

LORAN/EUROFIX/EGNOS Integration Test & Validation Programme - Concept and First Results"

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Abstract

The dream of GNSS satisfying the sole-means of navigation requirements has failed. Today the future of radionavigation is expected to be the integration of different diverse systems, which are able to augment each other and act as appropriate back-up systems to each other. To investigate the interrelation between GPS, DGPS, EGNOS, and Loran-C/Eurofix a Test & Validation Programme was developed by NELS and Telematica. The phase of concept development is already finished and the first measurements are expected to start in autumn 2000. The trials will take place for road, rail, maritime, surveying, military, and time applications.

1 Background

Satellite navigation is becoming more and more involved in many fields of applications. Especially in the transport world there is a strong demand on high quality positioning and navigation information. This is valid for all modes of transport like road, rail, inland waterways, maritime and aviation. In addition to this, the non-transport sector (agriculture, survey, timing, etc.) is using GNSS in an intensive manner. In the future multimodal transport will also rely on the availability of high quality time and positioning information. Today GPS is a wide-spread system among the community of navigation users, but it does not fulfil the stringent requirements for many safety of life applications like aviation and Search-and-Rescue (SAR) or high-end logistic applications like fleet management of hazardous/valuable goods.

Actions were initiated on a European level to overcome the technical barriers of existing Satellite Navigation Systems as well as the institutional problem of being dependent on a foreign military operated and controlled system like GPS or GLONASS. These actions result into a decision to develop EGNOS and to define an independent European contribution to a future GNSS-2 under the name Galileo.

Since about 25 years the terrestrial navigation system Loran-C has been available for civil use. The US DoD has transferred the LORAN infrastructure to the host nations which modernised the stations and added some new to make the system widely available to civil users. With the Eurofix service LORAN will be able to broadcast DGNSS corrections, integrity messages and other data without interfering with the Loran-C navigation function.

Status of Loran-C/Eurofix

LORAN (LORAN is an abbreviation for LONg RANge Navigation) -C is a pulsed radio navigation aid, which gives position in the horizontal plane. It is used both in hyperbolic and in circular mode. The system was developed by the US Department of Defence and used for military purposes for approximately 20 years until 1974, when it was made available for civil use. The US Defence has replaced Loran-C with the satellite based navigation system GPS and, as a consequence, all US owned Loran-C assets overseas were transferred to the host nations. This has resulted in an extensive modernisation of the system for civil purposes world-wide. New stations have been or are being installed as national initiatives.

NELS - the Civil Northwest European Loran-C System - is based on an agreement signed on the 6th August 1992 Denmark, France, Germany, Ireland, the Netherlands and Norway, where 4 former US Coast Guard stations - Bø and Jan Mayen in Norway, Ejde on the Faeroe Islands and Sylt in Germany - have joined 2 existing French stations - Soustons and Lessay - and 2 new stations - Værlandet and Berlevåg in Norway. A third new station is planned to be installed at Loophead in Ireland in the future. The American stations were transferred to the host nations on 31st December 1994 and the transmitter equipment was upgraded.

In Russia a similar system named Chayka is in operation and can technically be combined with Loran-C.

Furthermore Loran-C can be used to broadcast DGNSS corrections, integrity messages and other data. This service is called Eurofix and NELS has implemented

Eurofix on four stations (Eurofix Feasibility Phase). These stations are LessaySylt, Værlandet and Bø.. Eurofix is developed by Delft University of Technology. The implementation of Eurofix will take place in two steps, which are shown in the following figures.

