Easy-OBU Project
Technical Assessment and achieved results

Praha, 13th of June 2014, Dr. Jörg Pfister

Easy-OBU research project in a nutshell: GSA supported international project aimed at an introduction of cheap positioning solution with improved accuracy

- **What are we doing:** we are developing and preparing market introduction of a new On-Board-Unit capable of providing more accurate location information in challenging situations (such as tunnels) at low cost

- **Who we are:** an international consortium consisting of Efcon (AT), PWP Systems (DE), Austriatech (AT), ITS&S Association (CZ) and ČVUT (CZ)

- **Public support:** the project is partially funded from the 7th Frame Programme of the European Union

Validation in 3 stages

- **Internal Validation**

  Real-life test trials have been conducted with the scientific concept car. In this test-bed additional high performance equipment has been installed, to enable a detailed technical analysis.

- **External Validation**

  A pilot installation of Easy-OBU has been has been set up with 10 vehicles in 3 countries (Austria, Czech Republic and Germany) collecting data at the Easy-OBU server for a whole year.

- **Expert Response**

  In addition to the technical assessment special demonstration events and workshops have been organized by Easy-OBU, to collect feedback from experts and users ➜ for professional applications.

Concept-Car as Test-Bed for Internal Validation

L1/L2-GPS-Receiver with Antenna

3-Achs-INU

Independent Measurement Acquisition

Corrsys
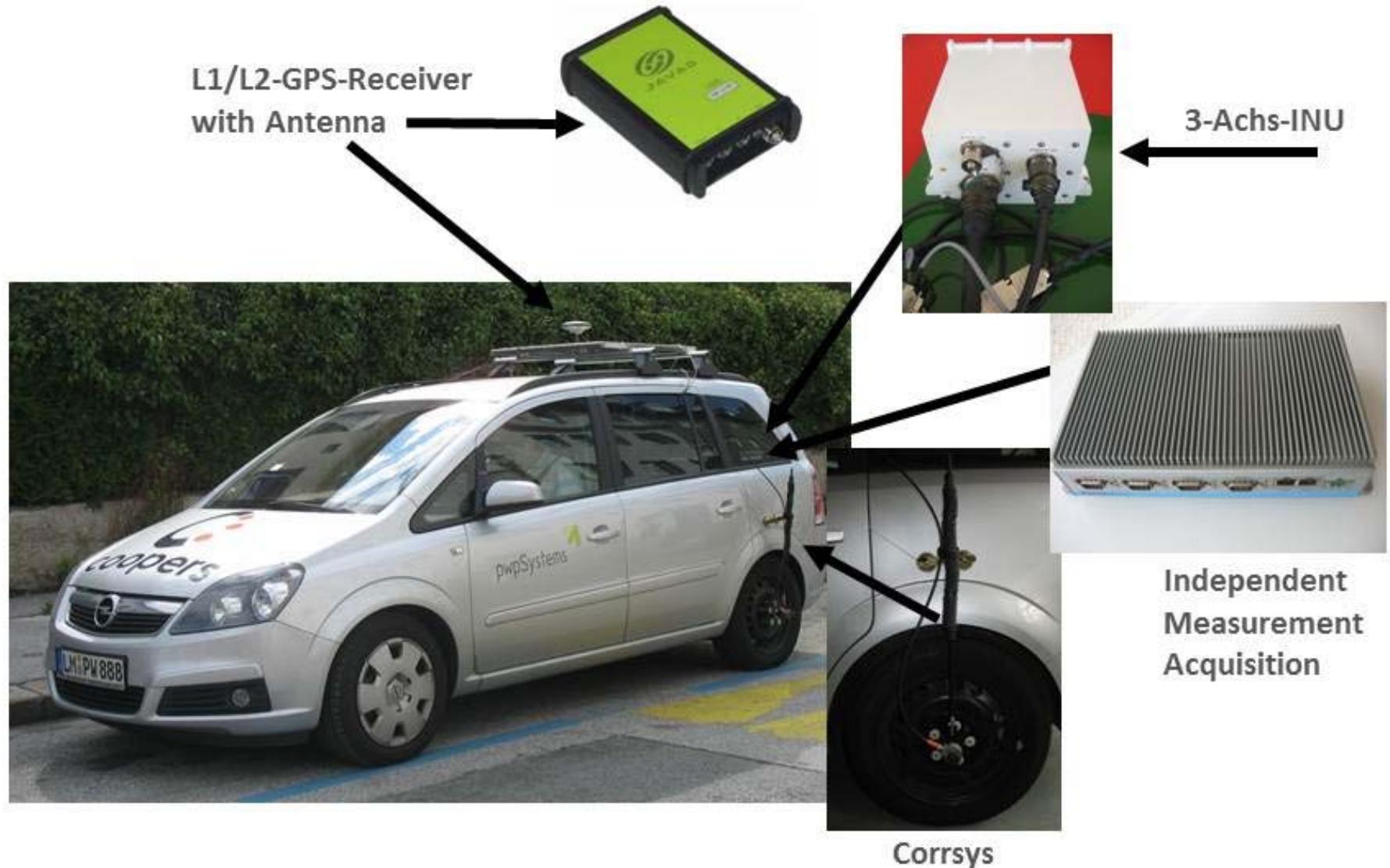
Equipment in the Concept-Car

Easy-OBU Prototype

iNemo-Module + GNSS (EGNOS)
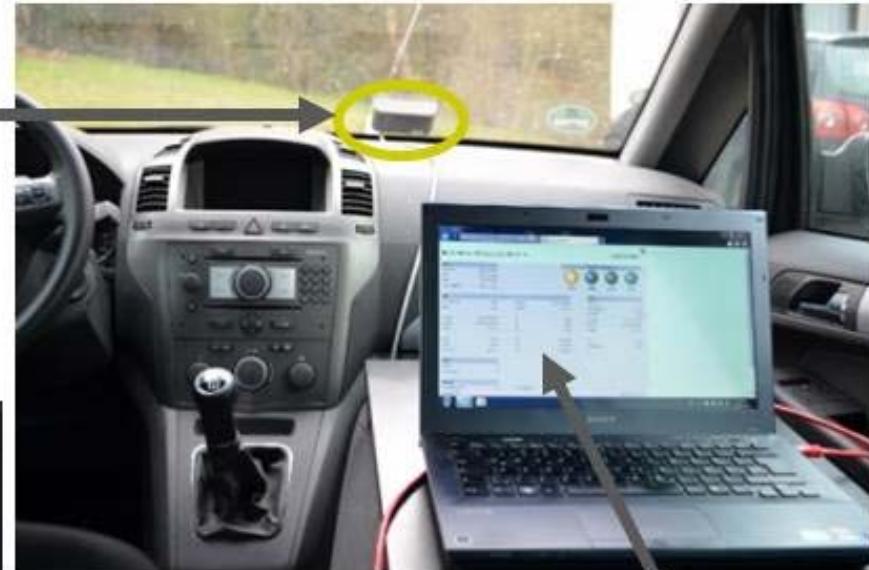
