PILOT WATER DEPTH MEASUREMENTS BY THE COMMERCIAL FLEET

By

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ABSTRACT

The paper describes a cooperative pilot project on water depth measurements. The pilot is a common project of individual ship masters, knowledge institutes, ICT suppliers for the inland navigation sector and Rijkswaterstaat. The purpose of the project is to show that for individual ship masters, cargo traders, waterway authorities working together and sharing information is beneficial with low costs. The vessel owner gains fuel efficiency, reliability in terms of ETA and a maximised cargo capacity regarding actual water depths and predictions. The waterway authority gains detailed actual information on the riverbed condition. Shippers gain a more reliable supply chain against maximised efficiency .Therefore, the under keel clearance, the position and the draught is measured, send to shore, and translated into the water depth, and, subsequently send back to the participating ships. The paper gives a description of the pilot project, shows the first results and gives an outlook to future developments.

1. INTRODUCTION

Having 4,400 km of waterways which are used most intensively for freight transportation, the Netherlands is the most important European hub for transportation by water. This Gateway to Europe is crucial for the growth of the economy. With the construction of the Maasvlakte 2 in the Rotterdam port a considerable increase in the transportation of cargo is foreseen. With the current modal split the expected volumes will result in a congested road system, so the waterways must become an attractive alternative. In order to maintain and further enhance the opportunities a better usage of the waterways is required. Therefore, the Dutch Rijkswaterstaat started a program Impulse Dynamic Waterway Traffic Management. In essence, the purpose of the program is the sharing of (digital) information and co-operation in the logistics chain. Smit, R.J. et al (2013) described the new knowledge and recommendations to bring the gained knowledge to practice.

One of the spin offs of the program is COVADEM, a pilot project for collective water depth measurements in which the navigation sector participates. By sharing water depth information in a clever way it is possible to maximize the loading capacity, to sail more efficiently and to guarantee a reliable ETA (Expected Time of Arrival). This will safe money and increase the profits. The paper will describe the first results of the pilot. Also the accuracy of the water depth measurements will be discussed.

2. DESCRIPTION ONGOING PILOT PROJECT

Electronic Navigational Charts for inland waterways exist for years already, however they do not show accurate water depth information. Skippers have considerable interest in knowing the actual depth of their waterway as well as in depth-forecasts for some days ahead. Skippers now assess depth using their echo-sounder, but so far do not share these data. Therefore, as a spin off of the Impulse Dynamic Waterway Traffic Management project the Covadem project is started. The result of the project is providing water depths based on measurements on board of commercial inland ships

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by measuring the under keel clearance with the echo sounders. The idea behind collective depth-measuring and communicating is to deploy the information garnered in a systematic way thus creating the opportunity of maximizing the cargo volume but it requires accurate up to date information on water depths. Since all commercial ships are equipped with echo sounders it gives the opportunity to share the measured actual depth during sailing. A pilot project is going on now in order to proof with a limited number of participating ships that reliable depth information can be collected.
The pilot project started in spring 2013 with one commercial vessel. As this was very successful an upgrade was carried out mid 2013 to 10 ships. At the end of 2013 it was decided to continue and to upgrade to 50 ships. Having started around August 2013, this pilot will continue towards the end of 2014.

