Klaus Aichhorn*, Bernhard Hofmann-Wellenhof**,
Wolfgang Böheim**, Franz Weimann**, Johannes Vallant**

GNSS-based vehicle terminal for mechanized forestry operations

1. Introduction

The basic development work was carried out in a project called EGNOS Navigation Terminals Development and Demonstration Activity – Phase 2 (EGNOS NT2) which was aiming at the industrialisation of navigation terminals. Independent terminals were developed for land applications (e.g., monitoring of dangerous goods transport, modernisation of forestry operations) and also for sea applications (e.g., vessel monitoring). The project was co-funded by the European Space Agency (ESA), and was carried out by an international project consortium. TeleConsult Austria was responsible for the development of two different terminals for mechanised forestry operations: a pedestrian terminal for forest inventory and lone worker protection and a vehicle terminal for application in the forest logistic chain management. After successful completion of the project EGNOS NT2, TeleConsult Austria further developed the vehicle terminal to a product ready to enter market. According to the needs of different forest enterprises, the hard- and software can be adapted as required.

This paper focuses on the presentation of the detailed design and application of the GNSS-based vehicle terminal for mechanized forestry operations.

2. GNSS-based vehicle terminal for mechanised forestry operations

2.1. Background – forest logistic chain

The forest logistic chain includes the felling of trees by a Harvester, the intermediary transport of the felled wood to a piling site (timber yard) by a Forwarder, and the delivery of wood to, e.g., a saw mill by a transport truck. The developed

* TeleConsult Austria GmbH, Austria
** Institute of Navigation and Satellite Geodesy, Graz University of Technology, Austria

mobile terminal can be installed in all three different vehicles to support on the one hand the navigation and guidance on forest streets and on the other hand the communication with the logistic centre at the forest office.

The operational procedure in the forest logistic chain can be described as follows:

- the Harvester sends a message about felled wood to the forest office;
- the forest office informs the Forwarder, which transports the assortments to the roadside and lays out a piling site;
- if enough wood is available, the Forwarder sends a message to the forest office including the location of the piling site, the tree species, the wood mass and sort;
- the forest office informs a transport company and sends the coordinates of the piling site to the corresponding transport truck which is responsible for the delivery.

By using the mobile terminal, the transport truck can navigate to the piling site on the shortest and, thus, fastest way. At present, satellite-based systems are not quite commonly used in the forest logistic chain. The development of a functional terminal system, which automates and accelerates the forest logistic chain, offers new markets within Europe. An indication for the potential of such systems is the introduction of a similar system in Scandinavia, which is less modern and not yet fully developed.

Studies showed that due to navigation and guidance a time saving of up to 30% is achievable for the work flow within the forest logistic chain. This will save resources and costs in the forest enterprises and, therefore, directly effect also at the end user.

2.2. Field of application

The vehicle terminal can be separated into a mobile unit for the vehicles and into a logistic centre at the forest office (Fig. 1).

Generally, the mobile terminal is used as navigation aid in the forest vehicles, but also as communication tool to the forest office. Thus, the actual position and the target point (e.g., position of piling site) are visualized on a digital forest map on the mobile terminal. The position information of the vehicles is transmitted to the forest office in a predefined interval and thus can be displayed on a digital forest map.

For interaction, the logistic centre in the forest office can send text messages to the vehicles and vice versa. Additionally, the location of piling sites (including wood mass and sort) can be transmitted to the forest office. Improvements in automation and coordination of the forest logistic chain are possible in this way.