Laptop (supervision of Test execution)
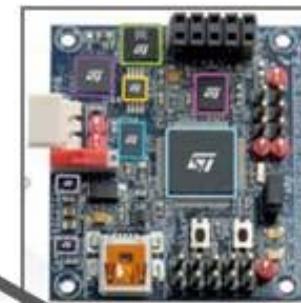
Easy-OBU can offer location precision improvement to applications that do not insist on real time availability of the location information

Loss of GPS signal at the tunnel entrance

Sensors in the OBU detect car motion

GPS signal reacquisition, sensor data sent from OBU to central system

Refined positioning data for the loss-of-signal period delivered back to the OBU
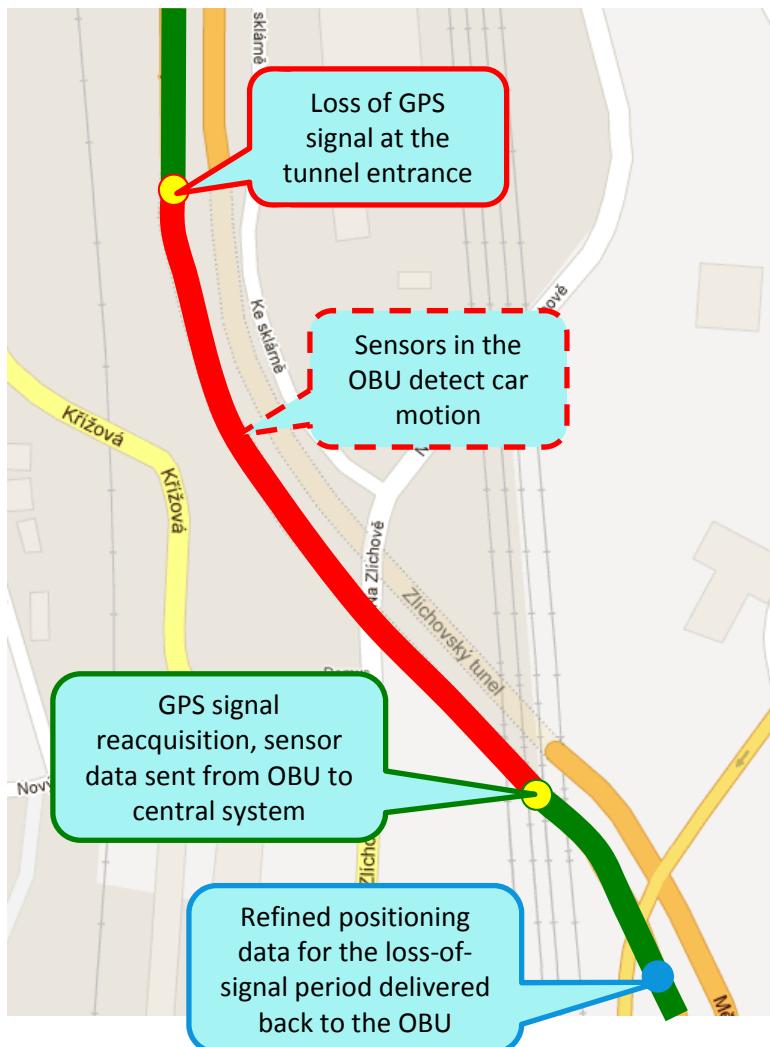
The only limitation of Easy-OBU (and a "price" paid for the low cost of the unit) is availability of the refined positioning data only after a short delay.

Easy-OBU is suitable only for applications that do not necessarily require the improved location information in real time:

- Shortly after leaving the tunnel, but not during the signal loss in the tunnel

- Examples of such applications may include:

    - Fee collection (tolling, parking etc.)

    - Car Sharing pay-per-use models

    - Route controlling (e.g. hazardous goods transport monitoring

    - Fleet monitoring with analytics that requires a more precise location information

    - Ecological apps (CO_2 monitoring etc.)

Validation campaign with Concept Car

- **Odenwald**

  1st scenario with the "Lohberg-Tunnel", which has a length of 1080 m. Environmental conditions are rural with medium hilly terrain.

- **Darmstadt**

  2nd scenario with the "City-Tunnel", which has a length of 540 m. Environmental conditions are urban with 4 – 8 story buildings.

- **Limburg**

  3rd scenario with the "Schiede-Tunnel", which has a length of 245 m. Environmental conditions are a mixture of the first 2 scenarios.

