Contribution of Norwegian partners (Aanderaa Data Instruments and NIVA) to Safeport project (2010-2012). Final report

NFR-196866 – Entry and Berthing Ship and Port Advising System as an Element of Port ITS. Program MAROFF-2.

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Introduction to Safeport:

Safeport is a joint project between Polish (Gdynia Maritime University, Port of Gdynia Authority S.A., Ship Design and Research Centre S.A and Sprint Sp.Z.) and Norwegian partners (Aanderaa Data Instruments A/S and NIVA) running over a time period of 3 years from 2010-2012.

The overall goal of the project is to improve the safety during approach, entering and berthing of large ships (e.g. ferries) in ports and harbors. Gdynia harbor (Fig.1), one of the largest in the Baltic Sea, and the bay of Gdansk was selected as the major test site for this project. Major components of the project included:

1. Computer simulations of how wind, waves and currents affect the Gdynia-Karlskrona Stena Line ferries. The computer simulations are improved by results from wind tunnel and tow-tank tests using downscaled ferry replicates.

Fig. 1: Stena ferry entering Gdynia harbor. Photo from MarineTraffic.com.

2. Computer modeling of physical conditions (winds, waves, currents, water level and density) in and around the Gdynia harbor. To calibrate and validate the model multiple instruments were deployed in the area. The output is a dynamic model that needs continuous input of wind data from a weather station installed in the frames of Safeport. With this information the model can predict wind and currents in the entire bay as well as just outside and in the harbor.

3. By combining 1 and 2 a ferry-adapted model is obtained that can predict how water and weather forces will act upon the vessel while approaching and navigating into the harbor. This model is running on a computer on-board that constantly receives wind information from a weather station installed at the harbor entrance as well as the position, speed and course of the ferry.

4. The end product is a dynamic visualization software, which is presented on a touch screen PC on the ferry bridge and at the Vessel Traffic Service (VTS) office in the harbor. It gives recommendations on the safest approach taking into account present weather conditions.

The Norwegian partners (NIVA and AADI) are mainly responsible for task #2 (above) in which NIVA builds up a met-ocean model and AADI supply field data, together with Gdynia Maritime University (GMU).

AADI, Sprint and GMU also jointly solved the task of transferring information in real time from shore to the ferry and set up an on-line station to provide necessary wind information to the model as well as detailed information about waves, currents and water level just at the harbor entrance.

We have close contact with the crew of the Ferry Stena Vision (Karlskrona-Gdynia) who will be the first using the system. It is of primary importance that they feel comfortable with the way the system works and how it is presented on the computer placed on the bridge.

