecture defined at the business level has to be worked out in the systems engineers level into a system architecture that is acceptable and unambiguous for the system engineer to build the components and integrate the modules into a (sub-) system

12.2.2.4Definition of architecture, services and functions

The objectives for taking the first steps towards RIS-architecture in INDRIS are as follows:

- Create consensus on the scope and contents of RIS[22];
- define the services to be supported by RIS, identify the added value of RIS and create consensus on the services and the added value of RIS;
- Bring cohesion in the individual systems and thereby structures the exchange of information in inland navigation.
- Form consensus on the new or changed tasks of actors in inland navigation and the technical systems needed to enable these tasks;
- Identify themes for standardisation.

The RIS services for different processes in inland navigation are defined as the basis for the standardisation phase as well as for the demonstrator phase. For every service the required function are specified as given in the following table.

Services	Functions
Tactical traffic information for navigation	monitoring of traffic interaction, vessels' and cargo characteristics
	(monitoring of) passing and manoeuvring arrangement and urgent traffic messages
	monitoring of geographical, hydrological and meteorological status
	monitoring incidents/accidents in the navigation environment including knowledge of cargo
	monitoring of notice to mariners, rules and regulations
	monitor of navigation aids and traffic signs
strategic and tactical lock planning on ship handling	presentation of actual lock/bridge status
	plan lock operations based on ETA's/RTA's of approaching vessels (voyage plans)
	functions Tactical traffic information for navigation
strategic and tactical terminal planning on cargo handling	presentation of actual terminal or port status
	plan terminal operations based on ETA's/RTA's of approaching vessels (voyage plans)
	functions Tactical traffic information for navigation
Vessel Traffic Management	monitoring traffic interaction on local or regional level using traffic management system
	monitoring of passing and manoeuvring arrangements in a river sector
	short- and medium term assessment of traffic situation
	monitoring of geographical, hydrological and meteorological status
	monitoring notice to skippers, rules and regulations
	monitoring incidents/accidents in the navigation environment
	monitor voyage plans

[22] This has not been achieved. The development is continued on the assumption that RIS is an ICT structure and not essentially a VTM structure with an open end to logistic service providers.

Services	Functions
Calamity abatement management-information	monitoring of incidents/accidents and focus on traffic situation
	assessment of the possible effects of the accident on environment, people and traffic
	retrieve information on position and activities of patrol vessels, police boats, fire squad boats
	initiation and co-ordination of search and rescue activities
	take measures on traffic, environmental and people protection
	monitor voyage plans
Route and voyage planning	retrieve transport characteristics - Port of destination, RTA at final destination and type of cargo
	Retrieve information on the fairway network
	Retrieve information on lock and bridge opening times and general waiting times
	Retrieve long term weather information
	Retrieve information on obstructions on the fairway
	Retrieve information on long term prediction of water levels, notice to skippers, rules and regulations
	Determine voyage characteristics with RTA's, ETA's, ETD at way points

Table 12.1 Overview of RIS services and functions from an architectural point of view

12.2.2.5 Impulse to the architecture development of RIS

A deliverable of WP 6 of the INDRIS project describes the first attempt to define the RIS architecture, concentrating on the policy level by defining the user requirements or the RIS services and in a. second step to define the operational level architecture.

A broad consensus and unambiguous identification of tasks and themes is a basic constraint to keep RIS effective and stable over a longer period of time. Therefore an architecture style is adopted which aims at the design of an enabling service. This design constitutes a framework to fit in the technical systems needed for the operation of the service. Starting point is the parallel discussions as drawn in figure 12.2. The first step is to unravel these discussions and the corresponding main questions. In the design process of the architecture for RIS, answers should be given to the main questions as presented in this figure. Given RIS architecture and the corresponding design process, it is possible to determine the impact of new developments, such as new strategies for traffic management or the introduction of new technologies.