Reference-Trajectory: Example Darmstadt
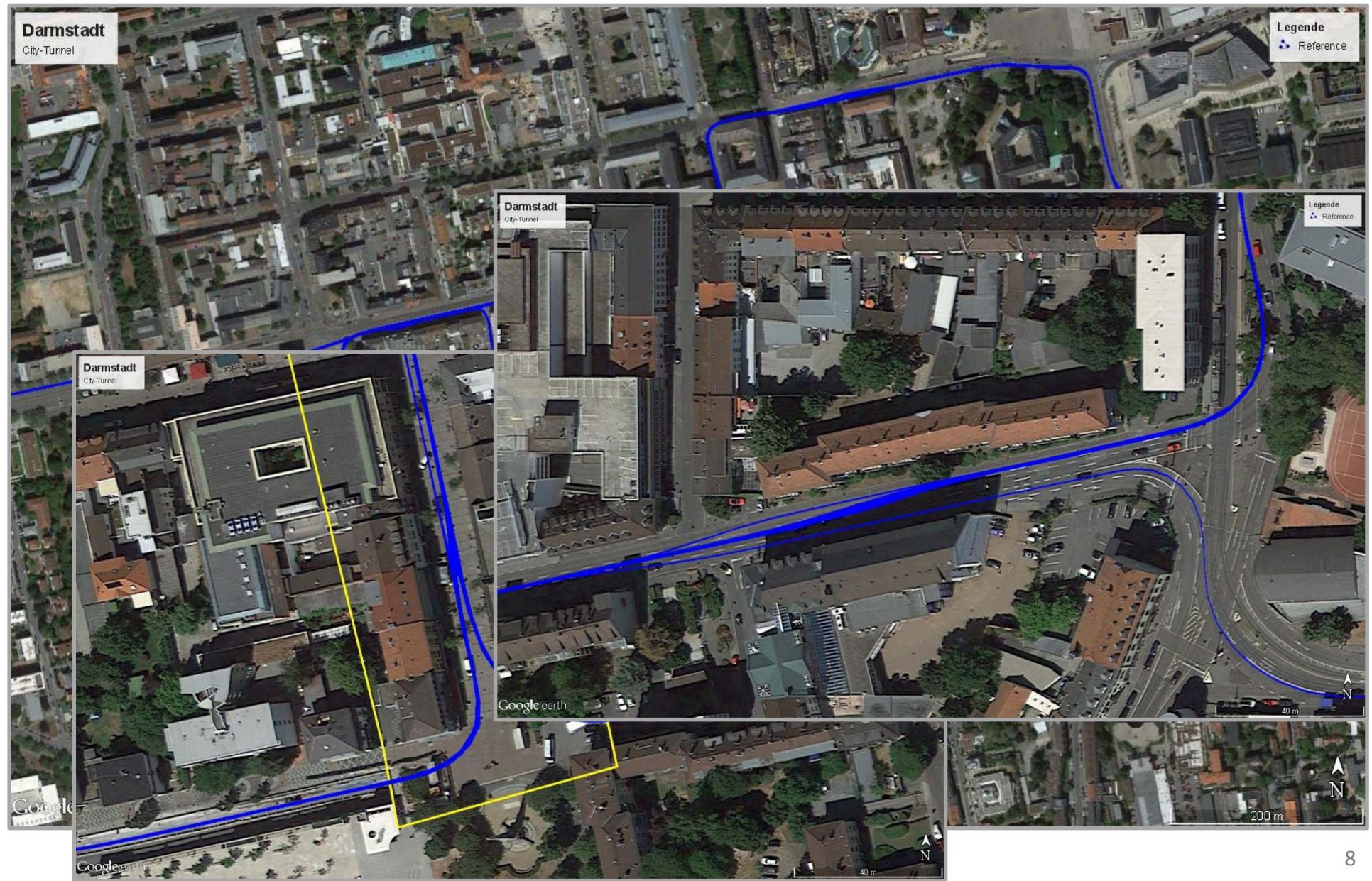
GNSS Results: Example Darmstadt
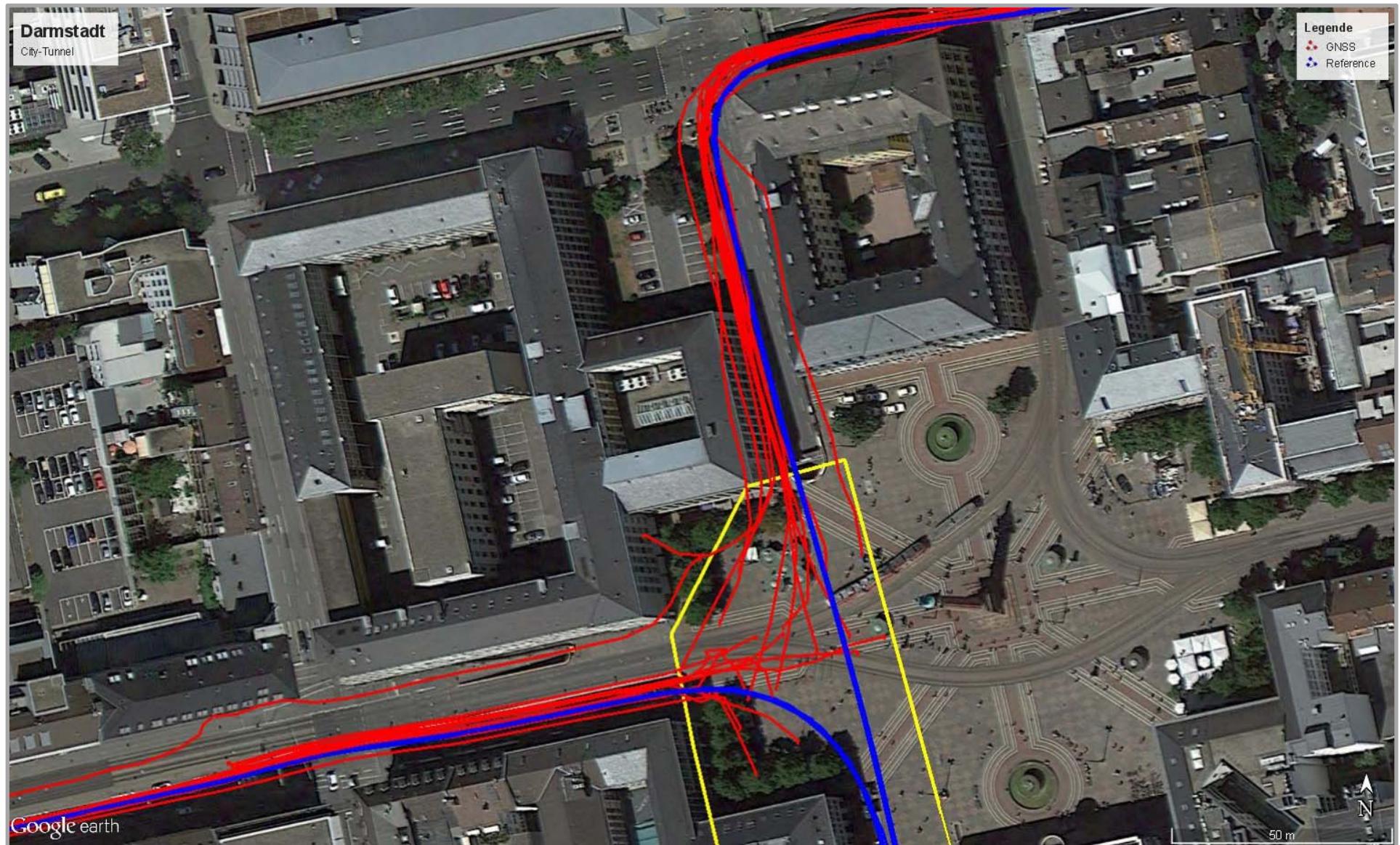
Easy-OBU Results: Example Darmstadt

