

**9<sup>th</sup>**  
**UCAAT** *User Conference on  
Advanced Automated Testing*

# Assessment of GNSS based equipment

Presented by: Ernst Phillip Mrohs



14/09/2022



## Validation and voluntary certification of GNSS

First ISO 17025 accredited laboratory in Europe for GNSS

ISO 17065 accredited certification body

Notified body 2603 for UAS and EETS

### Voluntary Certifications

- eCall (OEM, retrofit, PSAP)
- GNSS based systems,
- GNSS test benches
- GNSS correction services
- ...



Member and active participation in DIN, ETSI and IEEE and delegated expert by DIN to CEN and ISO

Participation in national and EU projects for UAS, automated driving, railway, NextGen-eCall, ....



Quelle: ETSI



Quelle: DIN



Quelle: CEN



Quelle: IEEE SA

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# To my person

Ernst Phillip Mrohs

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Senior Product Specialist of TÜV Süd

M. Sc. in Geodesy and Geoinformation (TUM)

Associate Fellow of the Royal Institute of Navigation

Member of IEEE, DIN and CEN standardization groups upon PVT/PNT (e.g. DIN NA 131-06-02 AA, CEN/CLC/JTC 5, IEEE P1952 RESILIENT POSITIONING, NAVIGATION, AND TIMING USER EQUIPMENT WORKING GROUP)



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# Relevance of correct PVT

**Challenge: Reliability, Safety and Accuracy of position, velocity and time (=PVT)**

- Regulation UN ECE R152 Uniform provisions concerning the approval of motor vehicles with regard to the Advanced Emergency Braking System (AEBS) for M1 and N1 vehicles
- Implementing Regulation 2021/1228 amending Implementing Regulation (EU) 2016/799 as regards the requirements for the construction, testing, installation, operation and repair of smart tachographs and their components

**Mapping of requirements to reference measurement equipment**

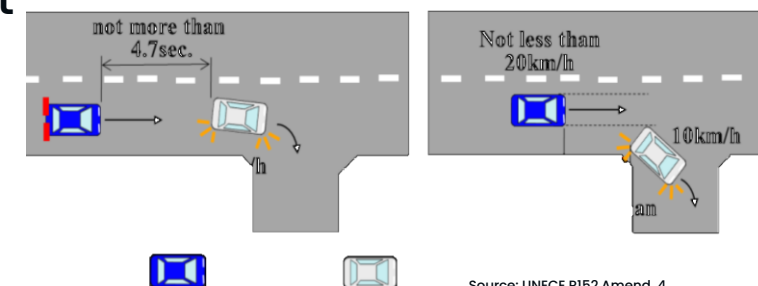
- Requirements in UNECE R152, e.g. Time to collision of at least 4 seconds, Maximum centreline offset of 0.2 m



**Calibrated Reference measurement equipment needed**



Source: UNECE



Source: UNECE R152 Amend. 4

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## Periodical Calibration essential

DKD-L 13-1: Calibration certificate is proof of traceability to national standards, as required by DIN EN ISO 9000 family and DIN EN ISO/IEC 17025

Typical annual calibration of measurement equipment

Typical outputs of GNSS measuring instruments (e.g. position output) are not directly traceable to SI units



**No calibration for GNSS based equipment**

## Today's solution: Usage of high-quality GNSS-equipment

Correctness of measurement based on

KPIs claimed by manufacturer

Calibration of GNSS equipment but only for temperature/frequencies/...