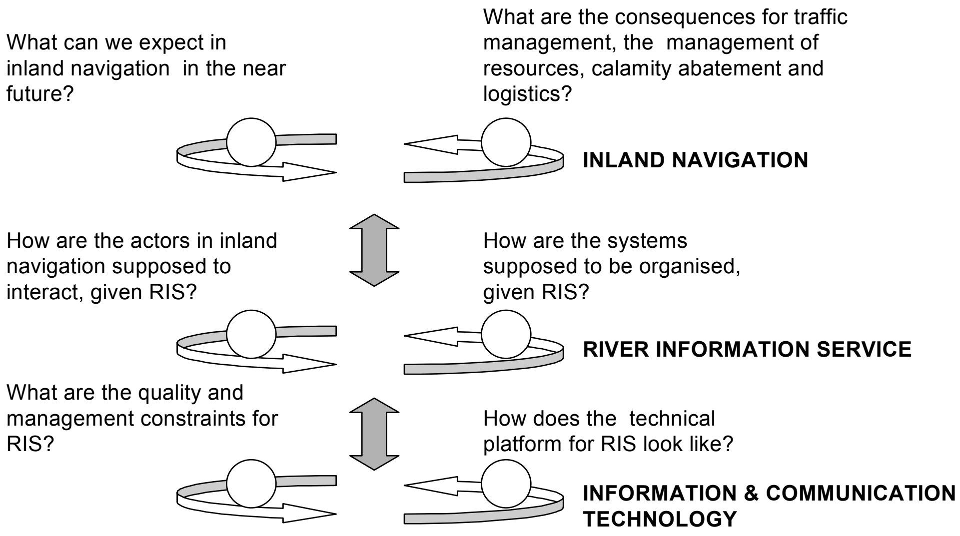

Figure 12.2: The adopted architecture style – questions to be answered

In various chapters of the final report of WP 6 an answer is given to the six main questions, as outlined in figure 12.2. By answering these questions a design for RIS can be made.

It is concluded that the architecture for RIS should function as a framework for good understanding of the objectives and content of RIS. Within this framework themes for standardisation can be identified. Currently, within these themes:

- The degrees of freedom of RIS are limited, in the sense that non-ambiguous communication between actors (exchange of information and knowledge) in inland navigation becomes possible;
- RIS is still an enabling service which can be tailored to processes in the navigation and planning loops;
- RIS is still an enabling service which can be tailored to a specific river area and the requirements of the competent authority;
- Commercial service providers might use RIS, provided that they comply with the RIS standards. This adds additional conditions for the use of data acquired and the management of the waterway authorities.

The final architecture is out of scope of the INDRIS project. The report of WP 6 should be looked upon as an impulse to architecture for RIS. Not all the questions related to the design of architecture have been answered completely. Therefore in the final chapter of the report suggestions have been made to proceed towards *the* architecture for RIS. There are three main steps to be taken, namely:

1. Gain assessment for this reported impulse to architecture for RIS. Incorporate annotations and comments to this document;

2. Incorporate the results and lessons learned from the demonstrators;
3. Bring the RIS concept to a final status

The RIS architecture should form the basis for policy makers, users and engineers to design, develop and construct the communication and information systems for RIS. It also should form the basis for skippers and operators to arrange their tasks according to RIS and equip the vessels control rooms and back-offices with the information and communication systems for RIS.

12.2 Co-operation between EU member states and industrial partners

The co-operation of the European member states in INDRIS was a success factor for the development of INDRIS. It appears that some of the administrations involved were interested in some kind of management system along their fairway network.

In Austria, attempts were made to install a guidance system along the Danube to mitigate any problem that arises form navigation in a mountainous stretch where skippers are not able to observe other vessels in time.

In the Netherlands similar problems of visual and radar detection of other ships became apparent. It was observed that inland vessel’s radar were not adequate to locate targets that were hidden behind dikes and obstacles. The idea was generated to provide vessels with a radar image of a shore antenna (a so-called shore based radar traffic image). This antenna could see the vessels that were hidden to the ship’s radar antenna.

Across Europe a great interest was aroused in the ECDIS developments. In Germany the development of Inland ECDIS was already started at the beginning of INDRIS. This has taken place in the Project ARGO.
If inland water transport should be a competitive mode as compared to other modes, more attention should be given to the solution of the problem of reliability of inland transport. Inland ECDIS was seen as one of the options that can provide solutions.