Comparison of Results: Example Darmstadt

Position error over time of referenced test (Darmstadt: 16.03.2014)
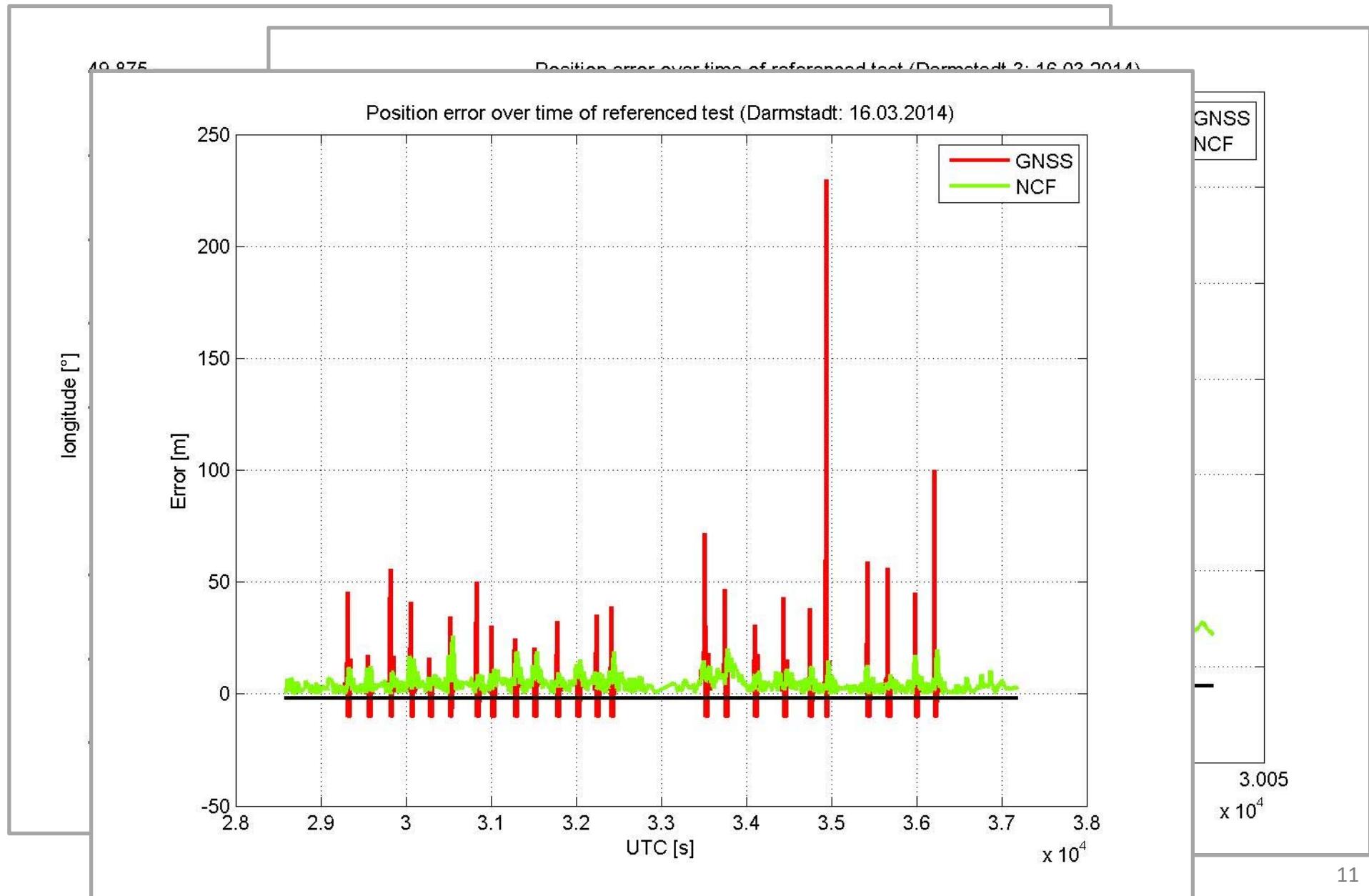
Histogram of the error distribution for NCF solution