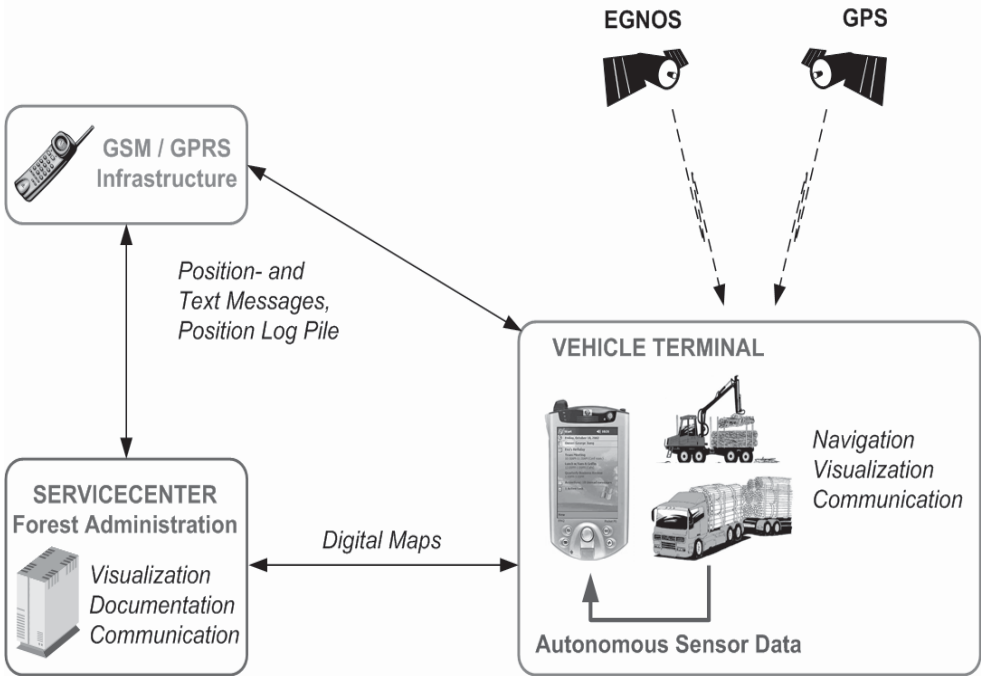


Fig. 1. Vehicle terminal concept

2.3. Architecture and functionality

The terminals consist of a processing and visualization module, a communication module, and an external high sensitive GPS/EGNOS (Global Positioning System / European Geostationary Navigation Overlay Service) receiver. The terminal components are mounted in a special housing which provides protection against splashing water and dust. Further, it is shock-proof to meet the tough requirements in forest vehicles. The interfaces to the GPS/EGNOS receiver and the power supply are placed at the back side of the terminal (Fig. 2).

The processing and visualization module operates the application software, serves as user interface, and supports visual guidance using ArcPad. The user interface represents the main dialogue to control and manage the terminal. The ArcPad software is used for visualization purposes to display the actual position and the target point on a digital map either from commercial providers or from forest companies.