In Belgium and France the abolition of the markets for skippers had led to electronic systems. These systems support skippers to find cargoes. In France a system was designed working on Minitel. In Belgium another solution[23] was in preparation with the same purpose. They also were designing a system that would notify the use of locks and in this way regulate the traffic.

The execution of some European research projects notably INCARNATION and RINAC made the participants aware of these developments in these countries and efforts were made to combine these developments. It is the merit of the administrations of Austria, France[24] and the Netherlands that they have combined their efforts to establish a co-operation in order to get a definition of RIS and to work on the standards that are necessary for any progress in RIS.

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[23] This system is called BIVAS.

[24] In particular: Voies Navigables de France

At the same time, a number of companies were interested in the various applications related to RIS, particularly in the field of transponders.[25]. These companies were looking to expand their activities for seagoing vessels to other modes of water borne transport. This interest introduced transponder technology into INDRIS.

INDRIS came just in time to:

- Incorporate new technologies in inland navigation (AIS and Inland ECDIS)
- Put a framework for West European co-operation on RIS, standards and harmonisation (RIS guidelines, Inland ECDIS standards, AIS standards)
- Develop more user-oriented applications not only for Vessel Traffic Management, Safety of Navigation but also oriented to Value Added Services to the transport industry (VTM in large areas, on board applications and tracking and tracing and other logistic and transport information exchange).

In INDRIS, the majority of the suppliers seem to realise that are opportunities regarding equipment and software. It is expected that in a follow-up project the suppliers will make use of the benefits of INDRIS and develop tailor-made applications for the market.

12.3 Technical Issues and Feasibility

A number of technical issues were discussed in INDRIS. The most important one was the use of transponders. Two issues need to be discussed.
The first issue will need further theoretical and practical investigation. The AIS standard was developed for maritime areas, in which the traffic density is considerably smaller than on inland waterways or harbours. In harbour areas and high-density areas on inland waterways AIS communication can de faced with overload situations.

This overload situation will become more apparent in combination with shore based AIS networks where transmission of radar tracks as artificial AIS tracks will be integrated in the AIS communication. This will lead in these areas to restrictions in the use of AIS, which are not acceptable.
These problems are submitted to the maritime standardisation bodies for further considerations.

The second issue is the question whether or not to use IMO compatible transponders. As an argument in favour of the use of these transponders is the fact that transponders will be universally used. In many cases, inland navigation is operating in areas in which sea traffic is also operational, the so-called mixed traffic zones.
On the other hand the final IMO-AIS standards are still not formalised and small amendments are remaining. INDRIS started with standards fixed at the situation at 1 July 1998.

A critical factor seems to be the market price of a transponder. There is appreciable anxiety among prospective users regarding the costs of these IMO compatible transponders. This is one of the reasons that, up till now not a single public authority has the intention to make the AIS transponder mandatory.

[25] DASA and HITT played a large role in transponder technology in INCARNATION.

12.4 Benefits for users

The users can be described in a number of different user groups. The following user groups may be distinguished:

- Skippers
- Terminal operators
- Lock operators
- Fleet managers
- RIS-operators
- Logistic service providers

12.4.1 Skippers

The skippers benefit from RIS through the use of ECDIS allowing them to plan optimal ship drafts for their voyages and plan the routes when voyage preparation software is used. They are also able to benefit from fuel minimisation software and create lower fuel bills. They are also able to plan precisely their passage through locks using ETA's and get in return RTA's from the lockmaster. On top of that, AIS will contribute to safety since AIS is able to provide them with crucial identification information in cases where it is necessary to agree on certain manoeuvres. The reporting software will reduce reporting and skippers are also able to communicate their ETA's with terminals and agree in advance a RTA. In summary, RIS may provide him with benefits as time reduction for reporting, fuel consumption improvements by making arrangements in time and safety benefits using the AIS.

12.4.2 Terminal operators

Terminal operators are able to make improved planning for loading and unloading of the expected vessels if they have received accurate ETA information. This will remove waiting times at the terminal for an announced but vessels, not yet arrived. It will also contribute to a satisfactory planning of all terminal activities if this communication facility is directly coupled to the planning software used by terminal.