A first version of the software was developed and installed on-board the ferry by Gdynia Maritime University (GMU) and Sprint but at the date of writing this report the final version has not yet been released. It was stated by GMU during the final meeting in Gdynia (December 2012) that this work should be finalized in March 2013. A workshop is planned on-board the ferry and in Gdynia in April 2013 to demonstrate the end product. Figure 2 gives an overview of the different components working together in the system.
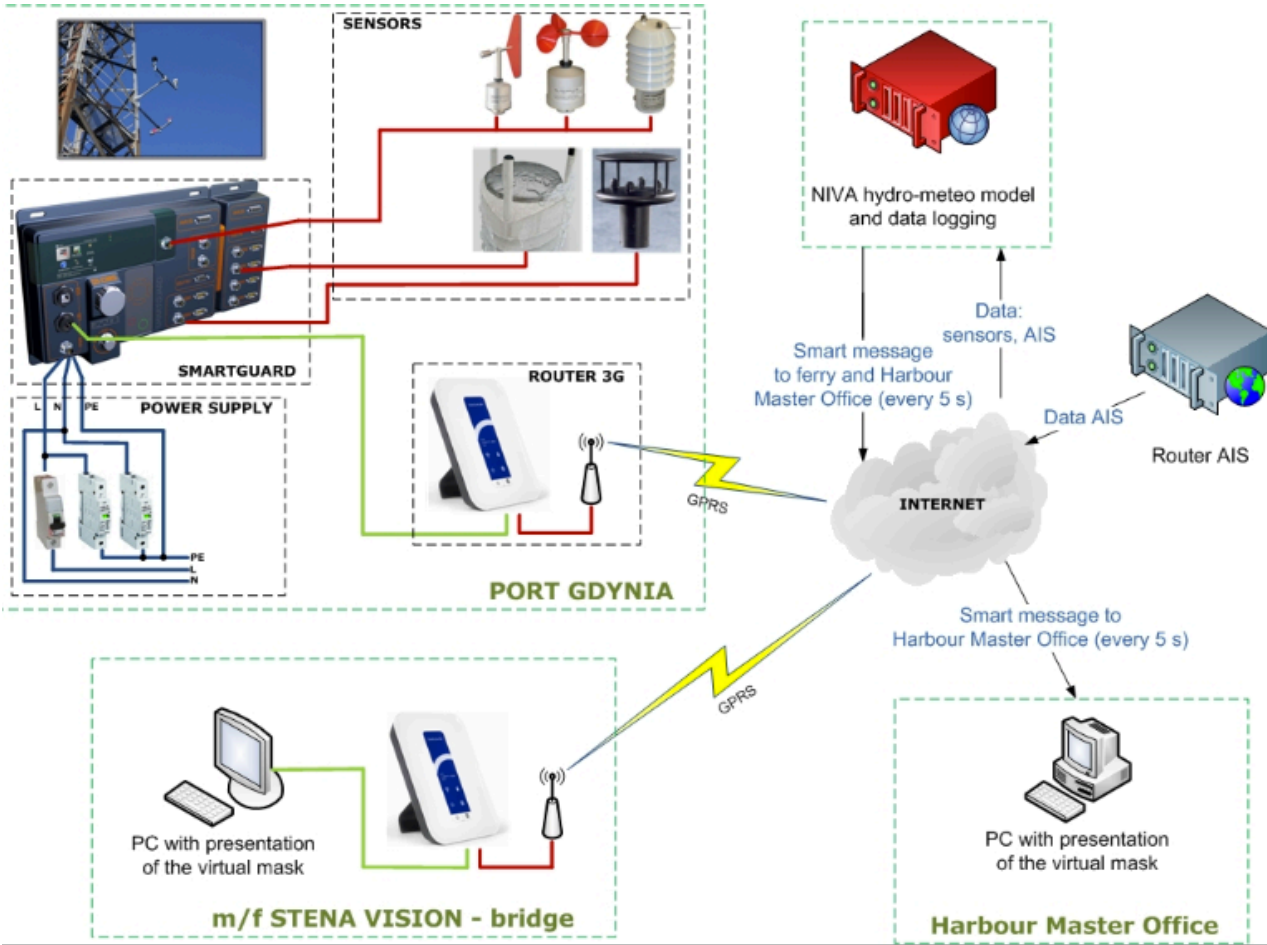

Fig.2: Overview of the hardware used in Safeport to support a safer approach and berthing of the Gdynia-Karlskrona ferry Stena Vision. Drawing courtesy of Safeport partner Sprint.

Work carried out in Safeport:

The Norwegian partners have accomplished more than the work that was originally suggested.

An environmental hydrology-meteorology model (of GEMSS type) was established for the Bay of Gdansk (Fig. 3) by NIVA. This model was calibrated/verified with ample field data from the area including more than one year of measurements of waves, currents, water level, salinity, temperature and oxygen using an on-line instrument from AADI (RDCP-600) installed just outside the harbor entrance (Fig. 4). In addition field campaigns were carried out in 2011 to collect necessary model verification data on salinity and temperature at around 20 points in the bay of Gdansk.

Fig. 3: NIVA model was built up with a coarser grid for the bay of Gdansk and finer grid for the Gdynia Harbor

The RDCP is still installed just outside the main entrance to the harbor and provide on-line data to the harbor authorizes. After some months of use in Safeport the cable to the instrument was dredged off and replaced by AADI.

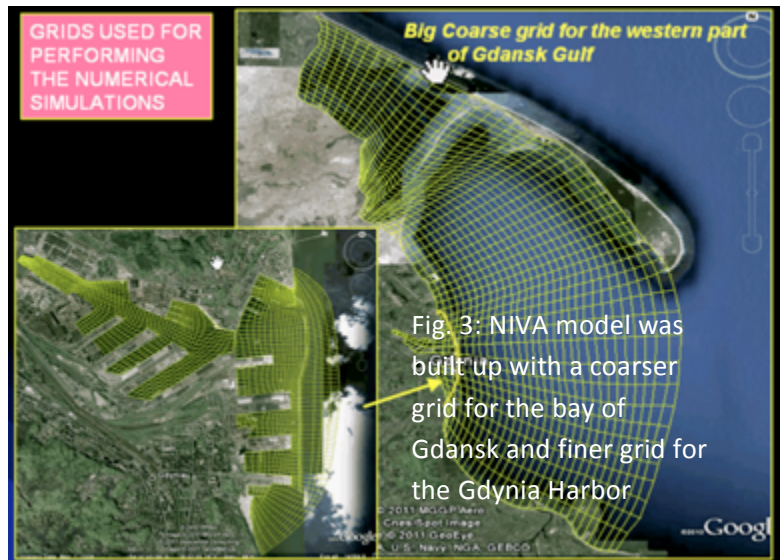An example comparing measured data from the RDCP with model data is given in Fig. 5.