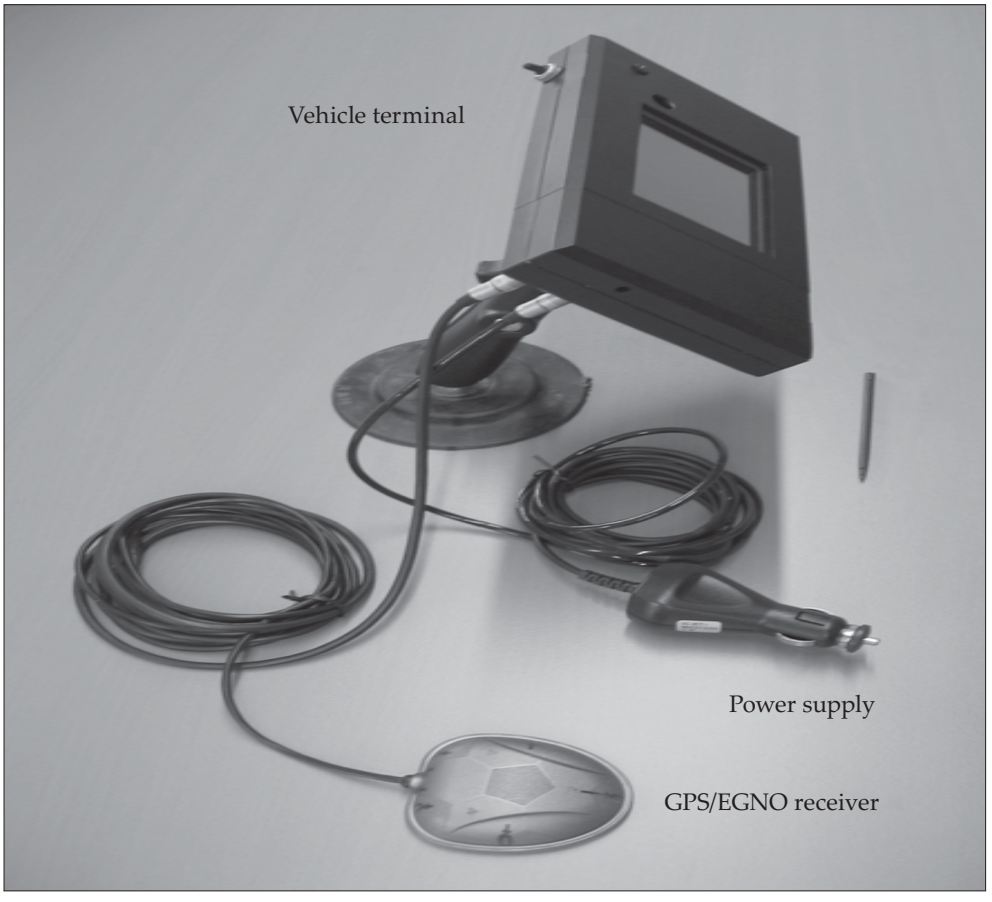


Fig. 2. Vehicle terminal hardware

A GSM/GPRS (Global Standard for Mobile communication / General Packet Radio Service) card integrated in the processing and visualization module is used for data communication.

Due to the continuous position transmission form the mobile terminal to the forest office and the open data communication link, the operator in the logistic centre located at the forest office can monitor all forest vehicles and provide instructions for the vehicle drivers if necessary.

Due to the usage of GPRS as primary communication medium, the cost for the data transfer is extremely low. GSM is used as back-up connection, if the GPRS service is not available (Fig. 3).