### Resulting Risks

Measured values are not reproducible / comparable

Measured values have a worse performance as stated

Equipment / Sensory errors



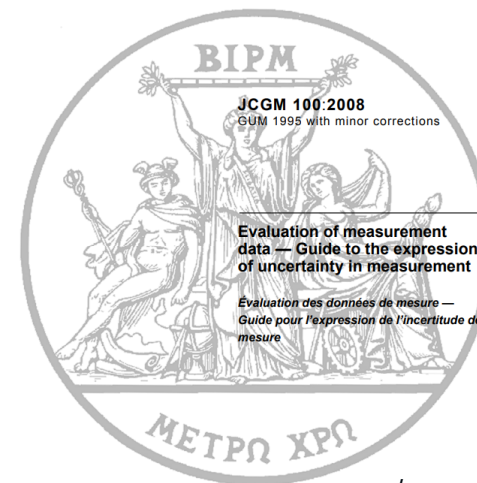
Source: NavCert-2020

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# NavCert solution

## Creation of test scheme

- Mapping of testing scheme against generic calibration approach to assess reference measurement systems
- Core of the assessment performance test in normal and “disrupted” scenarios covering critical scenarios
- Based on existing standards
  - Definition of scope of assessment
  - Overview of available standards, regulations, ....
  - Definition of assessment metric(-s)
  - Definition of measurement background
  - Definition of observables
  - Analysis of measurement uncertainty
- Validation / verification
- Amendment to accredited scope



Source: JCGM/BIPM



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PPP88117A:2021 Assessment of a GNSS reference	Developed by:
	Authorised by:

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# Background and metrics

Scheme based on published standards, e.g.

ETSI TS 103 246-3

ETSI TS 103 246-5

## Metrics

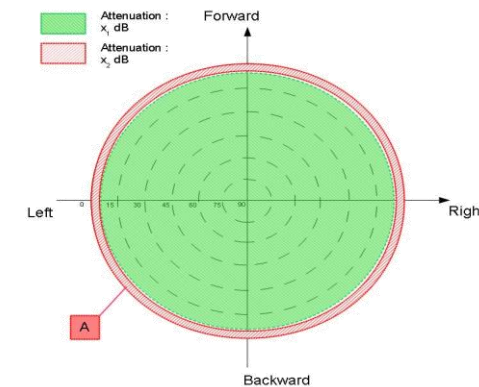
Position Quality

Distance between two systems

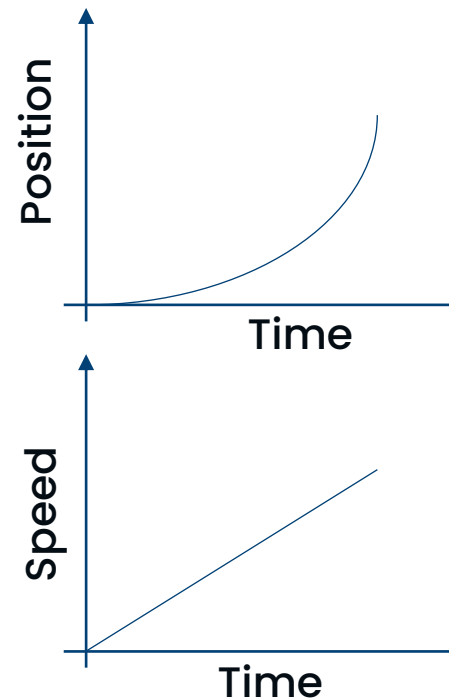
Speed Quality

Time Quality

Correction service quality



Source: ETSI TS 103 246-3



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# Defined Test cases examples