NCF: Position-Error-Distribution for referenced test of Easy-OBU

Percentage of position data with distance from reference

Deviation from reference in meters
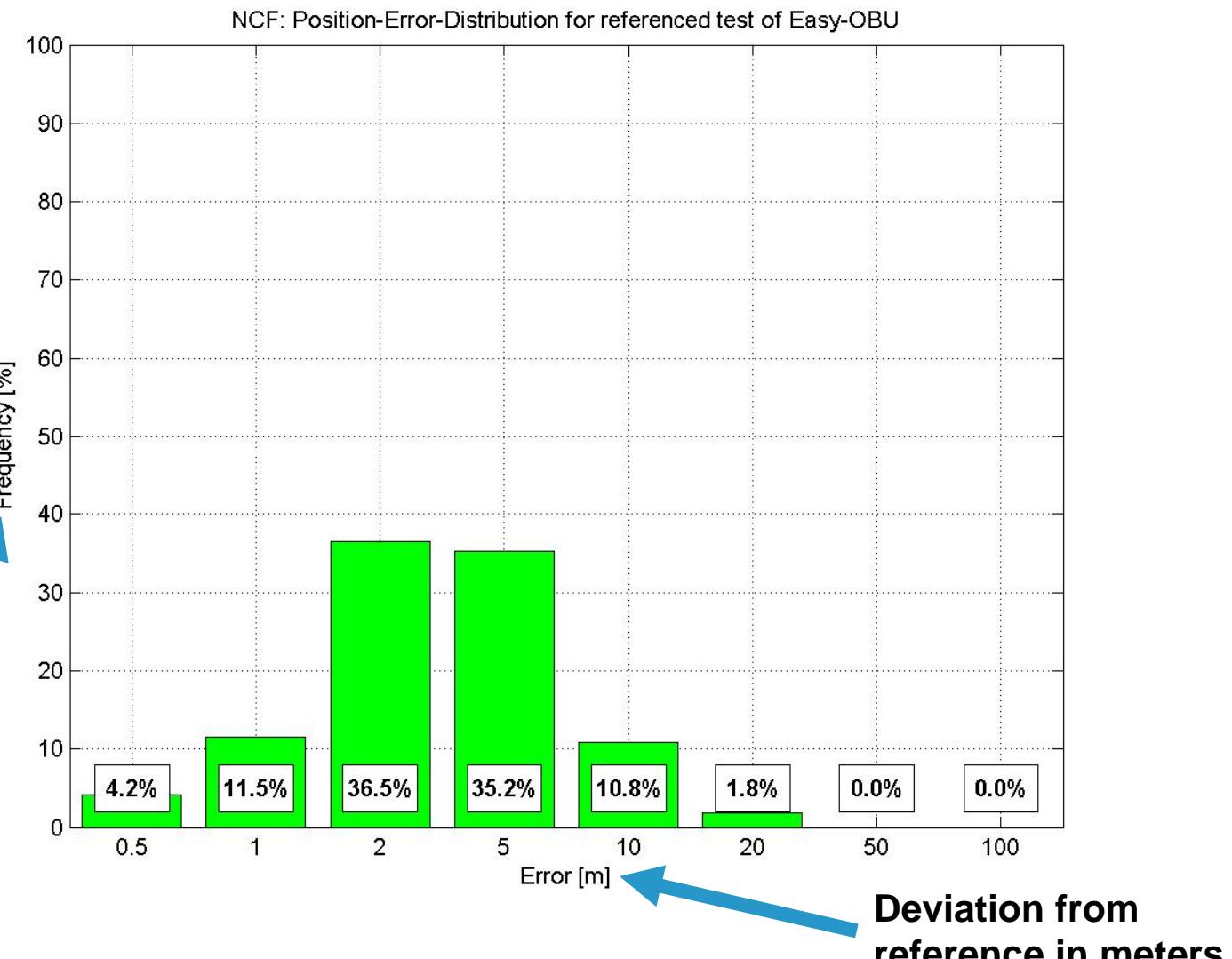
Comparison GNSS vs. NCF

GNSS

GNSS: Position-Error-Distribution for referenced test of Easy-OBU

4.9% 13.3% 40.4% 33.2% 6.4% 1.0% 0.6% 0.2%

NCF at GNSS fixes

NCF: Position-Error-Distribution only for valid GNSS fixes!

4.5% 12.4% 38.4% 35.5% 8.4% 0.8% 0.0% 0.0%
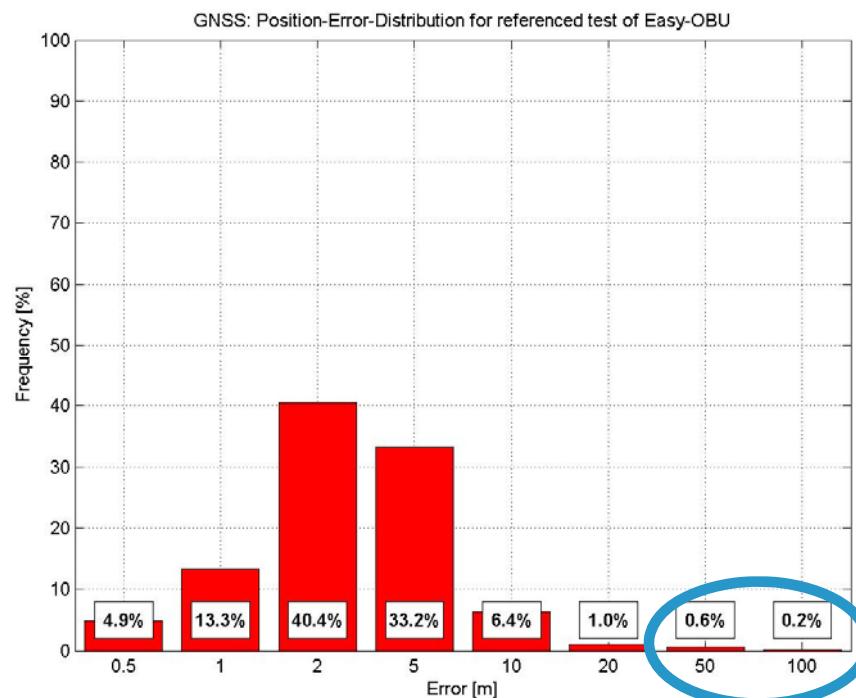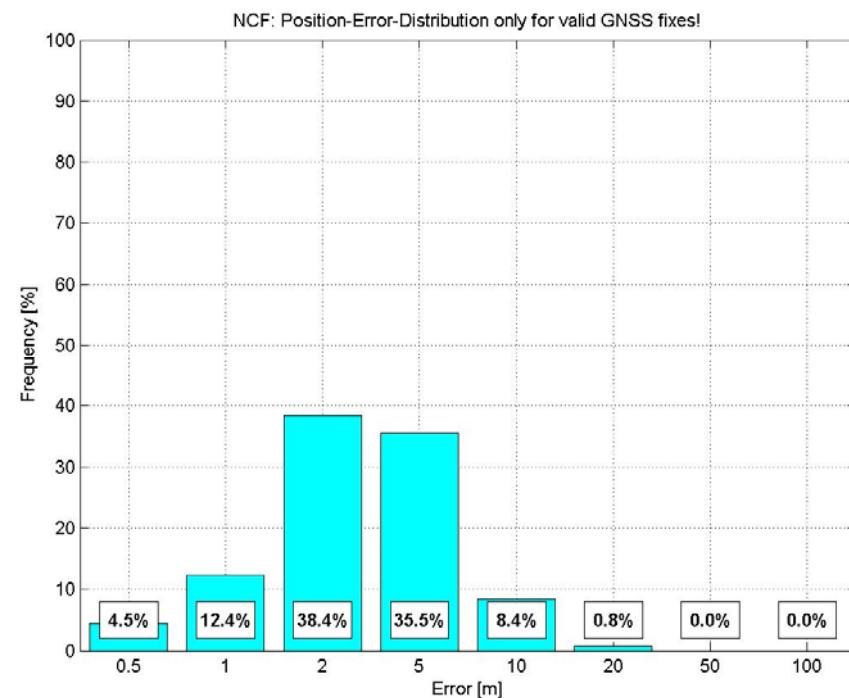
The large position errors of GNSS could be all corrected!