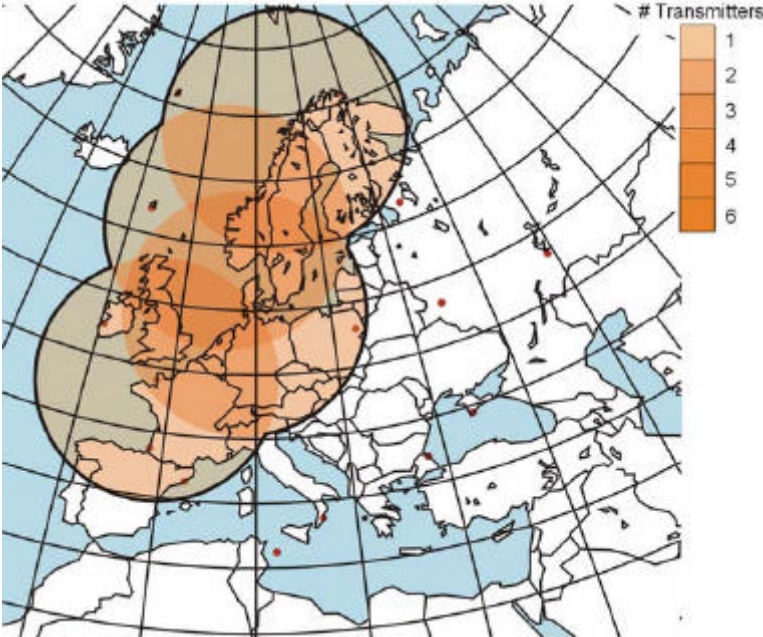


Figure 1: Eurofix Implementation Step 1