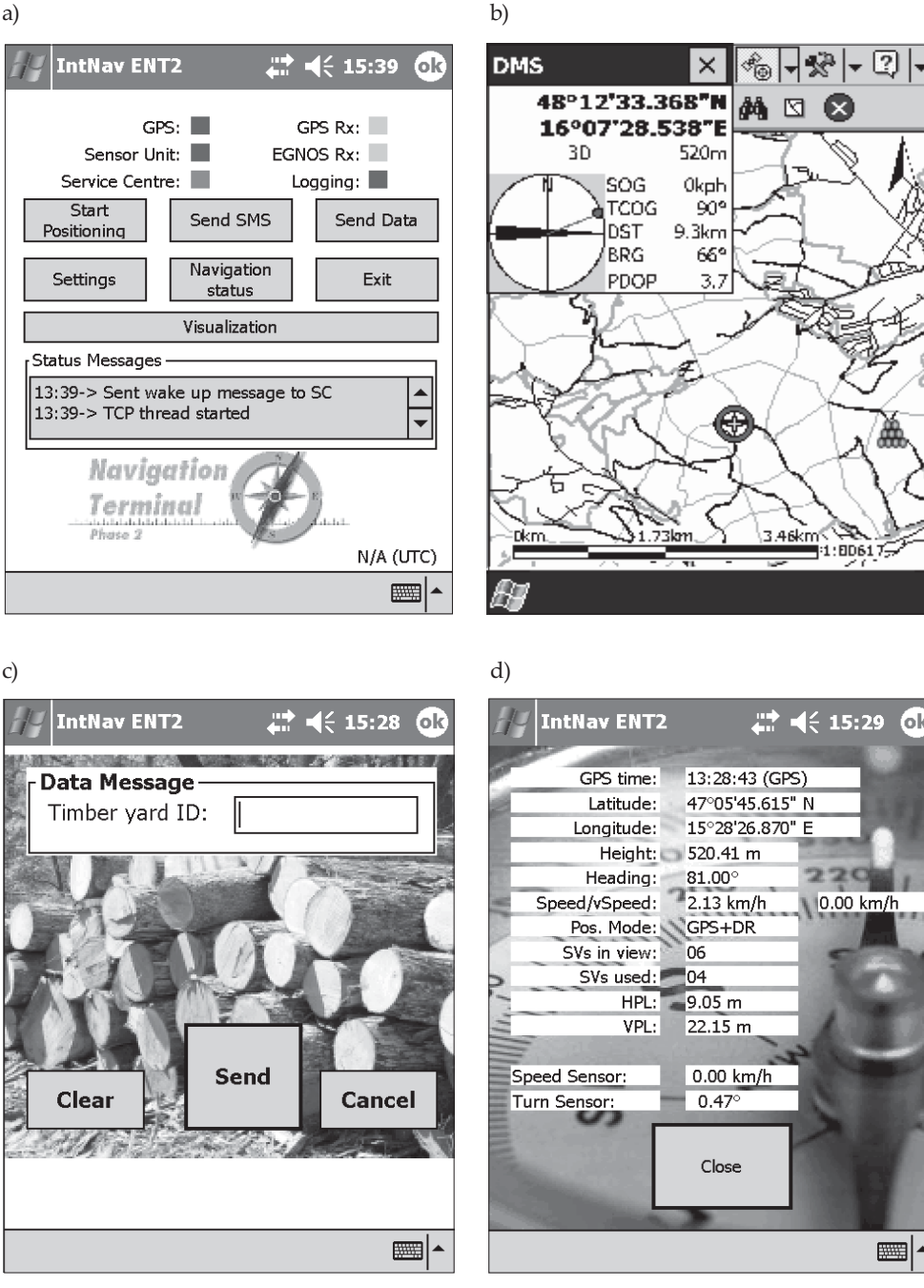


Fig. 3. Application software: a) application software start window, b) navigation view, c) timber yard view, d) navigation status window

2.4. Architecture of the logistic centre

A conventional desktop PC (Personal Computer) or a laptop can be used as logistic centre in the forest office. Generally, the logistic centre integrates a communication, a visualization part, and a database. The communication part is realized by the so-called service centre software (Fig. 4a on the attached interleaf) which offers a user interface and establishes the communication connection to the vehicle terminal. The service centre software is mainly responsible for the data exchange between the forest office and the vehicle terminal.

The following messages can be sent from the logistic centre to the mobile terminals or vice versa:

- position messages are sent from the user terminals to the logistic centre in predefined intervals and forwarded to a visualization software;
- text messages and data can be sent bidirectionally for coordination tasks;
- the location and information of a new piling site (timber yard) can be transmitted from the Forwarder (vehicle terminal) to the logistic centre;
- the timber yard database (Fig. 4c on the attached interleaf) can be sent from the logistic centre to the transport truck (vehicle terminal).

The visualization part is realized either by a web-server-based visualization tool or alternatively by the ArcView software. Thus, an overview about all the vehicles of the company in the forests is provided to the coordinator (Fig. 4b on the attached interleaf).