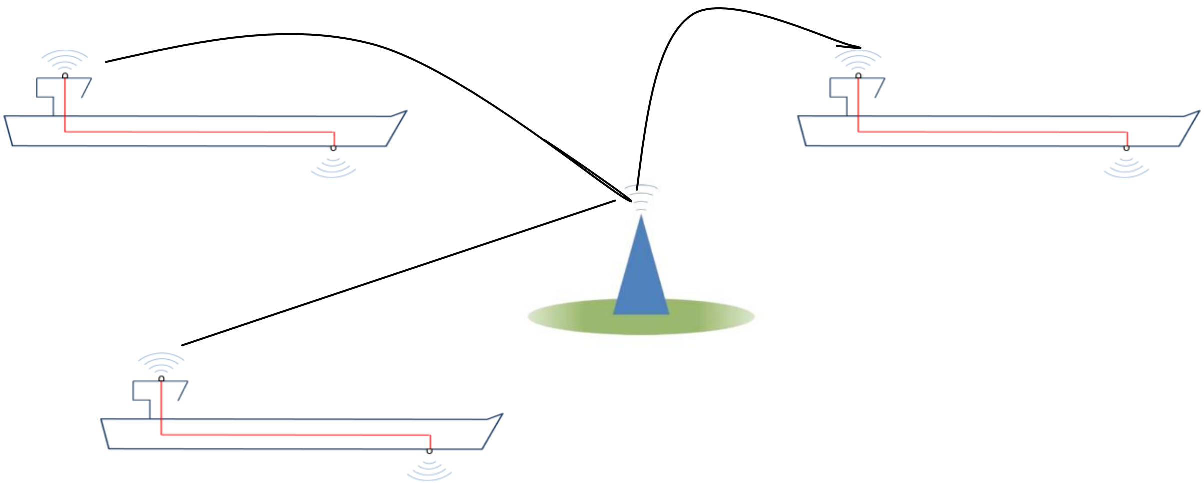

Figure 1: Sharing information

In essence, the method of providing water depths is as follows. The bed level data measured by the commercial fleet with their echo sounders is send to shore based servers together with characteristics of the ship and trip information, such as AIS position, draught and fuel consumption. All these data are used to compute a correct water depth taking into account ship sinkage and trim, ship speed and flow velocity. This is necessary because the echo sounders on commercial ships are intended to measure the under keel clearance and not the water depth of the waterway. The computations are done by Marin and Deltares with sophisticated numerical maritime and hydrological models.
Then, the real water depths are send back to all the ships participating in the project and they can use it when loading the cargo, planning their trip, or when they are sailing on the river Rhine. However, the results can also be used for calibrating numerical morphological and hydrological models. Furthermore, from the measured data also a lot can be learned about sinkage and squat of ships during their voyage as this information is available real time. Finally, the ships can visualize the water depth on ENC's with the proper viewer.

In order to realize this, on board of the participating ships small units have been installed to collect the data and to send it to the server based on shore. In principle, instruments already on board of the ships are used as this keeps the costs low. A simple computer is placed to collect all data and put it together in one message to send to the shore based server.
The next step is carried out by Deltares and Marin. Deltares computes with a numerical model the twodimensional flow velocities in the fairway every four hours. Then, Marin computes the sinkage and the squat of the ship using the ships speed and the flow velocities, and the result of all computations is a measured water depth. This is done for all participating ships. In other words: the measured under keel clearances by individual vessels are translated into water depths at the locations of the ships. The final step is sending back all these data to the participating ships and other stakeholders. In this way relevant and actual water depth information is shared.

The pilot project is carried out in order to address many aspects:

- Possibilities to use the on board instruments (echo sounders, GPS, et cetera)
- Testing of the equipment on board
- Building and testing of the shore based server
- Making procedures for sending the data
- Validating the water depth
- Handling the enormous amount of data
- Presentation of the data to the users

This paper is not the place to deal with all these aspects in detail. The most important one is the accuracy of the measured water depths which will be discussed in section 3 together with some other aspects.