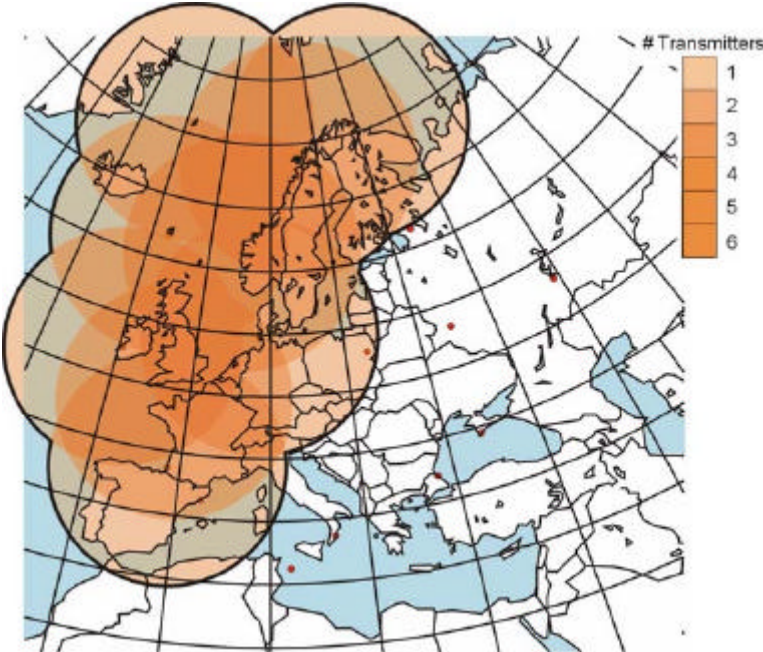
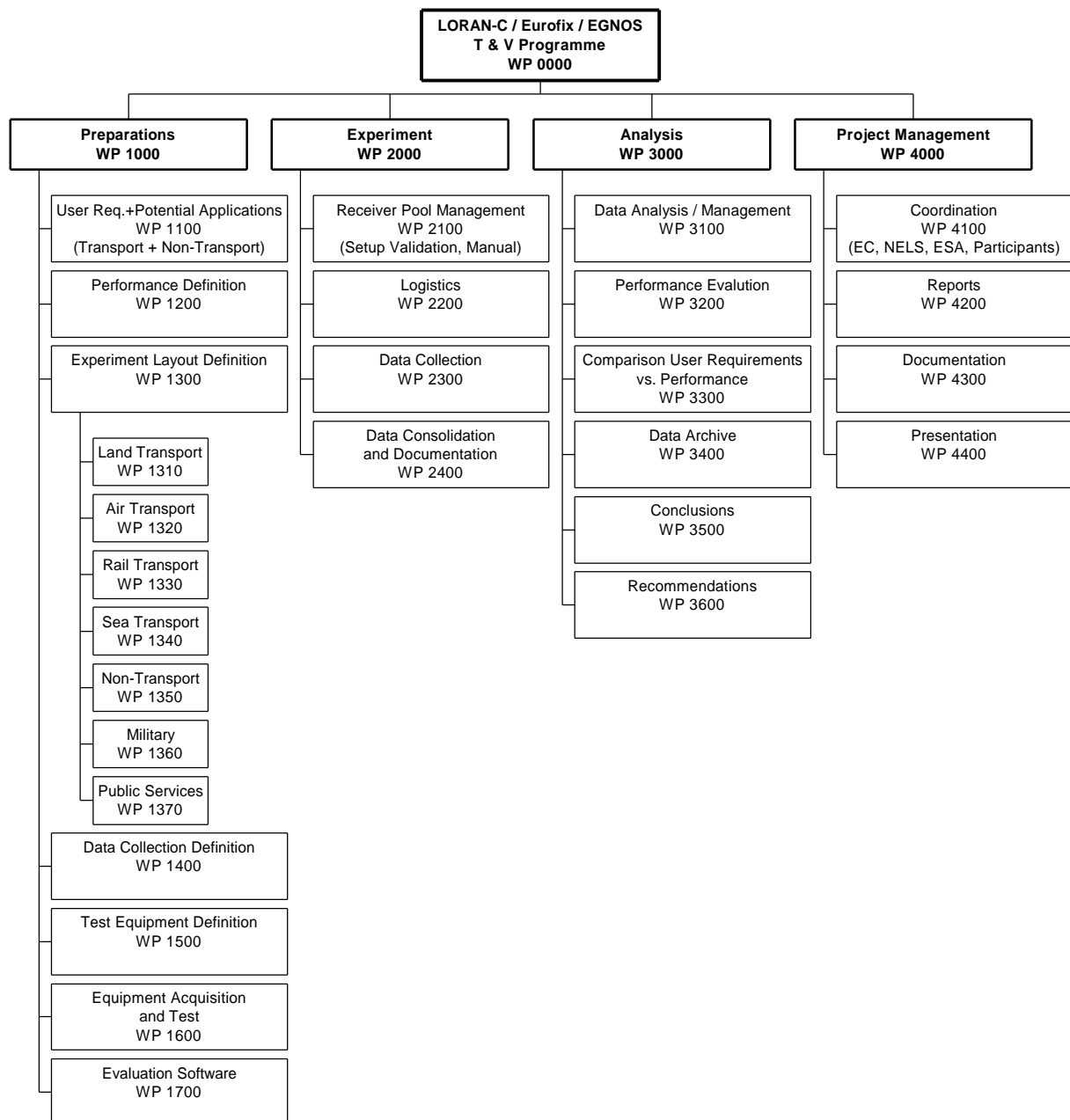