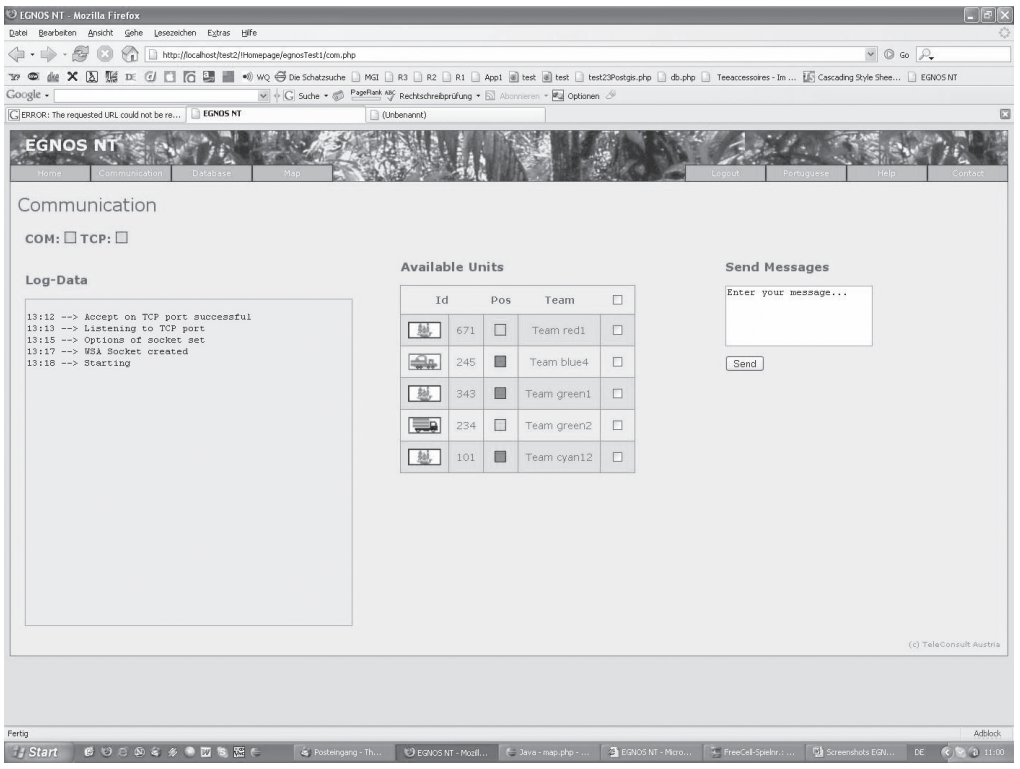
2.5. Conclusions

The development of the vehicle terminal can be seen as innovative approach which will accelerate and automate the forest logistics management. Forest enterprises, using the available terminals and the service centre will save time and resources of up to 30%. As a secondary effect, also end users will save cost.

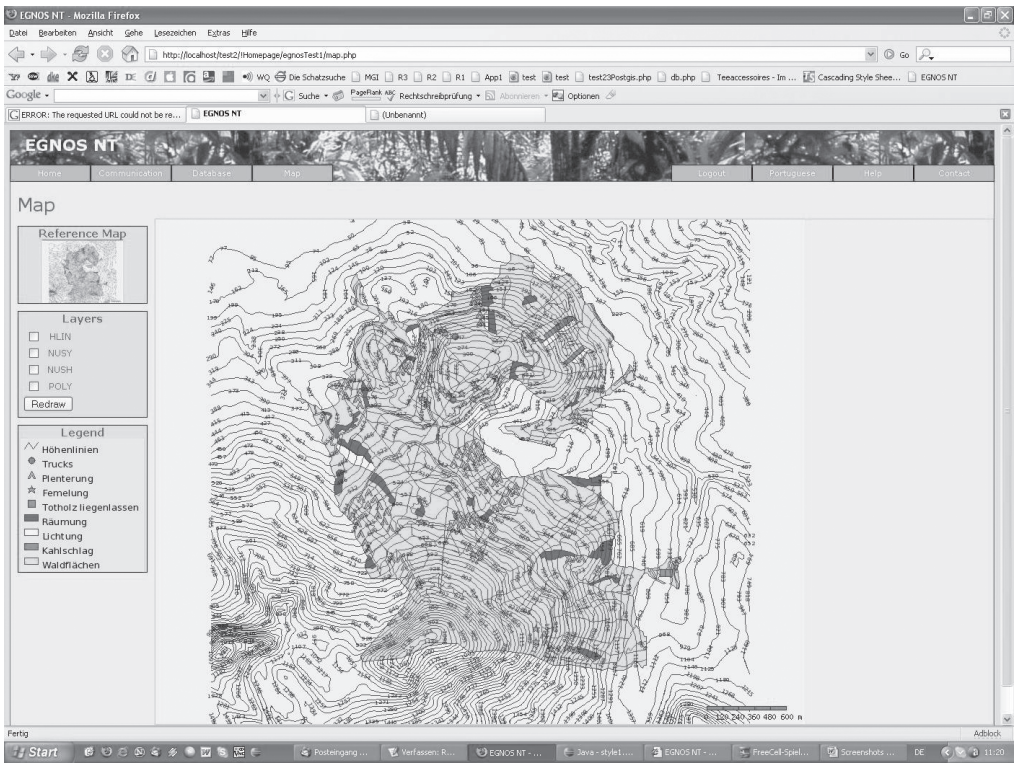
Acronyms and Abbreviations

EGNOS – European Geostationary Navigation Overlay Service
EGNOS NT2 – EGNOS Navigation Terminals Development and Demonstration Activity – Phase 2
ESA – European Space Agency
GNSS – Global Navigation Satellite System
GPRS – General Packet Radio Service
GPS – Global Positioning System
GSM – Global Standard for Mobile communication
PC – Personal Computer

a)



b)



c)