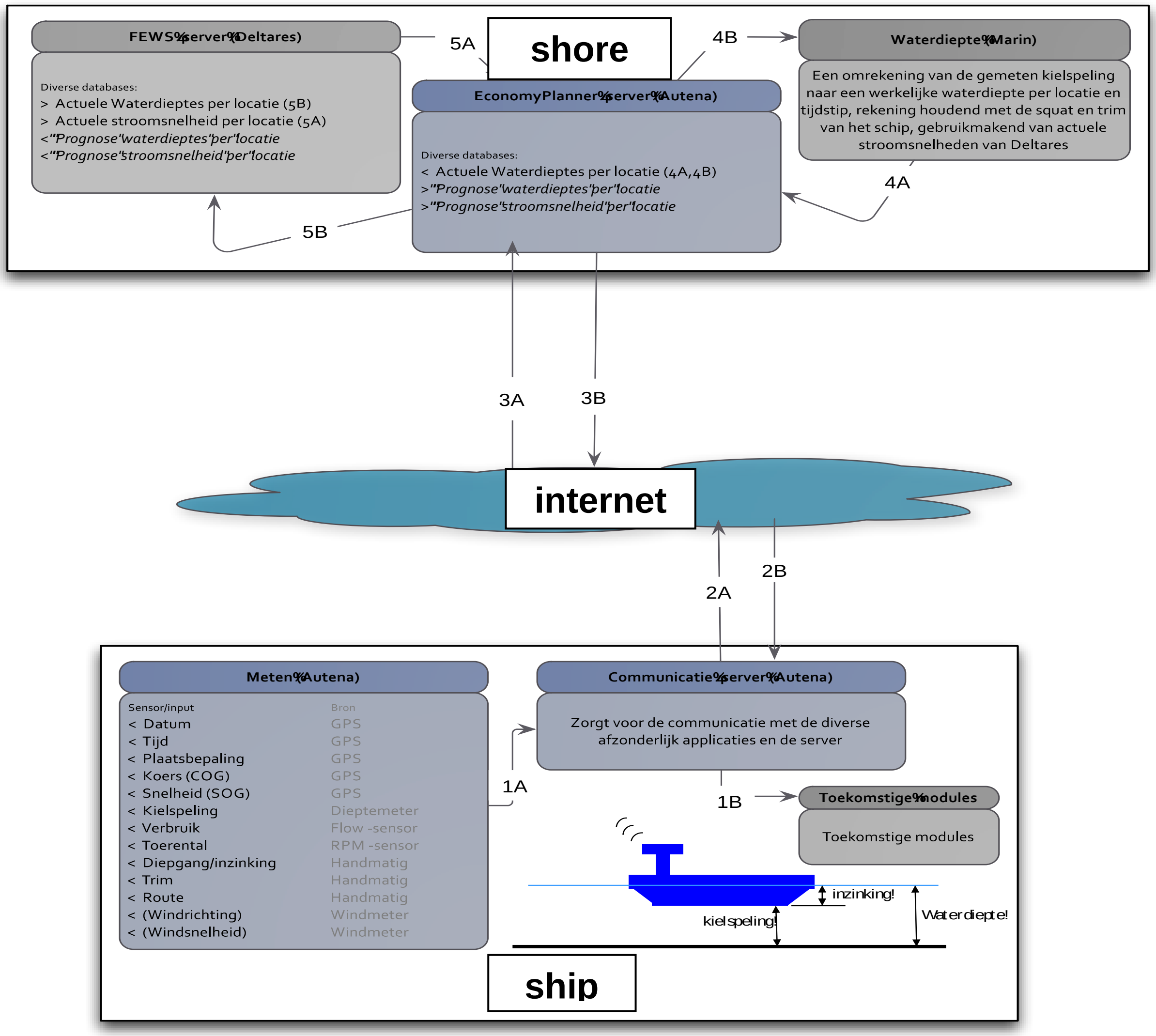

Figure 2: Set up of the pilot project

3. DISCUSSION

It is important that the shared water depths are accurate and reliable. This means that the data have to be checked. A procedure has been set up to carry this out as the water depth depends on many parameters, but in principle the real water depth $D_{reference}$ at a certain location (x,y) and time (t) reads:

$$D_{reference}\,(x,y,t) = h_{waterlevel}\,(x,y,t) - h_{bedlevel}\,(x,y,t) \qquad (1)$$

The water depth measured by a ship can be given as:

$$D_{measurement}\,(x,y,t) = D_{keel\ clearance}\,(x,y,t) + D_{draught}\,(x,y,t) + D_{squat}\,(x,y,t) \qquad (2)$$

The accuracy is given by the difference between $D_{reference}$ and $D_{measurement}$. There are different options to determine the difference. However, one of the most important influences is the uncertainty in the bed level due to the morphodynamic behavior of a river bed. This is discussed in detail in Van der Mark et al (2014). One of the options is to compare both values $D_{reference}$ and $D_{measurement}$ at a location with water level gauges and a fixed bed. With respect to the value of $D_{measurement}$ the echo sounders and draught instruments are validated.

