Paper 66 – Shipborne Information Services

Van der Burgt, T.; Şentürk, B.; Wouters K.
Rijkswaterstaat Centrale Informatie Voorziening (RWS CIV; Ministry of Infrastructure, executive organization, Central Information Services), Delft, The Netherlands

Email (1st author): therry.vander.burgt@rws.nl

ABSTRACT: Rijkswaterstaat has a fleet of patrol vessels at its disposal to provide mobile VTS services in order to keep the fairways safe and waterborne transport flowing and to protect the environment. To provide the crews of these ships with the information they need and to enable them to report irregularities with pinpoint accuracy, a new and innovative Ship borne Information Services system was developed which allows detailed monitoring and management of inland shipping in the Netherlands.

1 INTRODUCTION

The intricate fairway network in the Netherlands with hundreds of locks, bridges, weirs and thousands (inland shipping, recreational, fishing and coaster vessels) of vessels transporting people and (dangerous) goods every day necessitates constant vigilance from waterway authorities, especially in densely populated countries as in Western Europe.

In addition to services provided by vessel traffic centers, Rijkswaterstaat patrol vessels work together with water police and safety inspection organizations to ensure safe traffic on the waterways. Due to complex infrastructure and the high traffic density, the vessel’s own variety of information systems and VHF communication has too many limitations to enable the crew to handle this in an effective and efficient way. An integrated and intuitive information service is required to meet those goals.

2 INFORMATION REQUIREMENTS

2.1 *Tasks and roles aboard a patrol vessel*

A regular Rijkswaterstaat patrol vessel crew consists of three people:

- Captain; responsible for the vessel, its maintenance and repairs.
- Mobile VTS operator; responsible for nautical issues, directing vessel traffic, deployment of the patrol vessel and organizing the daily schedule together with the captain and the assistant captain.
- Assistant captain; often being trained for captain and eventually mobile VTS operator.

The crew of a patrol vessel not only facilitates safe and swift travel along the fairway but also monitors water levels and shallow sections, water quality, inspecting aids to navigation (buoys), enforcing the riverine rules of conduct, reporting information for Notices to Skippers, assisting public events and performing inland shipping inspections. These inspections include boarding inland shipping vessels and checking the skippers’ papers.

To support these tasks, the typical patrol vessel is being equipped with a navigational workstation containing an ECDIS viewer, integrated with radar and AIS and several “office” workstations where the crew can use mail, internet, MS Office and the like. The “office” workstations act as a local server aboard the vessel connecting to the shore based Rijkswaterstaat IT network.

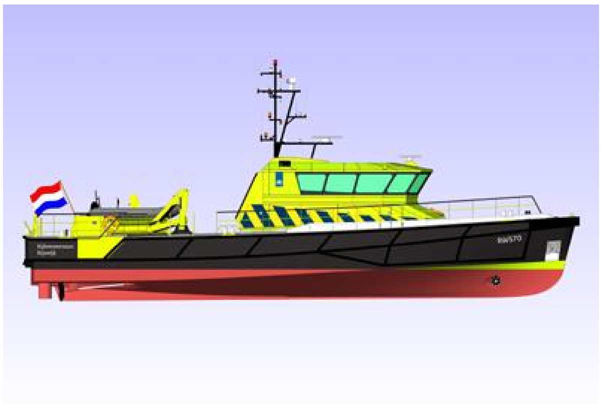


Figure 1: Typical Rijkswaterstaat patrol vessel

2.2 *IT provisioning issues*

The setup mentioned previously of the IT systems on board of the patrol vessels had a number of issues. Reliance on wireless communication links often meant slow and intermittent connection with the shore based network. Information had to be gathered from several different sources through separate IT systems and was incomplete or not up to date. The on board IT equipment varied across the patrol vessels and consequently maintenance and support was difficult.

This often led to crews using VHF or mobile phones to collect information from vessel traffic centers or other waterway authorities, increasing the workload and response times of all parties involved.

2.3 *Standardizing the fleet*

In 2010 a project was completed to harmonize IT equipment on the patrol vessels and ensure the correct placement of suitable communications equipment, thus providing a starting point for further improvement of shipborne information services.