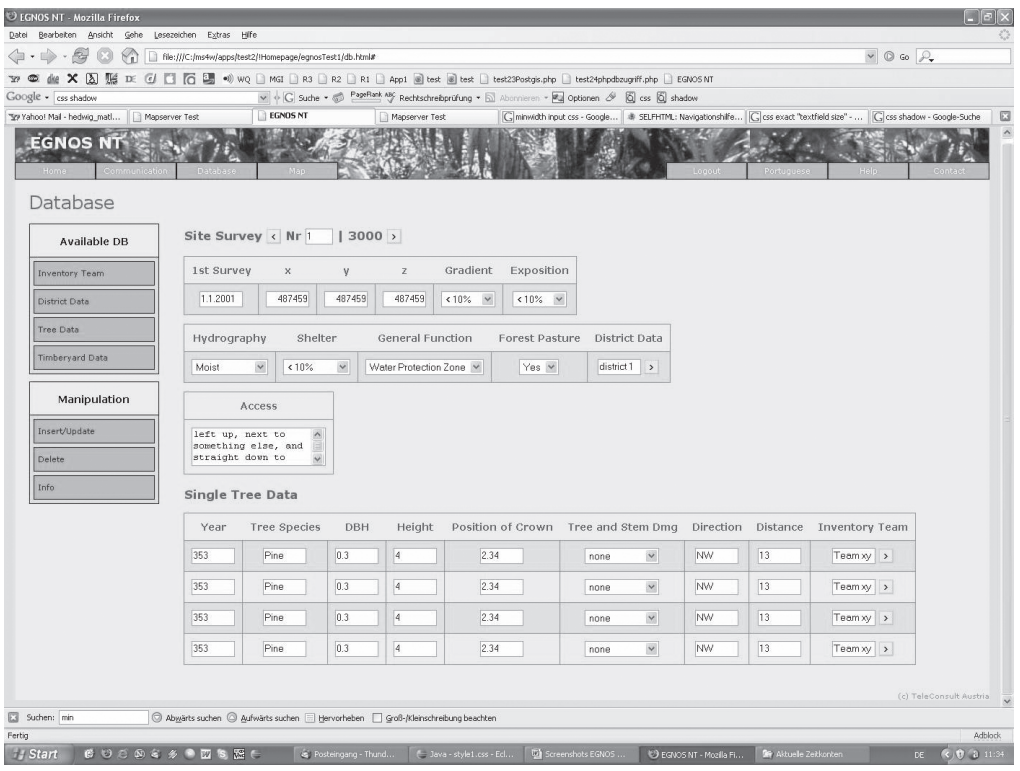


Fig. 4. Logistic centre: a) service centre software, b) visualization software, c) timber yard database

Bibliography

[1] Hofmann-Wellenhof B., Legat K., Wieser M.: *Navigation – principles of positioning and guidance*. Springer, Wien–New York 2003, ISBN 3-211-00828-4.

[2] Hofmann-Wellenhof B., Lichtenegger H., Collins J.: *GPS – theory and practice*. Springer, Wien–New York 2001, 5th revised edition, ISBN 3-211-83534-2.

[3] EGNOS NT2 (EGNOS Navigation Terminals Development and Demonstration Activity – Phase 2): Final Report, Version 1.0, dated 15.12.2005, EuroTelematik AG (Germany), INOV (Portugal), TeleConsult Austria GmbH (Austria).

[4] Weimann F., Aichhorn K., Ott B., Wasle E., Hofmann-Wellenhof B.: *EGNOS NT2, Navigation terminals for mechanised forestry applications.* Proceedings of GNSS2005 – The European Navigation Conference, Munich, July 2005.

[5] Böheim W.C., Weimann F., Aichhorn K., Hofmann-Wellenhof B.: *Navigationsterminal zur Optimierung der Waldinventur (Navigation terminal for optimization of forest inventory).* Österreichische Forstzeitung (Austrian Forest Magazine), 116, 11/05, 14–15.