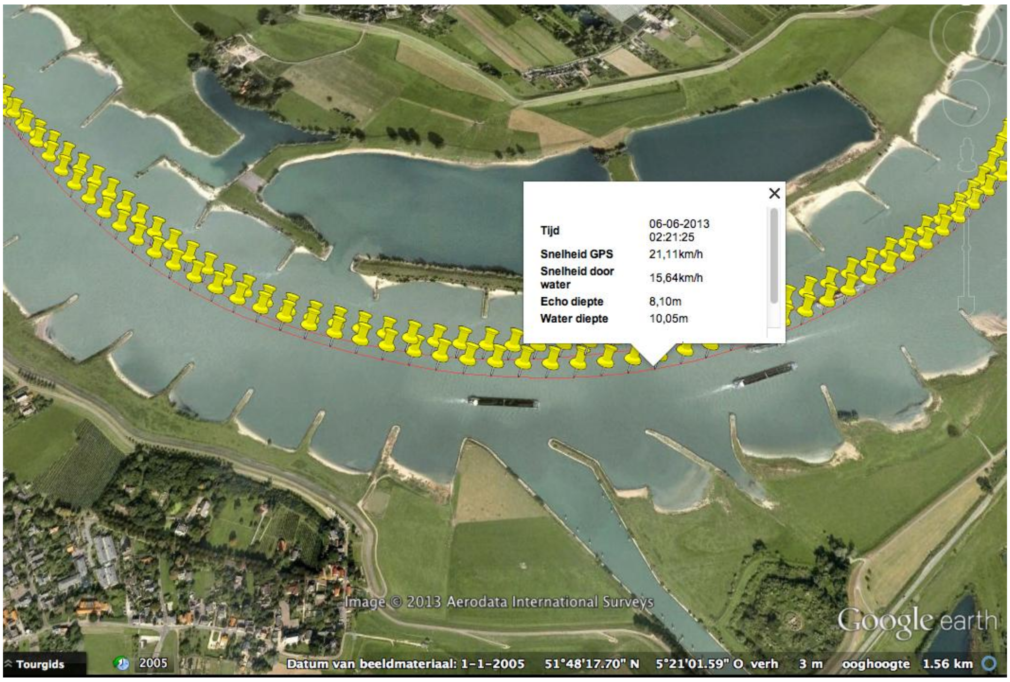

Figure 3: Plot of a vessel's track with locations of measured depth

It is the intention to present the actual water depth measurements as an overlay on ENC's. In addition, the measurements will be extended with predicted data using the predictive models developed by Deltares. This makes it possible to give ship masters insight into the water depth developments to be expected during a determinate journey, enabling a proper assessment of the bottlenecks to be passed already at the time of loading. Another possible extension is to add fuel saving advices.

Furthermore, it is also possible to combine the above-mentioned actual and predicted water-level data with available information about passage heights; skippers may determine maximal loading with regard to water depth (vis à vis the ship's draught) as well as to maximal passage heights. It that sense the pilot project is a base to develop additional services such as trip planning functionality using the full wealth of available information (optimal loading, optimal calculation of ETA's, advice for optimal position, speed and rpm in each leg of the fairway to arrive at the destination on time with minimum use of fuel), and emission reduction. In essence, a prototype of such a system, the Economy Planner has been developed already during the Impulse Dynamic Waterway Traffic Management project and tested succesfully. As departure and arrival times are determined in a well-calculated voyage plan, speed may be optimised with consequent economising on voyage costs. The most important effect is saving on fuel with consequent reduction of fuel costs and less emissions. Moreover the tonne/km value will be lowered with reduced fuel costs.