Figure 2: Eurofix Implementation Step 2

To investigate the possibility to combine Loran-C/Eurofix with other navigation aids the Loran-C / EUROFIX / EGNOS - Test & Validation Programme (LOREG T&V) was initiated.

2 Scope of LOREG T&V

A test and validation programme was initiated by NELS in co-operation with Telematica e.K. to demonstrate the potential benefits of a combined use of Loran-C/Eurofix and EGNOS within different fields of applications. The following figure shows the structure of the Loran-C / EUROFIX / EGNOS - Test & Validation Programme (LOREG T&V).



More detailed information on LOREG T&V can be found at: www.telematica.de/loreg

3 Time schedule and partners of LOREG T&V

The LOREG T&V Programme is structured into different phases:

- Phase 1 develops the overall T&V concept and the software for data collection, analysis, and visualisation (WP 1000)
- Phase 2.1 is the realisation of the measurement campaigns in a first version (WP 2000, 3000)
- Phase 2.2 is the realisation of the measurement campaigns in a complete version (WP 2000, 3000)

After the finalisation of Phase 1 in August 2000, which includes the identification of POCs, definition of test scenarios, development of evaluation and display software, etc. the phase 2 of LOREG T&V has started.

Phase 2 deals with the data collection, data analysis, and comparison of user requirements with the results of the measurement campaigns. To handle the big amount of expected data a data archive will be developed to render possible storage of all raw data collected through static and dynamic trials. Since the number of receivers available for testing will be limited, only a limited number of tests can be run in parallel. The management of the available receiver pool is also part of Phase 2, as well as the data collection from the different test sites. The data analysis will include statistics on the accuracy, availability, integrity, and continuity of the performed measurements. Different focuses regarding the data analysis will be put on static and mobile measurements.

This phase will cover all identified user groups, but the amount of data for each user group will be limited. Identified user groups and respective participants are:

- Road
Daimler Chrysler
DLR, Neustrelitz
Institute of Navigation of the University of Stuttgart
BZP (National Taxi and Rental Car Association), Germany
- Rail
GNSS and Loran-C in Road and Rail Applications (GLORIA), EU Project,
Project Team:
MAN Technologie AG
ASIT (Safety and Information Systems in Transport Ltd.)
DE-Consult (Deutsche Eisenbahn – Consulting GmbH)
HiTec Marketing (Vereinigung High Tech Marketing)
Reelektronika b.v.
TeleConsult Hofmann-Wellenhof & Partner OEG
ZIV (Zentrum für integrierte Verkehrssysteme GmbH, Institute for Integrated Traffic and Transportation Systems)
- Maritime applications
preliminary: Trinity House

- Inland waterways
Federal Waterways and Shipping Administration
Transport Technology and Telematics Division, Germany
- Aviation
BAZL (Federal Office of Civil Aviation), Switzerland
- Public security
State Police of Bavaria, Germany
- Surveying/GIS
Technical University of Dresden, Germany
Technical University of Zurich, Switzerland
- Military
German Military Geographic Office
- Time
Federal Office for Technical Physics

4 Specific test definition and sensors

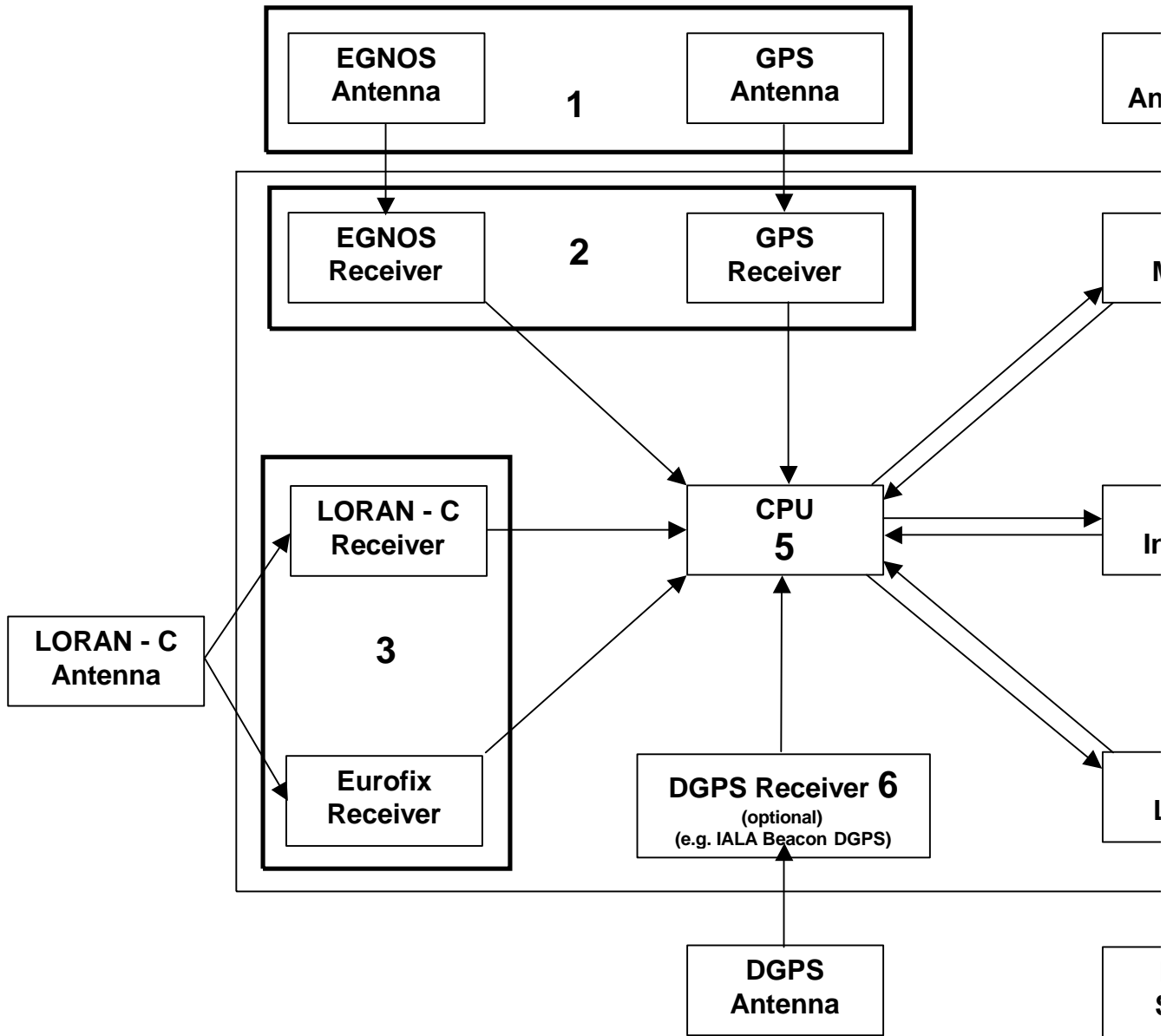
For each type of application specific test concepts were developed regarding application specific characteristics, availability of test vehicles, availability of receivers etc. For example for the road sector static and mobile test will be performed. The mobile measurements will be twofold:

- Mass test with approx. 200 – 300 vehicles and simple measurement equipment to get a larger amount of data, which is statistical significant
- Defined trials with complex test equipment under “problematic conditions”.

E.g. following “problematic conditions” were identified for the road sector:

- Urban Canyoning
- Tunnels
- Bridges
- Multi-storey Car Parks
- High Mountainous Regions
- Low Mountainous Ranges
- Areas with Strong Electromagnetic Interferences
- Multipath Environment

The used sensors for those specific trials include GPS, DGPS (by different broadcast technologies), Loran-C, Eurofix, and EGNOS. The different sensors will be combined as shown in the following figure.



Footnotes:

1. GPS and EGNOS antenna may be integrated into a single antenna
2. GPS and EGNOS receiver may be integrated into a single receiver
3. Loran-C and Eurofix receiver may be integrated into a single receiver
4. Bi-directional GSM communication will be used for
 - a) data output from the mobile black box to the fixed project centre
 - b) remote control of the black box
5. The task of the CPU is to handle the processes and data streams inside the black box (e.g. administration of data storage, management of the different input sources, etc.)
6. optional

5 Software

The Test and Validation Programme will be supported by a self-developed software, which fits the special requirements regarding data storage, administration, analysis and visualisation of results. This programme specific software solution is under development by TeleConsult Austria Hofmann-Wellenhof & Partner OEG. The current status of the software was successfully presented to NELs in August 2000 and the work will be continued as scheduled to have the complete version ready by October 2000.

6 Conclusions

The Loran-C/Eurofix/EGNOS Integration Test and Validation Programme (LOREG T&V) was initiated successfully and phase 2 has just started. A concept for application specific tests was developed by Telematica and approved by NELs. Contacts to different user organisations have been made and field tests are ready to take place as the first receivers will be available, which is expected for autumn 2000. An appropriate software to support the user specific requirements is under development and will also be available in autumn 2000. LOREG T&V will show up the potential benefits of the combined use of different terrestrial and satellite based sensors, which hopefully will help to overcome the restrictions of single navigation and positioning systems and will offer suitable and reliable solutions for all user communities in the future.