12.4.3 Lock operators

Lock operators are able to collect information of arriving vessels and make a planning of the use of the lock. This would require the dimensions of the announced vessels as well as the cargo of the vessel, so that the lock operator is able to determine the vessels that will be accepted for a cycle. He is then able to provide the skippers with a RTA at the entry of the lock. The lock keeper can now use several planning options such as minimising the number of cycles to reduce the intake of water with different salinity or to minimise energy used to level off the locks. It is also possible to use a fixed slot system, where vessels are able to reserve a certain lock cycle.

However, in the transition period between the present and future situations, problems may be expected due to the reservation system. A lockkeeper may know the arrival of a vessel equipped with RIS equipment, whilst for other vessels the presence and intentions to use the lock are made clear using VHF communication. This communication often takes place when the lock keeper is able to see the vessel (visually or by radar). The question is now whether or not well-equipped vessels have preference and reserve a place in a given lock cycle whilst other vessels may not have the same opportunity. This point should be discussed with the lock personnel, the competent authority and the skippers in order to find acceptable procedures in the transition time.

12.4.4 Fleet managers

Fleet managers may use a regional or strategic traffic image to have an overview of the position of their vessels. It is very similar to a taxi central that at any one time has an overview of the position and status of their taxis. Fleet managers may use the same regional traffic image as being used by VTM personnel. This, however, may damage the privacy aspects of other competitive fleet managers. The same information may be used but it should be restricted to vessels of the own company and to ships that are chartered by the ship owner. Filtering the available ship information that is present in the RIS centre may provide this information.

The same information may also be used for tracking and tracing purposes. Fleet managers may also provide information to the cargo owners on the whereabouts of their cargo if the connection between vessel and cargo is known. Specific test in order to demonstrate the viability has not been carried out during the demonstrations of INDRIS. This issue needs to be studied in more detail in a follow-up project.

12.4.5 The change from local to regional traffic management

The original idea of Vessel Traffic Management as provided in local VTSs may be changed by the introduction of RIS. The original role of the VTS-operator was to inform skippers regarding general but relevant information for safe navigation as well as providing traffic information. In some cases navigational assistance as defined by the VTS guidelines was provided in case where an inland vessel developed a radar failure in cases of bad visibility. By providing traffic information, a VTS-operator also contributed to a smooth traffic organisation. Voice communication was and is the major agent in inland VTS for communication.

RIS opens a new horizon. It was generally accepted that the skipper is and remains responsible for the safe navigation of his ship and that he contributes to the safety of other vessels by adhering to the navigation rules. In cases where he is not able to make safe navigational decisions he might receive information from the VTS to improve his decision-making and improve safety levels.

RIS will change this. The AIS and inland ECDIS technology on board enables the skipper to have information on board he never had before. This information is provided without voice communication. It strengthens the quality of the navigation decisions on board. It reduces voice communication and reduces the possibility for miscommunication and in that way improves safety.

The RIS-operator is not the same person as the VTS-operator. The VTS-operator was interpreting his traffic display and was providing information to the vessel but since nearly all this information is available on board the role of a RIS-operator is changing to traffic organisation and monitoring of larger areas than in the case of local VTS. Radar was providing the VTS-operator with a traffic display of the immediately area around a radar sensor, AIS with sufficient shore infrastructure provides a traffic image over a large area. This is the reason why some analysts call this a regional or strategic traffic image. The benefits of RIS as compared with VTS are now clear. The monitoring area is much larger than before, whilst the voice communication between vessels and a RIS-operator is sharply reduced. This provides opportunities to monitor and organise traffic in a large area, if need be. For the competent authority reduction of costs and increase of the span of control is possible and comes into reach.

The benefits of monitoring a large area in cases of dense populated areas and in mountainous stretches are, however, larger than the disadvantages. It is expected that inland VTSs gradually will phase out and be replaced by RIS infrastructure. In focal points, radar images will be used to complete the traffic images. RIS should be seen as a large improvement of Vessel Traffic Management proper. It places the responsibilities for safe navigation and navigation decision-making where it belongs: on board the inland vessel by its skipper.

12.4.6 Logistic service providers

Logistic service providers are highly interested in reliability of their services. They desire to provide high frequent, reliable connections within the inter-modal chains that are used. This means that in the planning stage, information should be available on water levels and draughts to be used in order to define frequencies and capacities. This reliability also requires that information on locks and bridges is available that can be used to optimise these sailing schedules.