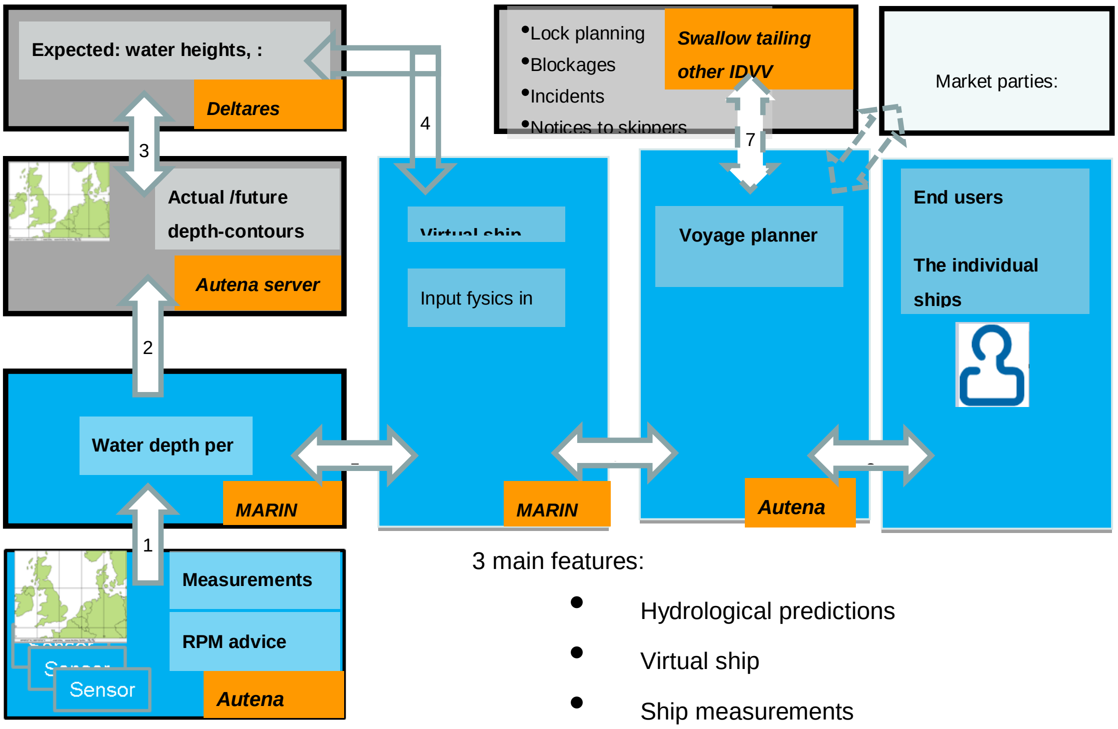

Figure 4: Economy Planner

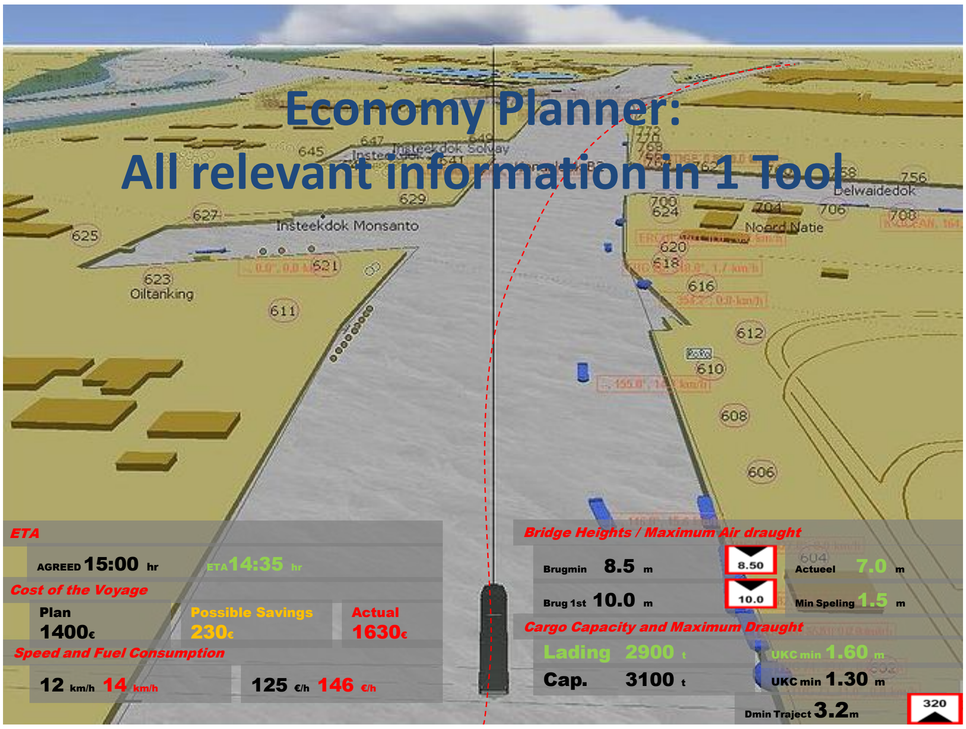

Figure 5: Future result: all relevant information in one tool

4. CONCLUSIONS

The sharing of data is the essence of the pilot project Covadem, e.g. cooperative water depths measurements. It enables ship masters to maximize the cargo volume. Up to now the results of the pilot project are positive and it is believed that the pilot will be successful, mainly because also the inland navigation sector participates. The idea is to start at the end of 2014 when the pilot ends, with a private company that deals with sharing cooperative water depth measurements. Steps are already being taken to enroll the concept over a sufficient part of Europe. This will fulfil the wish of the inland navigation sector for accurate water depth information because it allows to maximize the cargo carrying capacity, but also to maximize fuel efficiency and to reduce carbon emission. The next step will be upgrading to the Economy Planner, for detailed trip planning and reliable ETA's.

Summarizing: sharing actual and future water depth measurements is very beneficial for private and public stakeholders in inland navigation. The more ships collect and share their data with each other, the more detailed and accurate the actual navigation depth chart becomes, and the more accurate the future predictions. In exchange for sharing his own data, the skipper obtains information that has been derived from all the other data of skippers.

5. ACKOWLEDGEMENT

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