WABIS – AN INFORMATION AND OPERATING SYSTEM FOR INLAND WATERWAYS

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ABSTRACT

Inland waterway transport (IWT) is focusing on medium and long distances, in order to promote the strategic advantages in terms of loading capacity, security and cost effectiveness. Speed limitations (8-12 km/h) on rivers and especially on channels act against transport efficiency. In this context, competitiveness of IWT as key mode could be increased against land based transport modes by raising system speed (e.g. ship speed on channels/rivers and handling times in inland terminals - ITs), especially for special cargo and container transport.
Therefore, *WABIS* - an information and operating system for inland waterways, with a strong relation and information exchange to the information and management system for ITs (*BIDIS*) was developed. The overall design of the object oriented system, programmed in JAVA, is presented. Basic modules and capabilities of the system (e.g. *WABIS Ship Client* as bridge model, underlying data base concept, vessel traffic management system and ETA prediction using DGPS data).
The developed *WABIS* data base, which is used via SQL statements builds the center of the system. A vessel traffic management system (VTMS) is grouped around this kernel, providing "real time" information of vessels concerning relevant resources management (terminal state, locks) and their local traffic situation. In this context, provided information can be seen as value added service for skippers.
Spatial information is introduced through "Inland ECDIS" data, used as background for the *WABIS Ship Client* and the *WABIS Traffic Control Center*. Online data transfer with the workflow management system for inland terminal (*BIDIS*).
Traffic control and management are coupled with ETA predictions using ship positions from DGPS transponders and an enhanced prediction model based on "cellular automates".
Thus, *WABIS* includes management services, which reduce the risk for safety and environment in inland waters and maximize the efficiency of transport operations using the waterborne mode, which is an essential basis to increase systems speed and make inland navigation competitive to land based transport modes.

Keywords: vessel traffic management system, information system, inland waterways

1. INTRODUCTION

The Inland Waterway Information and Operating System *WABIS* supports waterway operation by collecting, processing and providing traffic relevant information to skippers, ship companies and *BIDIS* users via the *WABIS Traffic Control Center* (Fig. 1). By connecting multiple information sources, including automatic update of ship position from on ships mounted GPS systems, it is possible to calculate traffic forecasts and resend this information to users.
WABIS Traffic Control Center consists of various input/output communication adapters collecting and sending data from *WABIS Ship Clients* and *BIDIS* and transferring this data (position, speed, reports etc.) to the underlying relational database management system (RDBMS). This client/server architecture accepts *WABIS Ship Client* request, processes them and sends a reply (ETA, micro scale forecast etc.) back to the client, and thus ensures necessary performance and security issues.
Main *WABIS* components and concepts, such as communication scheme, *WABIS Ship Client*, *WABIS Data Base* and *WABIS Traffic Simulation* are subsequently described.