In the operational phase the progress of the voyage as compared with the planned progress is important for the logistical service provider to implement additional measures to ensure that he satisfies his contracts and keep his clients satisfied. RIS is able to provide the required information to make inland transport more reliable. RIS is considered as an agent to improve and increase the cargo volume transported through the European inland water network.

There is also an increasing demand for green transport. It is well known that the emissions due to the fuel consumption as well as noise levels along the inland waterway network are decreasing as compared to road transportation. The differences in speed and delivery times may not always be critical and consequently when supply chain demand and improved planning is introduced in the inland water transport chains, the consequences of the lower speeds may be fully or at least partly compensated.

12.5 Organisational Requirements

A system, as INDRIS meant to be used across Europe, can't function without tight agreements regarding standards. The management of INDRIS has quickly grasped the importance of standards and harmonised procedures and directed that the results of work packages regarding AIS and the data dictionary would be used in all demonstrators. At the same time it was thought necessary that guidelines for RIS are developed and used. The organisation of these activities needs to be carried out on international level in order to keep sufficient momentum. This momentum is necessary because suppliers of hardware and software will not start producing hardware and software for RIS, if standards are not fixed and may be changed.

RIS can’t further develop when a supra-national agency is not taking care of the standards and has sufficient authority to be regarded as the focal point for standards. It is not clear how such an agency can be established. This agency is not yet found that can act as the committee that approves, amends and issues standards and harmonisation procedures. It is necessary that these issues are addressed soon, in order to speed up the development and implementation of RIS across Europe.

12.6 Conclusions

INDRIS started as an ambitious project with ambitious objectives. These objectives that were set at the beginning, were not fully achieved. However, on the other hand, the project has attracted parties that were not a part of the project in the beginning. This contributes largely to the final results, since nearly all West European countries now support these results. Looking back at the INDRIS project, one could say that this project came at the right time and started up a whole series of projects in telematics for inland navigation and was the beginning of a European network of VTMIS systems for inland navigation.

The conclusions can be divided into a number of categories:

- Co-operation between EU member states and industrial partners,
- Technical issues and feasibility,
- Benefits for users,
- Organisational requirements

12.6.1 Co-operation between EU member states and industrial partners

The following conclusions have been drawn:

- An excellent working co-operation has been achieved in INDRIS by creating common objectives and win-win situations by sharing information.
- Co-operation between industrial partners should be stimulated because industrial partners are inclined to look more at commercial issues and competition rather than at co-operation to achieve efficient and cost-effective transport.
- Co-operation between industrial partners in a project should be co-ordinated by a non-commercial management of such a project.
- The approval of EU project is more important to some partners than the actual execution of the project and the exploitation of its results.
- Some partners are only interested in their own work and do not show much concern with the objectives of the project

12.6.2 Technical Issues and Feasibility

The following conclusions have been drawn:

- The technical realisation of RIS and many of its elements has been demonstrated successfully on several locations in Europe.
- Interconnectivity within RIS and between RIS and other systems can be realised by setting and maintaining open data and communication standards.
- Inland ECDIS is a very strong platform as a reference for geographic information and applications using this information. The Tactical Traffic Images and Strategic Traffic Images on board and on shore for Vessel Traffic Management, Planning purposes and safe navigation exemplify this.
- Inland ECDIS charts are available for the Rhine and the Danube.
- On the basis of Inland ECDIS standards such as S52 and S57 as well as the performance standards, commercial suppliers of all kinds of systems can design, develop, build and sell their own applications.
- EDI reporting as used in BICS is already a success and avoids extensive confusing communication, especially about dangerous goods transports
- AIS transponders according to the IMO standards can be applied in inland navigation, thus contributing to safe navigation. They are particularly useful in

areas of mixed traffic with maritime and inland navigation as well in areas with high shipping densities and areas with special navigational difficulties such as rivers in mountainous stretches like the Danube.
- Standard IMO AIS transponders are still non-existent: every supplier has its own specific peculiarities; these should be changed to the actual standards as agreed in IMO. A test bed such as the German test bed will help identifying loopholes in the standards and contribute to a general application of AIS transponders.
- INDRIS contributed to the standardisation committee of AIS transponders by upgrading the standard for inland navigation use.
- A standard for data and communication in inland navigation has been designed.