Fig. 4: RDCP-600 with bottom frame on dock during 6-months service and exchange of broken cable, dredged off.
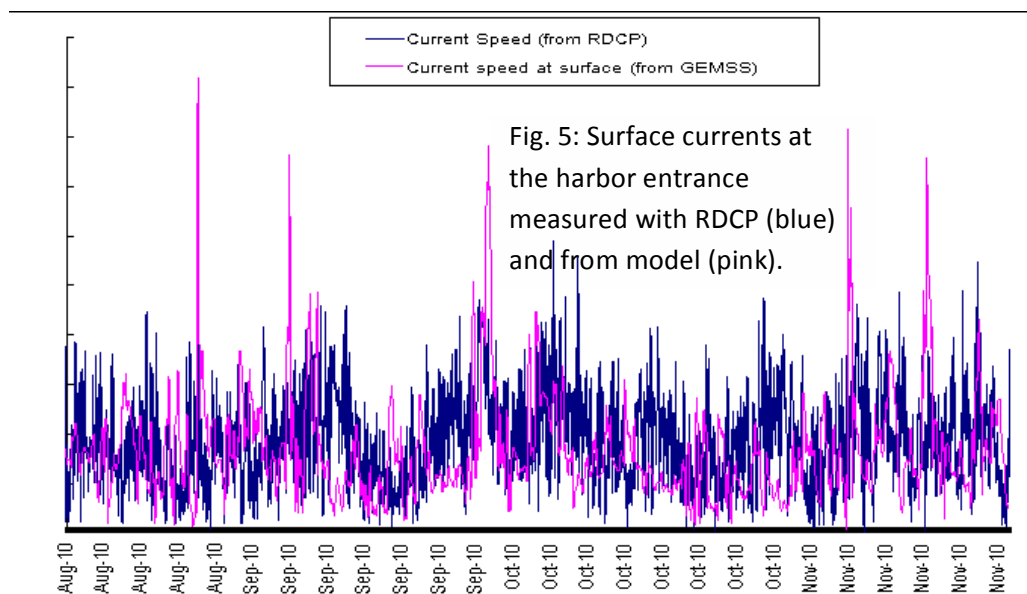

Fig. 5: Surface currents at the harbor entrance measured with RDCP (blue) and from model (pink).

The established model is dynamic and ready for assimilation of real-time monitoring data from a meteorological station installed by AADI and Sprint at the entrance of the harbor within the (Fig. 6A-6C). This station gives on-line information (Fig. 7) on winds with redundant sensor for increased reliability (speed and direction), air temperature, air pressure, humidity and precipitation. Other sensor that could be plug-and-play added to this station later if needed by the Port of Gdynia include e.g. visibility, water density/salinity (for ships limited by their draft) and icing on the dock.

Fig 6A: Wind and Weather sensors installed 15 m above ground level.

Fig 6B: Wind and Weather sensors at harbor entrance

Fig 6C: Cabinet with AADI Smartguard, Globe Star III GPRS modem and power supply.
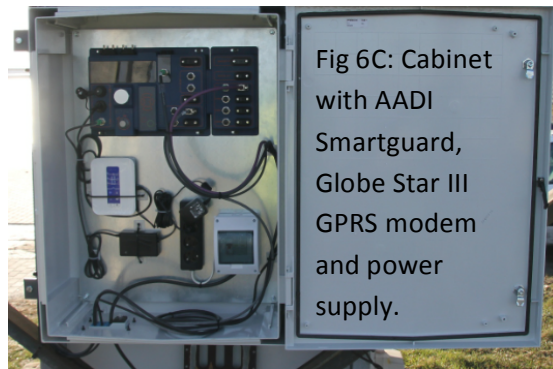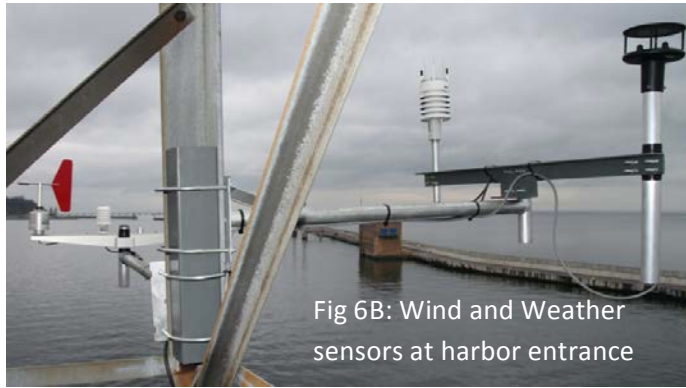