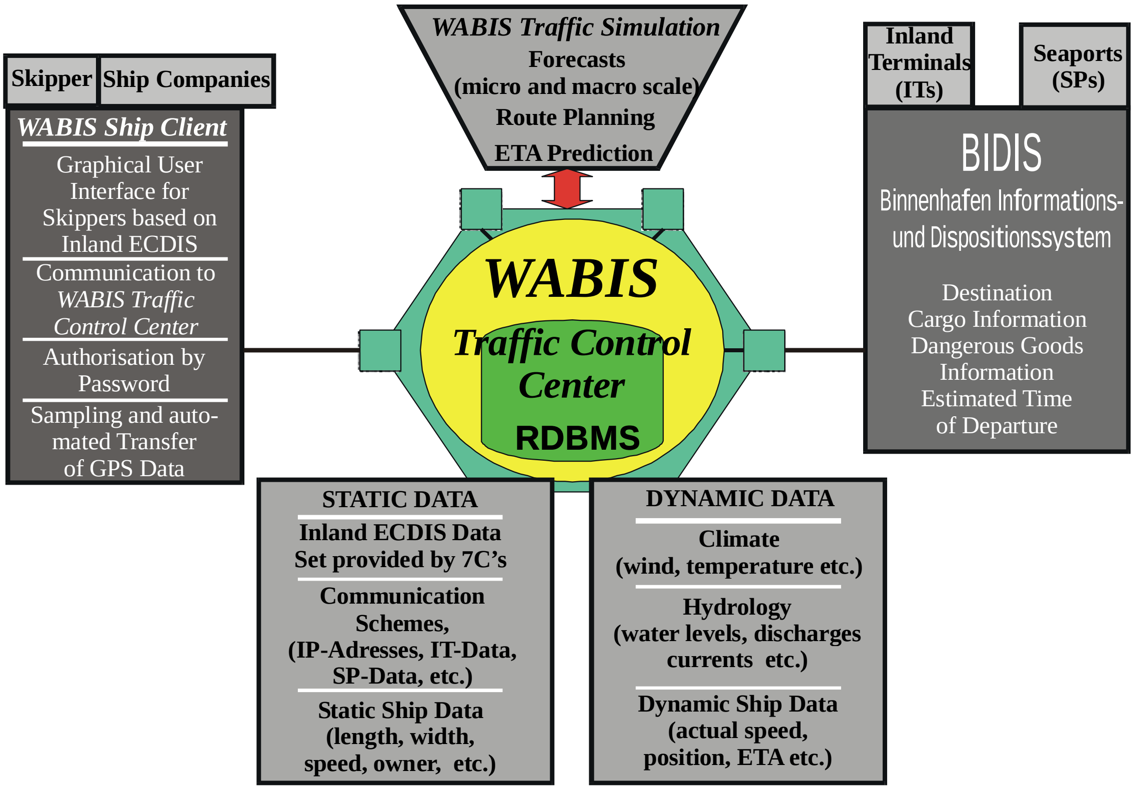

Fig. 1: *WABIS* Components and Tasks

2. COMMUNICATION SCHEME

Communication is grouped around the *WABIS Traffic Control Center*, where special communication adapters manage point-to-point communications with *WABIS Ship Clients* and ITs.

Internet technology is used for communication with ITs. Ship positions and actual speed is transfered using WCDMA (Wideband Code Division Multiple Access) – a GSM based package transfer method. GPRS would be the first available service.

On board the ship (Fig. 2) GPS data is spooled to a log file for later route statistics and planning. Every 10-15min position and speed are sent to the *WABIS Traffic Control Center* and processed. Forecasts and warnings are sent back to the client.

Robustness of the system due to interference and system failure must be examined under operation for used GPS/DGPS and GPRS service, in order to avoid "white spots" in client data. This requires field tests during operation and the analysis of failure/disturbance and gap times. After introduction of the error free satellite-based positioning system GALILEO of the European Union usable for civilian purposes the error rate and standard deviation will be minimized and therefore the application of the introduced technology for navigation would be possible.

The developed communication between *WABIS Ship Client* and *WABIS Traffic Control Center* is flexible, minimizes investments into the infrastructure on board of ships and on shore (no relay stations) and is easy to install.