Part of an overarching program (Impulse Dynamic Fairway Traffic Management), this project was outlined with the aim of upgrading the "office" workstation to a mission workstation, providing all the necessary information by integrating information systems through an intuitive user interface: project Shipborne Information Services (SBIS).

2.4 *Requirements*

The project goal was stated as: providing information to authorized users in an intuitive and accessible way, enabling a better and more efficient execution of traffic management tasks.

Further analysis led to the following sub-goals or requirements:

- Optimization of information exchange between patrol vessel systems and shore based systems.
- Easy and intuitive access to information sources.
- Registration of logging and audit trail information.
- Usage of standardized templates for drafting documents.
- Presenting information from different IT systems in an integrated and synchronized way.
- Presenting integrated information from different IT systems on a geographical map.
- Presenting integrated information tailored towards specific situations, including radar and AIS data.
- Guaranteed availability of information, regardless of shore connection availability but depending on information class (real-time, near real-time, non-real-time; refreshed periodically).

The information to be integrated consists of the following categories:

- Fairway infrastructure: geography, traffic lane/carriageway, riverbed, shape, sizes, capacity, draught, man-made constructs.
- Fairway network: interconnection, nautical classification.
- Operating times of locks and bridges.
- Planned openings of bridges and lock cycles.
- District authority geographical borders.
- Safety regions geographical borders.
- Planned and actual aids to navigation
- Pipes and cables
- Cargo and voyage information: identification, type, convoy composition, dimensions,(types of) cargo, number of blue cones, number of crew, number of passengers, current and planned travel, hull(s).
- Vessel information (identification, owner, operator, certificates).
- Current position and course of the patrol vessel.
- Traffic information (current position, speed and course of other vessels).
- Planned limitations of fairway use (usually due to maintenance of the fairway infrastructure)
- Unplanned limitations of fairway use (e.g. lock malfunction).
- Traffic measures.
- Legislation, rules of conduct (location specific), jurisprudence.
- Law enforcement history of vessel
- Law enforcement history, location based
- Permits (vessel related)
- Permits (location related)
- Current hydrographical and meteorological values.
- Hydrographical and meteorological forecast
- Berth usage

Patrol vessel crew members should also be able to add information gathered from visual observation or communication with others.

2.5 Devising a solution

Fortunately, River Information Services (RIS) key technologies have been implemented in the Netherlands in previous years, such as European standardized technology; Automatic Identification System (AIS), Electronic Reporting International (ERI) and Notices to Skippers (NtS). These information services are readily available, limiting the (still substantial) effort to integration and provisioning.

Electronic Chart Display Information Systems (ECDIS) were examined as a possible integration platform. At first glance ECDIS seemed to be an ideal candidate as it offers rich functionality for displaying a large part of the needed information "out of the box".

Instead of using ECDIS, the decision was made to use a GIS (Geographical Information Systems) solution for several reasons:

- The proprietary nature of the available ECDIS viewers contained a high vendor-lock-in risk. This would also have a disproportionate effect on the ENC-viewer vendors in the Netherlands.
- Entering information into systems via a GIS viewer is easier and would prevent the necessity of purpose built changes. The same goes for a number of required data layers and connections.
- There would be a risk of crew using the mission workstation for navigational (safety critical) purposes (because of the identical look and feel. There was no need to apply safety critical requirements to a mission workstation. This made things easier but excluded its use as a navigational workstation.

Another important issue was the IT network connectivity of mobile vessels. Although The Netherlands are a small and densely populated country, mobile network coverage is primarily aimed at residential and business areas and roads, leaving substantial parts of the fairway network insufficiently covered for continuous data transport. This results in:

- Insufficient coverage for 2G/3G connections.
- Instability of the connections.
- Even more reduction of connection availability during incidents or a crisis as mobile communications tend to peak at these times.

Upgrading the communications network infrastructure as an obvious solution to these problems was discarded because of the cost involved. Instead, different types of shore–ship and ship–shore synchronization methods were investigated using the following prerequisite guidelines:

- Minimizing:
  - o data synchronization is limited to changes only.
  - o data synchronization is limited to the selected Area Of Interest (AOI)
  - o data synchronization time intervals are adjustable (reducing communication overhead).
- Prioritizing: volatile data is synchronized with a higher priority and more often than static data.