Fig 7: Example of real-time data presented at: http://217.68.102.27/AADI_DisplayProgram/setups/safeport/default.aspx. The station is measuring at 1 minute interval. Data is forwarded to Safeport model (see Fig. 2). So far 99.8 % of the data has been received. Occasional gaps in data are due to loss in GPRS communication.

For transfer of model input data (Wind speed and Wind direction) to the ferry a 3G/GPRS/WiFi modem (Globe surfer III) with antenna was installed on-board the ferry and connected to a touch screen PC located on the bridge of the ferry (see Fig. 2). A first version of the navigation support software was installed on this computer while waiting for the final product, which is under fine tuning by the Gdynia Maritime University.

For testing of reliability and message delay of the shore to ferry communication special software was developed and used for a time period of four months. The onboard computer was picking up new information, messages of similar size as real data, from a server at AADI in Bergen every 3 seconds. The software automatically stored data in log files that were e-mailed every day for evaluation by AADI. For evaluation of log files software was also developed which focused on geographical coverage in Polish waters, delay in data transfer and completeness of each transferred message. The outcome of these evaluations were:

- Coverage in Gdansk bay was good. First connection established about 4 h before arrival. For satisfactory navigational support coverage during last 1.5 h is enough.

- Number of lost messages when approaching harbor during the last 1.5 h was 0.1-0.4 % of the messages. Maximum number of consecutive messages lost was 18 which is equal to 54 s without data.

- Average delay in messages generated at AADI arriving to the ferry was 3 s. The maximum delay was 30 s.

- Worst scenario from testing is that 20 consecutive messages are lost + 30 s delay → 1 min 30 s delay. New wind data is reported every minute.

- Ferry WiFi working over satellite connection can be used as back up and/or main system in other waters were cellphone coverage is less reliable.

In addition to the planned work describes above NIVA did further model developments and tests which make it possible to predict transport, accumulation, break down and ecological consequences of chemical spills from ship traffic (e.g. oil). Such modules already exist in the GEMSS model, last major development of these were done after the Gulf of Mexico oil platform accidents, but they had to be tuned to the particularities of the area.

The Norwegian partners also organized several meetings in the project one on-board Stena Vision to which the ships captain and first officer was invited and one meeting in Oslo.

Description of the Norwegian partners:

Aanderaa Data Instruments (AADI) was founded in Bergen (Norway) in 1966 and has been developing, manufacturing and selling oceanographic and meteorological equipment since then. Today AADI belongs to a large consortium of companies, named Xylem, that focus on water measurements and water treatment. The main office for Xylem is in the USA. Main AADI products include current meters and current profilers, oceanographic and meteorological sensors. During the past 5 years several innovative solutions have been developed for aquaculture and off shore oil industry applications. At the company there is also development and manufacturing of systems to measure load on for example off shore cranes as well as sensors and systems for assessing weather conditions along roads and for traffic counting. The company has around 100 employees. There is an R&D department with about 15 persons and an engineering department with around 10 persons.
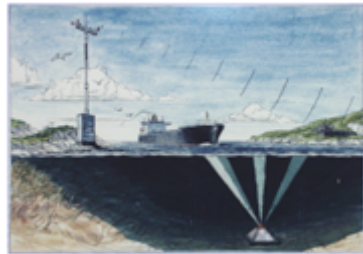
Norwegian Institute for water research (NIVA) is a private, non-profit research foundation with a staff of 220, including 130 researchers. NIVA has been Norway's leading research institute dealing with marine ecosystems and water pollution since 1958. NIVA carries out research; monitoring and development work on contract for public authorities and private clients in Norway and abroad. NIVA has important experience and expertise on ocean color validation protocols, including measurement, laboratory analysis, quality control, identification of match-ups, and statistical inter-comparison exercises. NIVA operates real-time and long-term oceanographic (including the ocean color) measurements from a network of ships of opportunity. NIVA also holds databases for international research and monitoring programs (for EEA). NIVA has got expertise in numerical modeling by means of the usage of several different 1-3 dimensional physical and the ecosystem models.