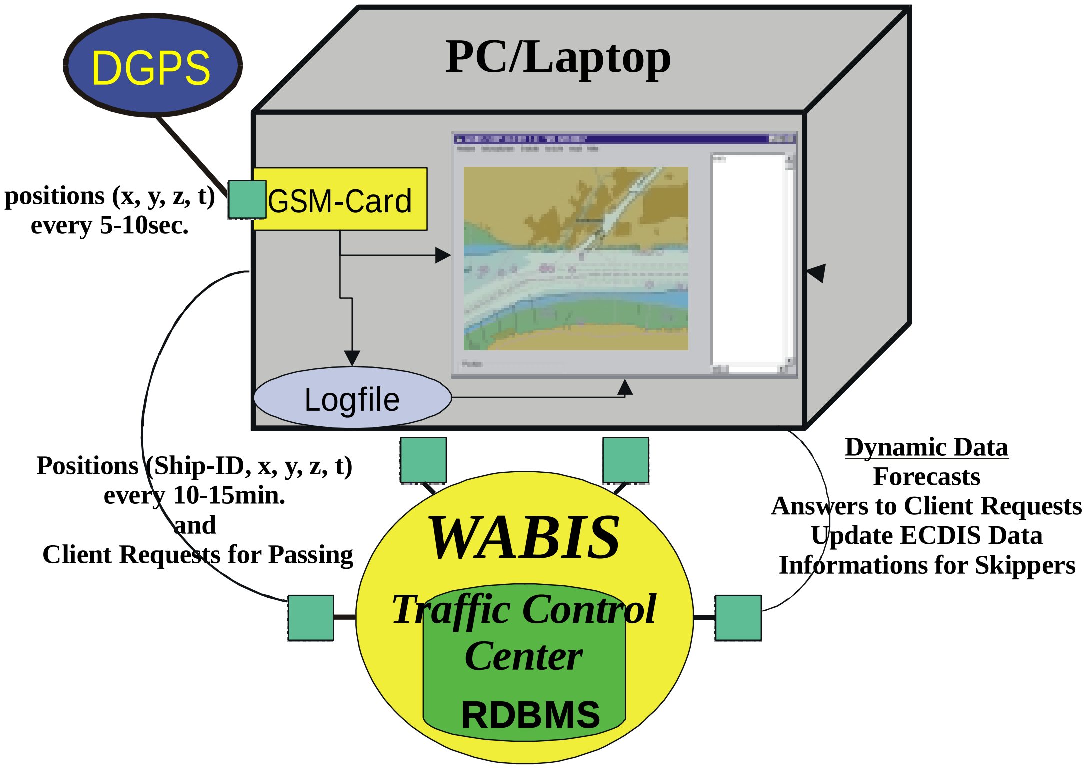

Fig. 2: On Board Communication GPS Transponder – *WABIS Ship Client*

3. WABIS DATA MANAGEMENT

Within the analysis of input data, static data and dynamic data are distinguished. Static data contain unchanged or annually updated objects (e.g. inland ECDIS data, ships geometry). Dynamic information, such as water level, notices for skippers (e.g. closing of areas, ice), is held in separated data bases with flexible and partially automated data extraction from administrations server services (e.g. with ELWIS - Elektronisches Wasserstrassen-Informationssystem, http://www.elwis-text.bafg.de, Wasser- und Schiffahrtsverwaltung or tidal water levels and predictions from http://www.bsh.de, Bundesamt für Schifffahrt und Hydrographie:).

Cargo information has to be entered manually or comes by automated data transfer from *BIDIS*.

WABIS Traffic Control Center and *WABIS Ship Client* use Inland ECDIS Data and special functions provided by the EC2007 ECDIS Kernel[1] with full IHO/IMO requirements (S-57 object cataloque / S-52 presentation library) and IEC 61174 standard. Inland ECDIS Data is handled separately to make special EC2007 Kernel functions (route planning, automated update control, exchange functions, print function etc.) accessible to the applications.

4. WABIS TRAFFIC SIMULATION

The *WABIS Traffic Simulation* provides forecasts for different purposes for vessel traffic management and control. The used approach is based on “cellular automates”.

Net topology is generated from ECDIS data. The waterway network is divided in sections (Fig. 3) containing edges (fairway section with constant parameter set, such as water depth, width etc.) connecting nodes (e.g. locks, terminals, crossings etc.). Nodes are handled as black boxes in separate modules describing their operation with individual functionality and modified input data (lock speed/time for up/down shift, capacities of locks and periods of operation as well as restricted navigation in special sections). At boundaries and ITs, special nodes had to be implemented to specify traffic input (source term) to the network. Sinks[2] are calculated from the interior network.

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[1] SevenCs Entwicklungsgesellschaft für Geo-Informatik mbH, Hamburg (Germany)

[2] Def.: Ships leaving the simulated waterway network.

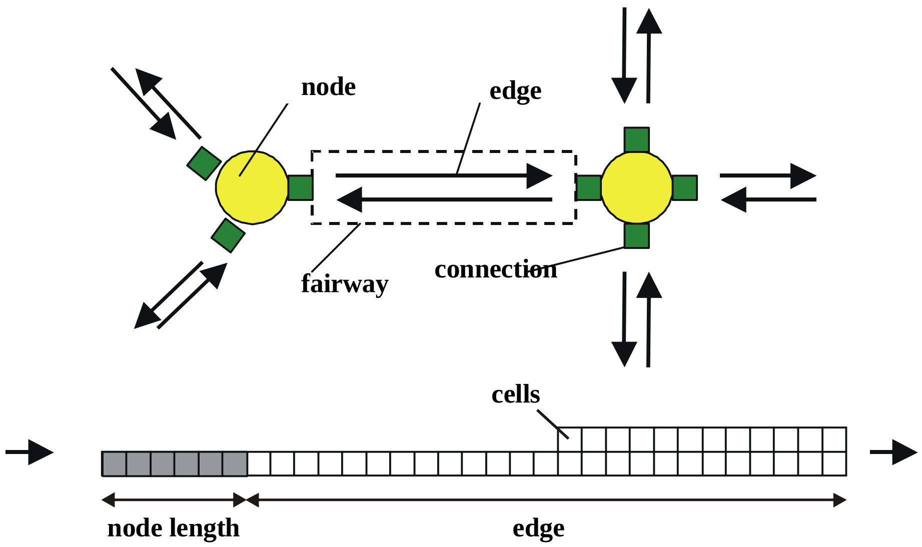

Fig. 3: Network Design with Edges/Nodes and Edge Splitting
to model Vessel Traffic on Inland Waterways

Simulations are used to

- predict ETA (macro scale simulation for all ships),
- to answer client requests for passing (Fig. 4, micro scale simulation in the local ship area, including answering to this ship and nearby) and
- to optimise lock operation (micro scale approach with communication answer to the lock and ships approaching the lock).