Final Results of the Internal Validation

| Parameter	GNSS	NCF
σ	6.64 m	3.38 m
RMS	4.12 m	4.24 m
CEP_{95}	9.39 m	11.03 m
CEP_{99}	25.89 m	17.39 m
$Error_{max}$	229.60 m	26.10 m
Availability	91.5 %	100.0 m
EGNOS-Availability	91.7 %	91.7 %

External Validation with OBU PWP-2 (Odenwald)
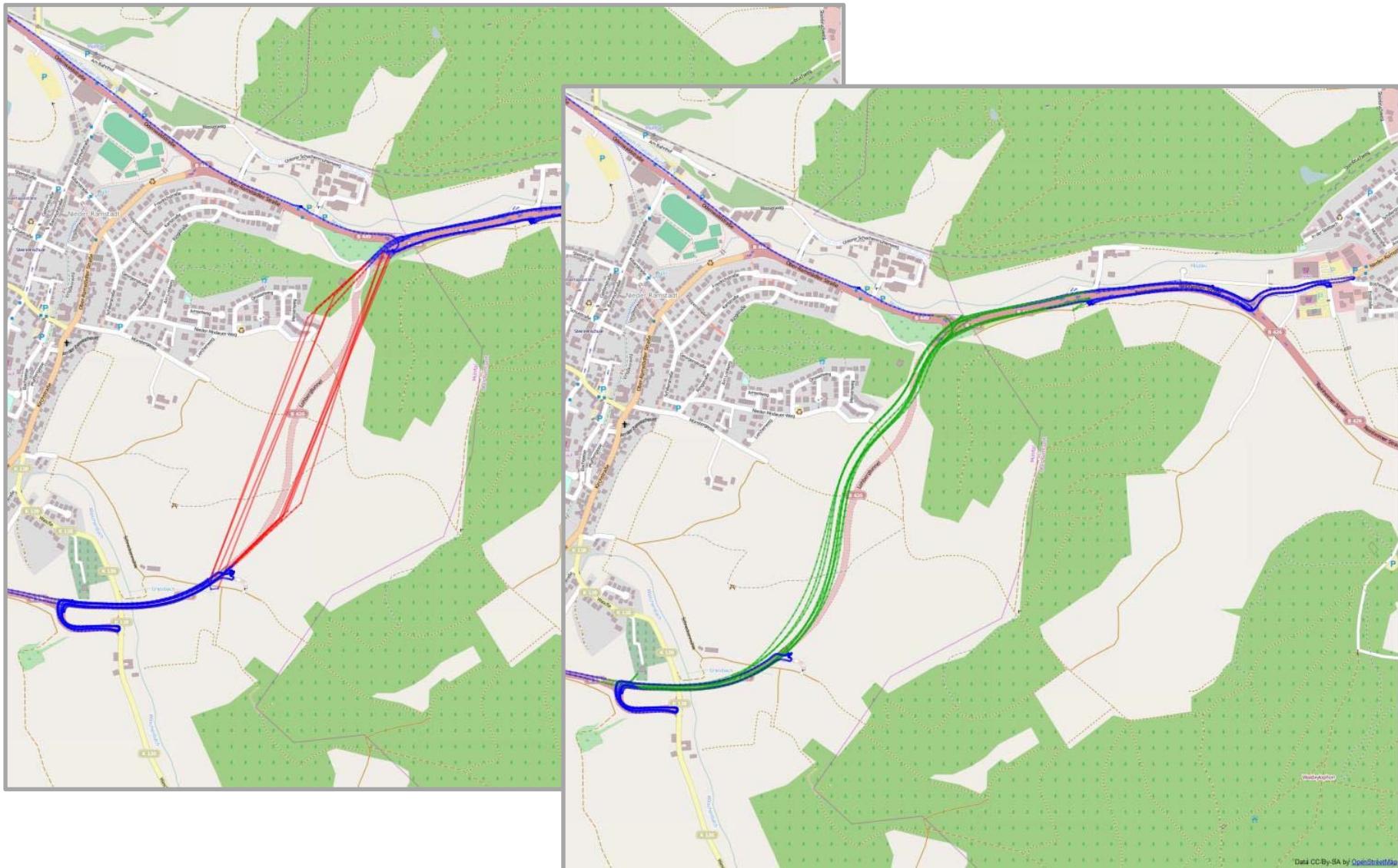
External Validation with OBU PWP-2 (Darmstadt)
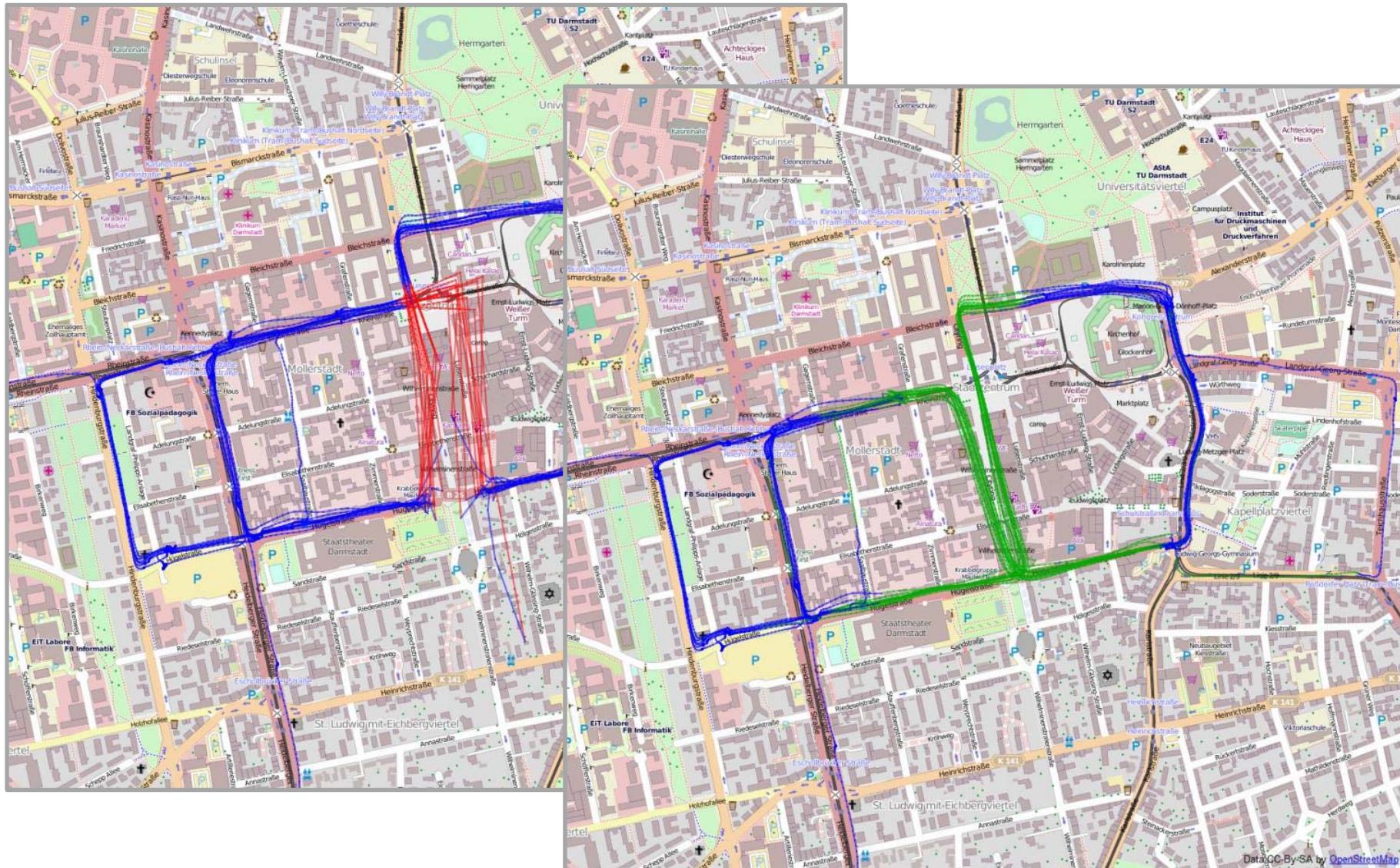
External Validation with OBU PWP-2 (Limburg)
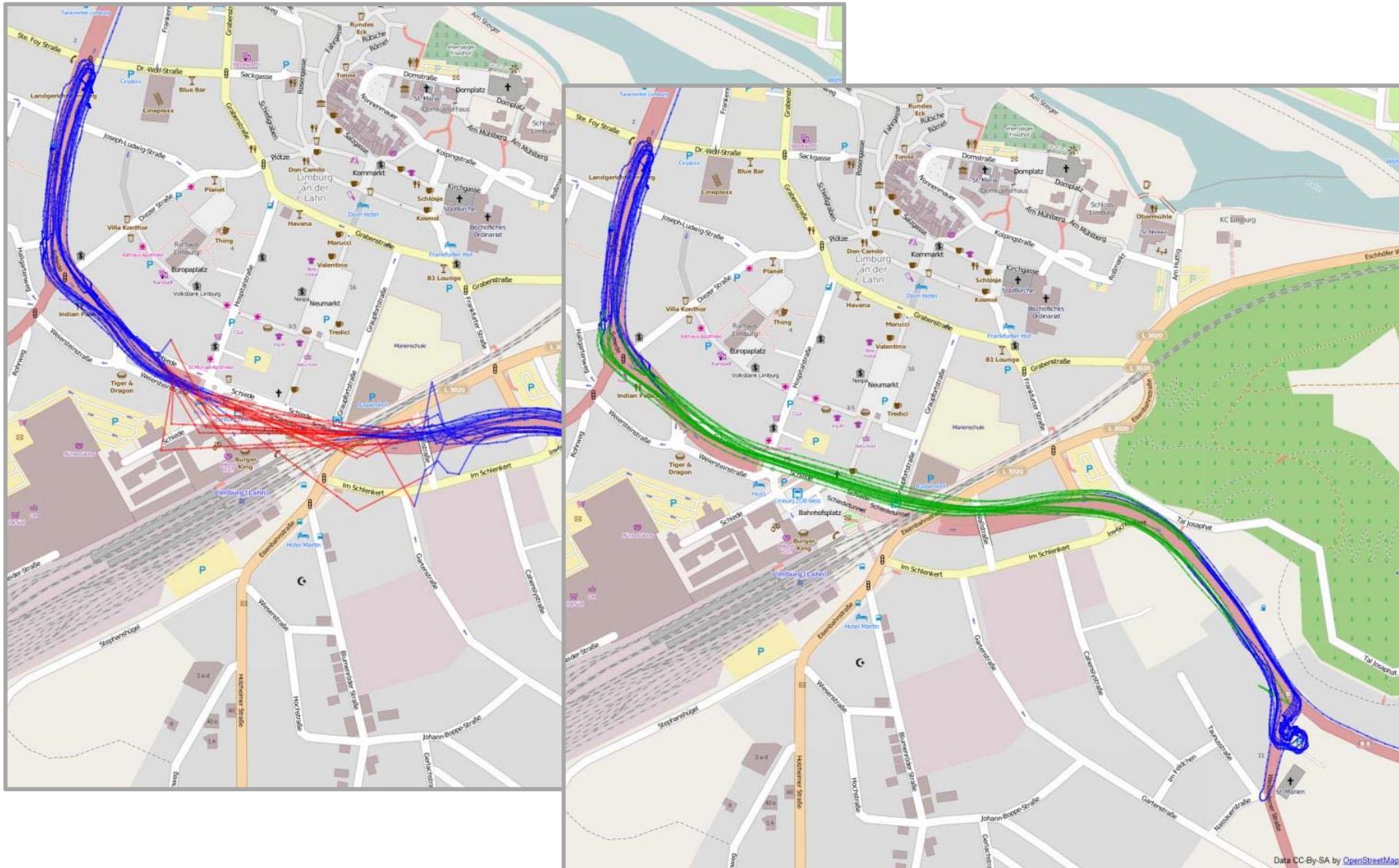
Easy-OBU pilot