12.6.3 Benefits for users

The following conclusions have been drawn:
- Voyage planning can be improved and rationalised using the INDRIS applications.
- Fuel consumption can be reduced with some INDRIS voyage applications because the skipper will have exact information about the RTA's (Requested Times of Arrival) at locks and terminals. This in turn will help to determine speeds at the various stretches of the voyage.
- Just-in-time transport can be implemented because of the excellent planning tools in RIS.
- Waiting times near terminals can be reduced because of better information exchange between terminals, barge operators and skippers.
- Safety can be enhanced at
    - RIS Vessel Traffic Management centres because they receive:
        - improved and more reliable information
        - less VHF communication on safety channels
    - Ships because they have available
        - improved and more reliable information
- The use of EDI leads to automatic reporting procedures resulting in less work of the navigator of an inland vessel.

12.6.4 Organisation Requirements

The following conclusions have been drawn:
- There is a large need for a permanent European structure for maintaining and updating standards.
- There is a need for a European committee to co-ordinate implementation of RIS and RIS features. In the meantime the first step has been undertaken to establish a "European RIS Platform" with representatives of the competent authorities.

13 RECOMMENDATIONS

The following general recommendations are made based on the project results of INDRIS.

13.1 Implementation Committee for RIS results

The general results of the demonstrations of RIS systems lead to the recommendation to start implementation of the results of these demonstrations. A first step is made by a Dutch initiative, to establish a European RIS Platform with representatives of the involved administrations. Switzerland is also invited to participate. This Platform will start to consider implementation plans of the most crucial parts of the RIS infrastructure that are within the competency of the national authorities. This is in essence a structure to share and disseminate voyage and cargo information for ships using modern database and sensor technology. It is recommended that this committee also discusses the introduction of Inland ECDIS collection of data structure and decides on the issue of transponders.

13.2 Standardisation and harmonisation

The standardisation issue is very important. Without standards, industry will probably not launch applications on the market when standards are changing. It is recommended to find the right European forums to discuss and fix the standards and improve the harmonisation process for all the components of RIS on an authoritative basis and acceptable for all parties involved. However when new technologies appear on the market steps should be undertaken to apply them even when standards need to be adapted. This is necessary in order to open the market for technologies that provide more power for less cost.

13.3 Expansion of the RIS concepts to non European member states

It is recommended to apply the RIS standards and the RIS concepts to all countries that belong to the major river basins in Europe. Even if the countries concerned are not yet a member of the European Community. This requires a broad expansion of the Membership (public as well as private partners) of any new project that strives to introduce and improve the present equipment of RIS

ANNEX 1 PARTNER LIST

Overview of companies, institutes and agencies that have co-operated in INDRIS

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ANNEX 2 PRESENTATION LIST

1997

Presentation	Date	Venue	Occasion
RIS	20.02.97	Rotterdam	Symposium MSR
INDRIS Proposal	10.04.97	Strasbourg	Fachausschuss VBW
RIS & Inland Waterways Management	05.06.97	Bruges	European Inland waterways authorities
RIS	17.11.97	Amsterdam	VTMIS congress

1998

Presentation	Date	Venue	Occasion
RIS	15.01.98	Rotterdam	Kick-off meeting INDRIS
RIS	05.03.98	Strasbourg	CCR congress
Functional Definition Phase	18.03.98	The Hague	RINAC Consortium
INRIS general	07.05.98	Duisburg	Telematik Gruppe VBW
INRIS general	27.05.98	Amsterdam	IHMA congress
INDRIS general	04.06.98	Vienna	European Inland waterways authorities
INDRIS & INCARNATION	08.06.98	Lisbon	EU DG-VII dissemination
INDRIS general	16.07.98	Rotterdam	Rotterdam Port Authority
INDRIS & inland waterways	3/16.08.98	Moscow/St. Petersburg	Work visit Russia
INDRIS general	7/11.09.98	The Hague	PIANC congress
VOIR/INDRIS	10.11.98	Rotterdam	Rotterdam Maritime