Starting point for the different methods was the AOI. Data within this AOI can be partitioned in a number of ways and different update strategies can be applied. These were combined resulting in the 3 options below:

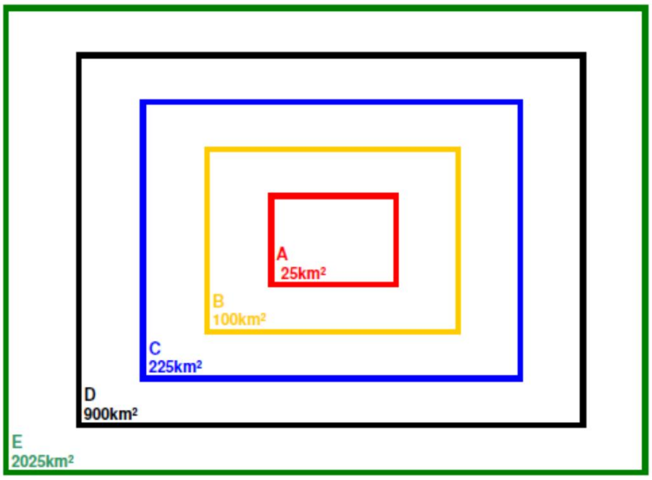


Figure 2: Area Of Interest Sizes (example)

1. Divide the AOI into 5 encompassing parts: A (small), B (average), C (large), D (larger) and E (largest). Synchronize ΔA every 15 minutes, ΔB every 30 minutes, ΔC every 45 minutes, ΔD every 60 minutes, ΔE every 75 minutes
2. Divide the AOI in 3 encompassing parts A, C and E. Synchronize A every 15 minutes, C every hour, E every 5 hours.
3. Divide the AOI in 3 encompassing parts A, C and E and discern 3 priorities in every part.
   Synchronize
   ΔA priority 1 twice every hour,
   ΔC priority 1 once every 45 minutes
   ΔE priority 1 once every two hours,
   ΔA priority 2 once every hour,
   ΔC priority 2 twice every seven hours,
   ΔE priority 2 once every seven hours,
   ΔA priority 3 twice every seven hours,
   ΔC priority 2 once every seven hours,
   ΔE priority 2 once every day.

These mechanisms were analyzed taking into account the number of ships, expected to be in an area, data packet sizes and synchronization intervals. This led to the conclusion that mechanism

3 would be making the most efficient use of an unreliable data connection.

3 ARCHITECTURE (Information technology)

3.1 *Information architecture*

In paragraph 2.4 all information sets required were listed. Most of these need only be displayed on board and integrated in the ship's journal kept by the crew.

As a principle (single source of truth), data is changed only in the appointed source data sets. If a dataset is incomplete (e.g. the crew wants to refer in their journal to an encountered vessel which is unknown in the Vessel Information data set), the local copy can be extended with the incomplete data but this is not automatically changed in the source data set. The responsible owner of the source data set is informed about the missing data and will update it.

Special categories of data are the identification and authorization data sets. Due to privacy constraints, access to certain data must be controlled and logged. Since the crew must be able to log in without an active shore connection their authorization is copied and stored aboard the patrol vessel and can only be updated from the shore to avoid synchronization and lost update problems.

Since one of the recurring requirements is "Single sign on", the designated identity and access data store developed in a previous Fairway Information Services project, is required to be used.

Entries in the ship's journal are copied to a central journal dataset. Vessel inspection information (law enforcement information) is synchronized via the shore based dataset in order to prevent unnecessary hindrance by repeated inspection of barges by different patrol vessels whilst on the other hand assuring that patrol vessels are alerted to repeating offenders.