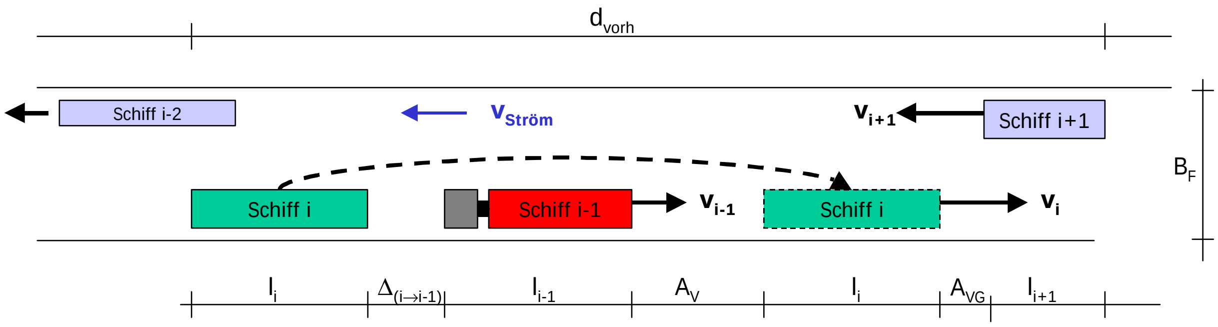

Fig. 4: Parameters used for Passing Simulation in *WABIS Traffic Simulation* Module

Another module covers analysis and prediction of future traffic conditions within the microscopic area, so skippers get information in advance and can react before dangerous situations occur (e.g. in narrow sections, at night, in one way-sections).

5. WABIS SHIP CLIENT / WABIS TRAFFIC CONTROL CENTER

Capabilities of *WABIS SHIP CLIENT* (Fig. 5) and *WABIS Traffic Control Center* are the same, except same additions (zoom in/out over the whole network, forecast control and input modification for simulation, special communication facilities for warnings and reporting, statistic module to identify traffic density and travel times etc.).

Ship positions, transmitted from DGPS systems, are displayed on ECDIS, combined with georeferenced topographical raster data to give the user orientation.