1999

Presentation	Date	Venue	Occasion
Progress ECDIS in Nederland	14.01.99	Dordrecht	Meeting Ministry of Transport, the Netherlands
Traffic and Transport Management	29.01.99	Strasbourg	Visit CCR Telematica group
Traffic and Transport Management	09.03.99	Brussels	Quatre Mains workshop
INCARNATION/RINAC/INDRIS	30.03.99	Rotterdam	Building bridges conference
Telematics in inland waterways	26.03.99	Utrecht	TROS television Program
RIS	12.04.99	Vienna/Bratislava	VTS demo Austria
INDRIS general	10.06.99	Balatonfured/Hungary	EIWN congress
INDRIS general	16.06.99	Amsterdam	ITS congress
INDRIS general	08.07.99	Luxembourg	European Inland waterways authorities
INDRIS general	23/24.09.99	Berlin	Waterways futures Urban and inter-urban perspectives
Traffic Management	04.11.99	Delft	PATO course
Rhine/Scheldt demonstrator	15.10.99	Brussels	INDRIS consortium meeting
INDRIS general	21.10.99	Paris	VTMIS workshop
Paying the way for sustainable mobility	8/9.11.99	Lille	Transport and Research Conference
INDRIS general	10/11.11.99	Grein	Danube demonstrator

Presentation	Date	Venue	Occasion
INDRIS general	17.11.99	Goes	Meeting Dutch Harbour Authorities
INDRIS general	02.12.99	Hamburg	Maritime and Inland Waterways navigation and transport workshop ISSUS
INDRIS general	02.12.99	Antwerp	Flemish demonstrator
INDRIS general	10.12.99	Paris	Seine demonstrator
INDRIS general	29.12.99	Nijmegen	KSCCC Telematica day Inland Navigation

2000

Presentation	Date	Venue	Occasion
INDRIS general	17/21.01.00	Singapore	VTS symposium
INDRIS general	7/8.03.00	Norway	FARGIS conference
VOIR-IRAS-INDRIS	17.02.00	Utrecht	Mobilon
Rhine-Scheldt demonstrator	25.04.00	The Hague	Workshop policymakers inland navigation
Rhine-Scheldt demonstrator	08/12.05.00	Dordrecht	INDRIS demonstrator
General ICT development in inland navigation	09.05.00	Dordrecht	KIVI group during the INDRIS demonstrator
The benefits of standardisation and ECDIS	15.05.00	Dordrecht	Visit Electronic chart supplier
INDRIS general	22/25.05.00	Macau	Eureka Asia
Rhine-Scheldt demonstrator	16.05.00	Dordrecht	Visit VTS operators
RIS and VTM in the future	17.05.00	Dordrecht	Visit VTS operators (two sessions)
INDRIS general	18.05.00	Bonn	Visit & discussion BMVMV
Rhine-Scheldt demonstrator	24.05.00	Dordrecht	Visit Harbour authorities
Rhine-Scheldt demonstrator	25.05.00	Millingen	Calamity demonstrator
Rhine-Scheldt demonstrator	29.05.00	Dordrecht	Visit local operational shipping and patrol departments. Nautical educational institutes
Rhine-Scheldt demonstrator	29.05.00	Dordrecht	Visit lock keepers
INDRIS general	29.05.00	Dordrecht	Visit Ministry of Transport of Egypt
INDRIS general	30.05.00	Rotterdam	Visit delegation from Vietnam
Rhine-Scheldt demonstrator	30.05.00	Dordrecht	Visit skippers
INDRIS general	06.06.00	Dordrecht	Visit members NNVO (National Organisation for Nautical Education)
INDRIS general	08.06.00	Wilhelmshafen	Themis meeting at world exhibition
INDRIS general	20.06.00	Strasbourg	Visit members CCR
Sailing meeting with INDRIS demonstration	05.07.00	Dordrecht	Visit members Thematic network WATERMAN
INDRIS general	7/11.08.00	St. Louis	Visit USACE
RIS and terminal planning	18.09.00	Dordrecht	Visit Terminal operators
Traffic and Transport Management Information and STIS	13.10.00	Dordrecht	CBRB (skippers branch organisation)
INDRIS general	07.11.00	Turin	ITS world conference
INDRIS general	01.12.00	Dordrecht	Visit AIS working group