- **10 pilot vehicles**

  Prototype-OBUs have been distributed among all project partners early in the project

- **Austria, Czech Republic and Germany**

  The pilot vehicles are active in Berlin, Halle, Darmstadt, Prague, Vienna, Graz, etc. for a timer period of 1 year

- **Easy-OBU server**

  All pilot vehicles are transmitting their data to central data

- **Wep - Application**

  To visualize GNSS data and NCF-solution from central server

Selected Bus Routes for Praha

Bus Stations:

- **Brezová-Oleško**
- **Jiretice**
- **Mníšek pod Brdy**
- **Psáry**
- **Psáry, Dolní Jircany, cihelna**
- **Satalice**
- **Smíchovské nádraží**

Data Volume:

- **+500 h**
- **approx. 400 trips**
- **Duration of 3 month**

External Validation Scenarios

- **Scenario 1**

  Link to internal Validation ➜ performance in Concept Car

- **Scenario 2**

  Detection of standing phase through inertial sensor, to eliminate errors and enhance distance travelled calculation

- **Scenario 3**

  Retrospective Gap Filling

  at Cholupice tunnel with

  a length of 1918 m.

Web Application for Track Analysis
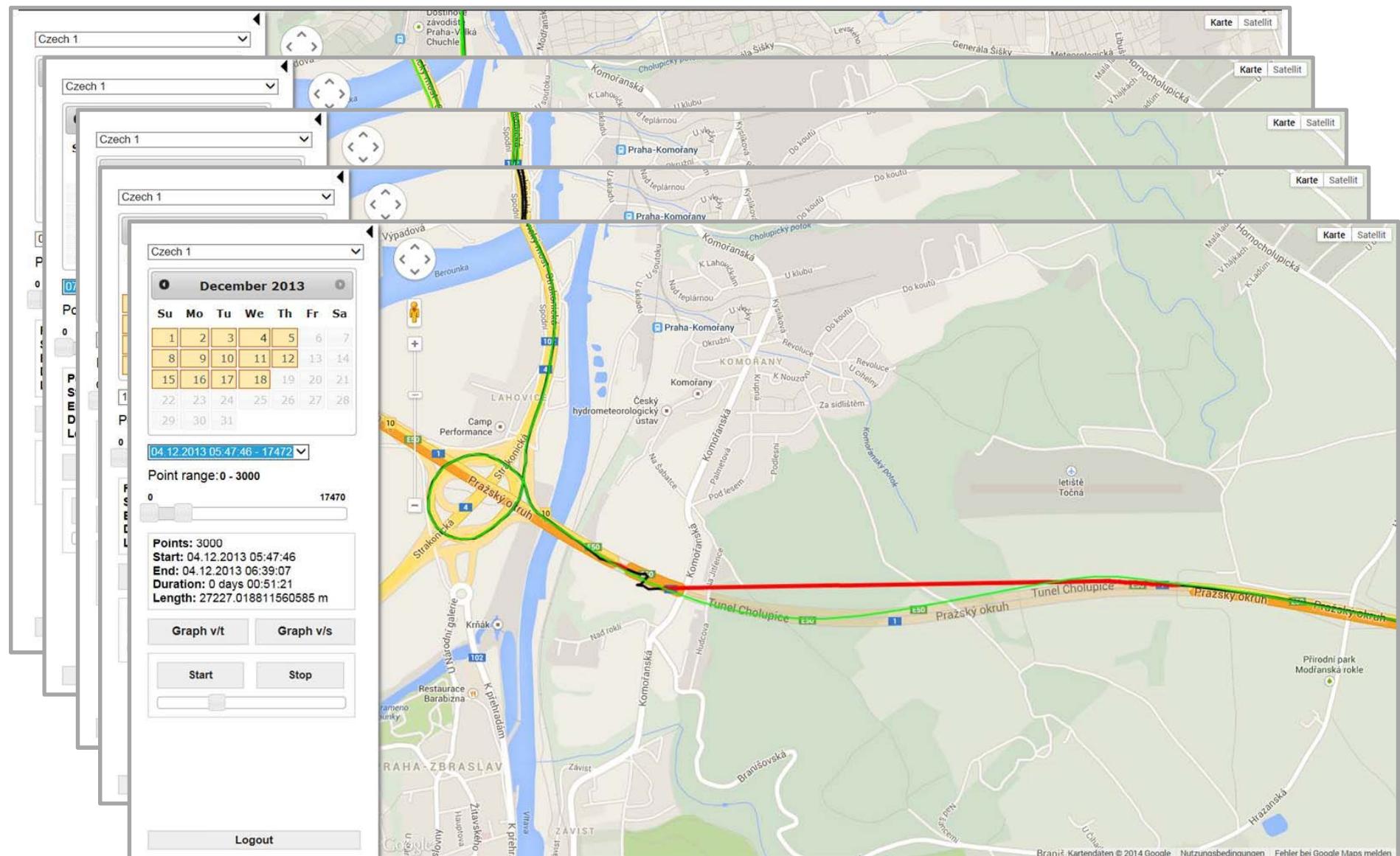
Summary

- **Retrospective Gap Filling**

  Easy-OBU has the capability to reconstruct the trajectory during GNSS outage on the basis of a low-cost inertial sensor head.

- **Cut large GNSS errors**

  GNSS fixes, which contain large errors can be identified and corrected by Easy-OBU in many cases.

- **Big pilot demonstration**

  The FOT like pilot was valuable for technical assessment and business development.

- **Demand is given in professional applications**

  The received feedback from experts was encouraging for Easy-OBU

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