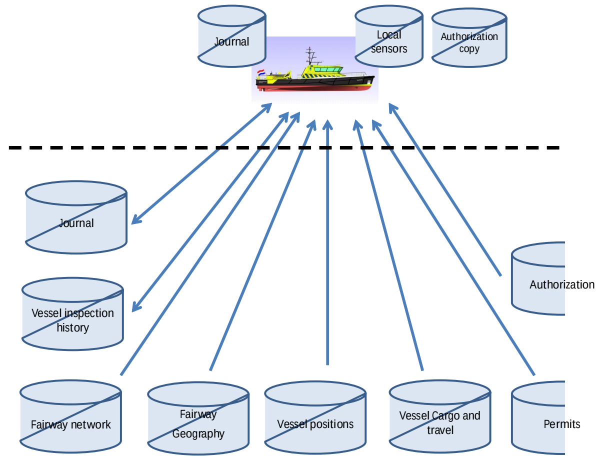
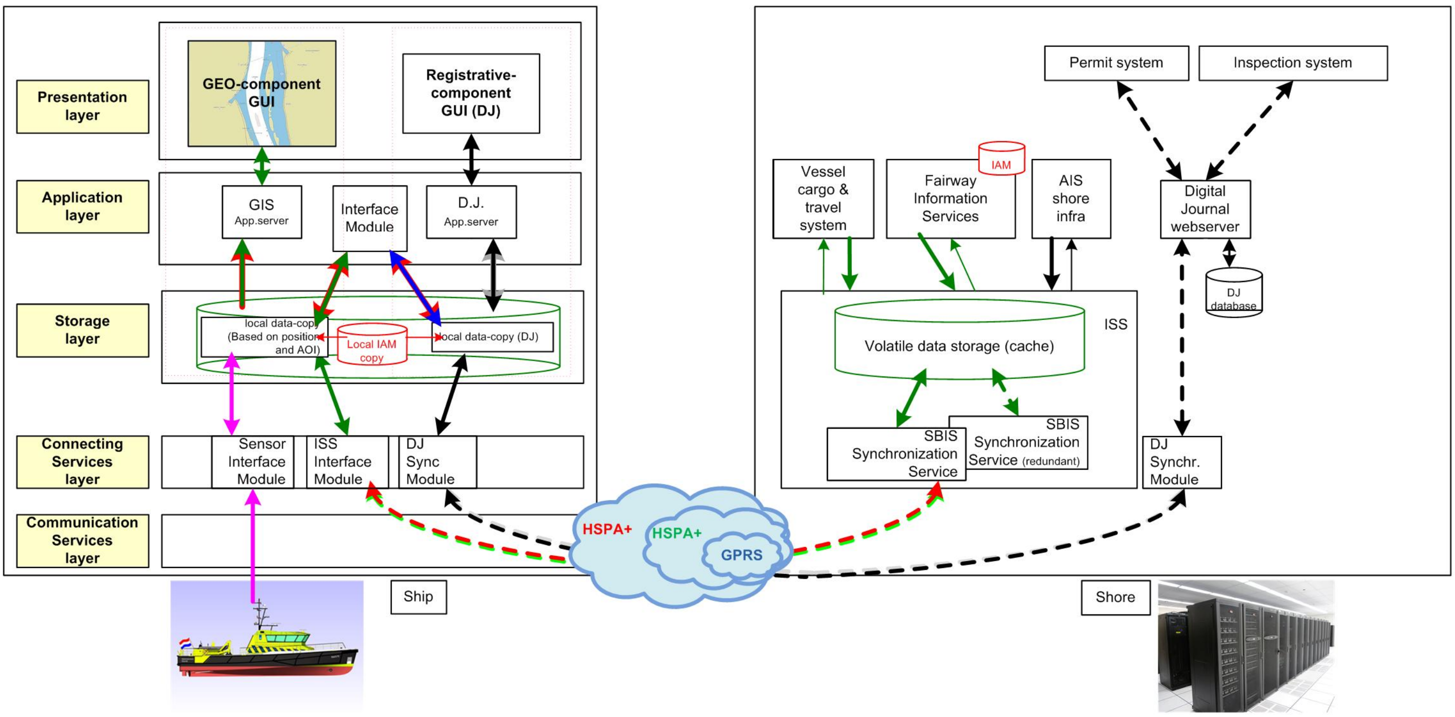


Figure 3: Information architecture

3.2 *Systems architecture*

Unfortunately most data is not available through standardized web services but is instead "locked" inside different systems, some of which are quite old, requiring a lot of effort to make the data available to new systems.