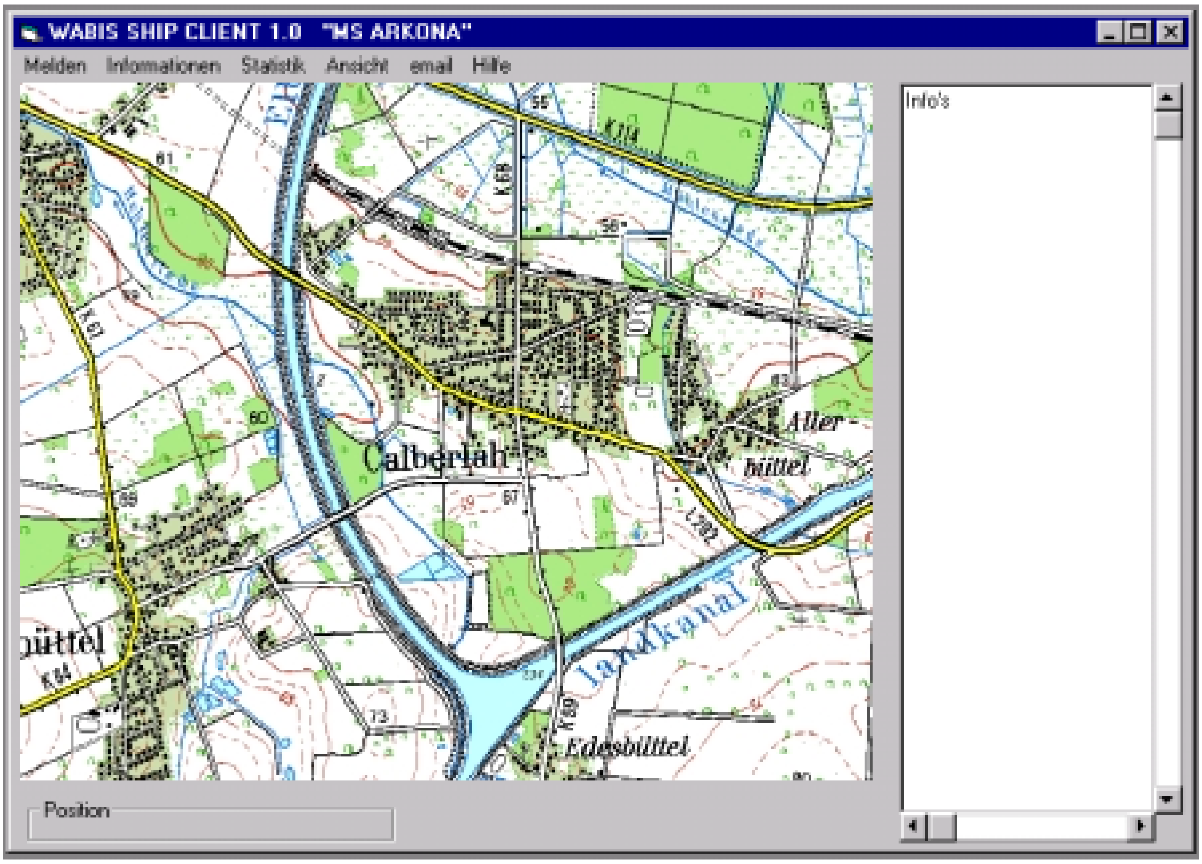

Fig. 5: *WABIS Ship Client* Desktop

After password checked login and automated cross check by the server application, skippers have to announce for *WABIS* access transferring route plan, destination and average speed. Ship characteristics and other data specific to the user are stored by the system after first login and associated to the user ID automatically sent by the client during login procedure. This information can be changed during the trip, if unforeseen stops or breaks become necessary.

Information for the skipper is automatically updated from central *WABIS Traffic Control* server and displayed in the info box. Route planning and ETA predictions are updated every 15min by the server application based on actual forecasts. Microscopic traffic condition are transferred upon request.

By microscopic traffic prediction the server application analyses local situation and sends an answer to the client giving a passing recommendation with necessary speed, taking safety guidelines and fairway conditions into account.

Mean travel times can be calculated by statistical functions from a local log file built by GPS positions and from earlier trips. This data can also be used to estimate travel times for route sections to answer requests from the ship company and for personnel planning in ITs.

Zoom in/out functions are restricted to the local area nearby the ship. A toolbar indicates which information is visible at each time.

An internal email application makes the skipper independent of other mail programs, providing email functionality on an “easy to use level” to get contact with his head office directly from his *WABIS Ship Client* application. Thus, data transfer to the official MIB system (Melde- und Informationssystem Binnenschiffahrt) delivering data about departure (location, date,time), ship information (type, name, official ship number etc.) and cargo information (type and danger classification) can be managed from the application.

In addition to these features the *WABIS Traffic Control Center* provides switching facilities to a tactical traffic image, reducing available information to its minimum to have decision support and traffic surveillance.

Apart from aspects concerning inland waterway navigation, the contact to ship operator and ITs (destination ports) is important to plan just-in-time delivery by optimised facility management in ITs. Thus, skippers and ship companies can authorise the *WABIS Traffic Control Center* to transfer data (actual position and speed, ETA) to *BIDIS Port Clients* and associated transport operators responsible to organise hinterland transport.

6. CONCLUSIONS AND FUTURE DEVELOPMENTS

Integration of IWT into existing multi modal transport chains as key mode or alternative to land based transport modes requires a steady flow information, parallel to the physical transport.

In this context, waterway operation and traffic management is essential to improve competitiveness of IWT against other modes. Thus, *WABIS* can play a key role to make IWT more flexible, optimise traffic and deliver positions and predicted ETA to user and recipients, to show that information is always accessible.

Future tasks will be the automated design of net topology for simulation of traffic scenarios, further development of the bridge model to store ship data (e.g. fuel consumption to calculate best speed conditions), a more flexible communication scheme and test of the system in practice.

Modelling traffic of large inland terminals and seaports (mixed traffic of shuttle services, seagoing vessels and barges) will be one of the most important issues to be implemented and tested.

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