ANNEX 3 LIST OF FINAL REPORTS OF WORK PACKAGES AND THEIR MAIN AUTHORS

1. Input from other research tasks, final report Work Package 1

   Author(s): C.P.M.Willems, AVV,
   Date: 01.05.98
   Code: T17.01/TR/AVV/010598/W95W70/1.0/E

2. Standardisation of communications, final report part 1 Work Package 3

   Author(s): P.H. Trommelen and K.J. van Staalduinen , TNO-FEL
   Date: 20.12.98
   Code: T17.03.04/TR/TNO-FEL/201298/W95W70/1.0/E

3. Standards for Tactical Traffic Image, Communication and Messages final report, part 2 Work Package 3

   Author(s): W.F.M. van der Heijden - TNO-FEL
   Date: 09.02.99
   Code: T1703/TR/TNO-FEL/090299/W95W70/1.0/E

4. Standardisation of Data, final report Work Package 4

   Author(s): L. Kuiters, AVV
   Date: 22.12.98
   Code: T17.04/TR/AVV/221298/WNTW70/1.0/E

5. Reporting database, final report Work Package 5

   Author(s): C. de Cena -Top View, Giorgio Allasia -D'Appolonia
   Date: 10.06.99
   Code: T17.05/TR/DAPP/100699/W95W70/1.0/E

6. Strategic Traffic Image, An impulse to architecture for RIS , final report Work Package 6

   Author(s): R.A. Visser – AVV and P.H. van Koningsbruggen - CMG The Hague B.V.
   Date: 01.07.99
   Code: T17.06/TR/AVV/010799/WNTW70/2.0/E

7. User requirements, Functional definition of the RIS concept, report Work Package 6.3

   Author(s): C.P.M.Willems - AVV, P Kluytenaar - Serendipity, L Kuiters and J.G. van Hezewijk -AVV
   Date: 30-06 1998
   Code: T1706.3/TR/AVV/300698/WNTW60/1.0/E

8. Voyage planning and ETA calculations, report Work Package 6.5

   Author(s): C. C. Glansdorp - Marine Analytics B. V. and D. ten Hove - Maritime Simulation Centre Netherlands B.V
   Date: 01-06-1999
   Code: T1706/TR/MARAN-MARIN/010699/W95W60/3.0/E

9. Rhine Scheldt demonstrator, final report Work Packages 7-10

   Author(s): C.P.M. Willems – AVV
   Date: 04.12.00
   Code: T17.07-10/TR/AVV/041200/WNTW70/1.0/E

10. Danube demonstrator, final report Work Packages 8-11

    Author(s): H Pozenel - Alcatel, C. Tippmann - ET&S
    Date: 30.06.00
    Code: T17.08-11/ALCATEL-ET&S/300600/W98W70/1.0/E

11. Seine demonstrator; final report Work Package 9-12

    Author(s): E. Flipo – Voies Navigables de France
    Date: 22.12.99
    Code: T17.09-12/TR/VNF/221299/W95W70/1.0/E

12. Assessment of INDRIS on the basis of the Rhine, Seine and Danube demonstrators
    Final report and sub work package reports, Work Package 13
    Author(s): B. Zigic (VBD-EBD), C. Glansdorp (Global Maritime), A. Niaye (ANAST), D. Jarvis (MSR) and J Prunieras (IFN)
    Date: 15-07-1999
    Code: T17.13.01/TR/ANAST/150799/W95W70/1.0/E
    Date: 29-06-2000
    Code: T17.13.02/TR/VBD/29061001/W95W70/1.0/E
    Date: 01-01-2001
    Code: T17.13.03/TR/MSR/010101/W95W70/1.0/E
    Date: 31-01-2001
    Code: T17.13.4/5/TR/ANAST/310101/W95W70/2.0/E

13. Final report

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Code:	T17.1701/TR/AVV-MARAN/12-01-01/W98W7.0/3.1/E

14. Policy report

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Code:	T17.1702/TR/AVV-MARAN/12-01-01/W98W7.0/2.0/E

15. Dissemination and exploitation

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16. Guidelines and recommendations for River Information Services, final report, WG789

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