Figure 4: Layered systems architecture



In order to protect operational systems containing the desired data from constant data requests by many patrol vessels simultaneously, an Information Synchronization Service (ISS) was envisioned as a collection and distribution platform between ship and shore.
This ISS periodically sends data requests in predictable and controlled intervals to the supplying systems. It stores the data and detects the differences between the new and previous data set. It then sends the information delta to the patrol vessels according to the AOI they sent to the synchronization service.
Once aboard the vessel, the data is stored locally and shown (together with local sensor information) on a digital map.
This geographical display is integrated with a registrative component to enable the crew to enter (journal) information directly linked to geographical coordinates.

This information is synchronized with the shore based central digital journal system which also provides permit and inspection information through its connections with the permit and inspection systems.

3.3 Technical architecture

Because a vessel on patrol is not easily reached by IT support staff, the shipborne part of the system had to be designed for low maintenance. Most problems should be solved by resetting or reinstalling the system.

The technical IT environment aboard the patrol vessels was standardized and consists of the components in figure 5 below.

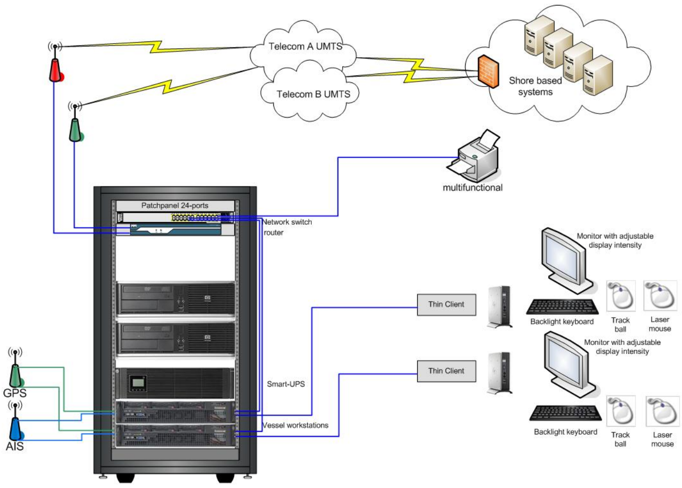


Figure 5: Shipborne technical architecture

SBIS Applications are all Java/Javascript web applications available through the Internet Explorer browser. The local geographical database is PostgreSQL with PostGIS extension.

The central IT environment is technically built up from mainly Java programs running on JBOSS servers with ORACLE databases.

4 IMPLEMENTATION

4.1 Project characteristics

Design and construction of a large part of the SBIS software was done via a European tender. The project ran from 2010 to 2014 with a budget of 10 million Euros. During this time, the software was developed and tested. The digital journal was already available as a web based application on most vessels but had to be changed in order to function connectionless and integrate with the geographical components that were. Effectively, two software development subprojects were run at the same time by two different parties, delivering an integrated product at the end of the project.

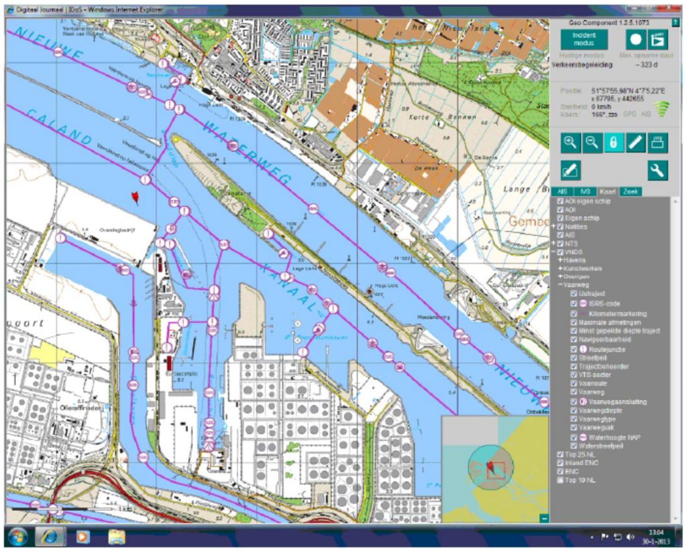


Figure 6: SBIS screenshot

Software quality was encouraged by using four instruments:

1. Before and during construction, required functionality was documented using a systems engineering approach.
2. During construction and upon delivery, software was subjected to a rigorous testing process (T-map). For this (and training) purpose a special "Test bridge" was built to put software to the test before being deployed on an actual vessel, thus reducing the chance of unwanted vessel unavailability even further.
3. Before the start of the project, a Project Start Architecture (PSA) was made. This PSA provided the project with principles, guidelines and the boundaries of the project's design space, aiming to make

sure that anything the project delivers fits into the business processes, information, systems and technical landscape of Rijkswaterstaat, ensuring the continued operation of the delivered product after the project is finished.

4. Technical debt was kept under control by employing an automated monitoring code quality checking process. This led to the SBIS software (including the digital journal software) being awarded 4 starts out of 5 on the Tuvit certification scale for IT maintainability (https://www.tuvit.de/en/certification-overview-1265-trusted-product-maintainability-certificates-1339.htm).

Installing SBIS on the 100 Rijkswaterstaat patrol vessels had to be meticulously planned to coincide with regular vessel maintenance in order to keep the availability of the vessels for operational purposes at an acceptable level.

4.2 Lessons learned

Although all project goals were met, the project encountered its share of obstacles along the way.

Splitting development over two subprojects turned out to be a problem as the members of these subprojects also had a maintenance responsibility, sometimes resulting in conflicts of priority.

A product which is literally at the end of several information chains, not only enhances the value of these chains but also exposes their shortcomings. Information gaps suddenly became visible, e.g. "unidentified ships" entering the electronic chart, because the identification of these ships hadn't been entered yet in one of the supplying data sets.

There were performance issues with the maps onto which the information was projected. Extensive study and testing eventually led to creation of the optimal geographic background maps in order to manage performance issues when processing and displaying the information. Limiting the number of zoom levels and layers solved that problem.

From an organizational perspective, getting a user population with years of nautical experience and seniority but a somewhat conservative attitude towards innovative Information Technology to adopt and fully exploit its possibilities requires considerable attention from the project organization.

Initially having started with e-mail newsletters to a wide audience the project quickly switched to personal emails targeting SBIS end users only when it was discovered that many employees received too many newsletters and hardly any were read.

5 FUTURE DEVELOPMENTS

In the near future it will be possible to enhance the accuracy of position information even more by integrating Radar images using the Inter VTS Exchange Format (IVEF) protocol developed by the International Association of Lighthouse Authorities (IALA). As developments are progressing towards cross-border exchange of AIS and integration of the Dutch Coast Guard AIS monitoring system, the areas of interest available to the mobile traffic manager will be extended even further.

Another subject currently under investigation is the use of Electronic Nautical Charts (ENC). While ENC's are used for navigational purposes they can also be used as a selectable layer of the geographical background (for information purposes) to supply the mobile traffic manager with an image closer to the skipper's point of view. Despite the earlier identified risk of crew using the mission workstation for navigational (safety critical) purposes because of identical look and feel, there is also a need for having the "skippers view" available when entering information about an incident.

To gain the most from the system an E-learning module has been developed, allowing user-training when it is most convenient.

6 CONCLUSIONS

The success of an IT project is of course not only determined by delivering on time and within budget (although this is no small feat as IT projects go) but mainly by its operational use and positive effects on the tasks performed by patrol vessels and their crews.

Of these tasks, responding effectively when a crisis occurs is where SBIS can really make a difference. During a crisis, the patrol vessel crew is focused on acting to resolve the crisis. Because of the automated logging features of SBIS, they don't have to reconstruct the events from memory when they are making their report. Another really useful feature is the ability to make a snapshot image of the AOI and send it via email to multiple recipients saving valuable time otherwise spent on the telephone and/or VHF describing the situation to other emergency services. Fortunately too few crises have occurred in Dutch waters since SBIS went operational to adequately evaluate the effects of its use in such cases.

The majority of Mobile VTS operators interviewed about the use of SBIS, however indicate that the availability of information required to respond adequately to incidents has improved since the introduction of SBIS. Additionally more administrative work is reported being performed aboard instead of ashore. Half of the Mobile VTS operators also report having more time available for tasks such as extra inspections, longer inspections and covering a larger area with SBIS.

REFERENCES

Şentürk, B., 2011, Data synchronization; Internal report on ship - shore data synchronization