Test Track	Reference (Control)	Track 1A	Track 2A	Track 2B	Track 3A	Track 3B	Track 3C	Track 3D	Track 3E
Type	Rural	Rural	Highway	Highway	Urban	Urban	Urban	Urban	Urban
Start	LAT: N 47.997601 LON: E 11.641396	N 47.995260 E 11.650159	N 48.030568 E 11.634930	N 48.056165 E 11.598043	N 48.094797 E 11.588305	N 48.118735 E 11.558475	N 48.1358913 E 11.5513249	N 48.1402914 E 11.5241176	N 48.1426814 E 11.5678418
End	LAT: N 47.996135 LON: E 11.655278	N 48.030539 E 11.634944	N 48.056173 E 11.597982	N 48.094805 E 11.588295	N 48.118041 E 11.558847	N 48.135855 E 11.551282	N 48.1402970 E 11.5241099	N 48.1473704 E 11.5518234	N 48.1473737 E 11.5518265
Length	1 km	4.5 km	5.3 km	4.6 km	4.7 km	2.4 km	2.4 km	2.8 km	1.5 km
Sky view	Open sky	Limited sky	Open sky (mostly)	Open sky	Limited sky	Limited sky	Limited sky	Limited sky	Limited sky
Physical Environment	Fields	Forest	Forest (distant) and fields	Fields (mostly).	Buildings, trench, small crossovers.	Buildings (height ~30 m)	Buildings (height ~20 m)	Buildings (height ~20 m)	Buildings (height ~20 m)
Elevation Mask (min)	> 5°	~40° – 70°	> 10° – 20°	> 5° – 10°	~30° – 80°	~30° – 60°	~30° – 60°	~30° – 60°	~30° – 60°
Factors Impacting the GNSS signals in the test track	-/-	High absorption, middle blockage effects	Weak absorption, weak blockage effects	Weak multipath effects	Strong multipath, blockage, and diffraction effects	Middle multipath, blockage, and diffraction effects	Middle multipath, blockage, and diffraction effects	Middle multipath, blockage, and diffraction effects	Middle multipath, blockage, and diffraction effects
Standard Reference <sup>2(s)</sup>	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3	CEN/EN 16803-1 ETSI 103 246-3
Velocity range	0 – 30 km/h	40 – 80 km/h	80 – 100 km/h	80 – 120 km/h	30 – 60 km/h	30 – 60 km/h	30 – 60 km/h	30 – 60 km/h	30 – 60 km/h
-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-



Rural scenario



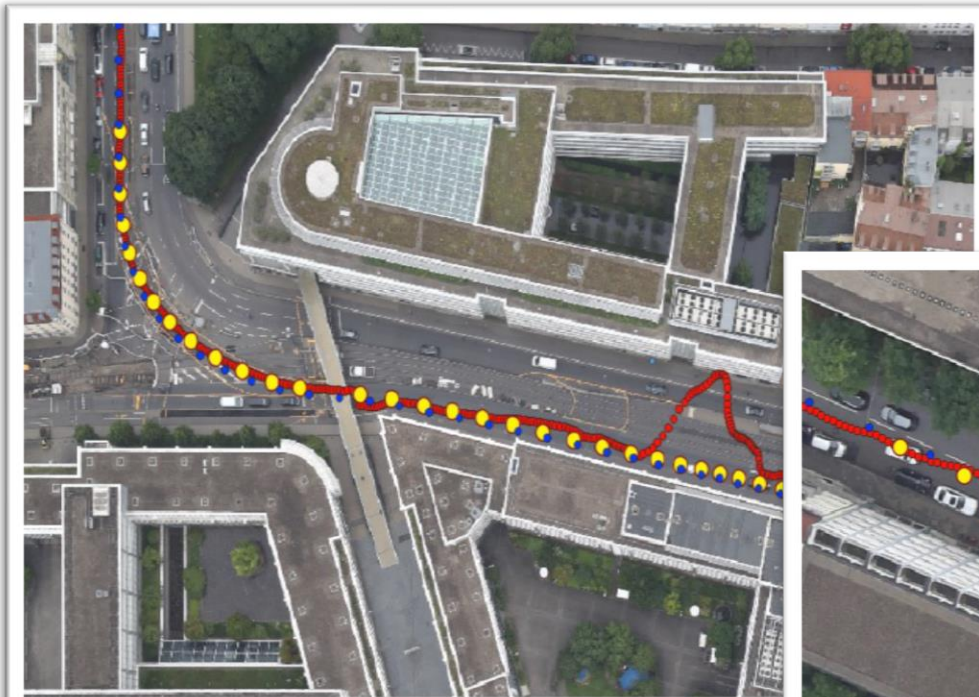
Urban scenario

Excerpt from VAGAD project (see Paulo Mendes et al., 2022, Certification of automotive GNSS receivers using aerial image data)

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# Evaluation



- GNSS independent Method
- Low Resolution filtered Solution
- High-resolution Type

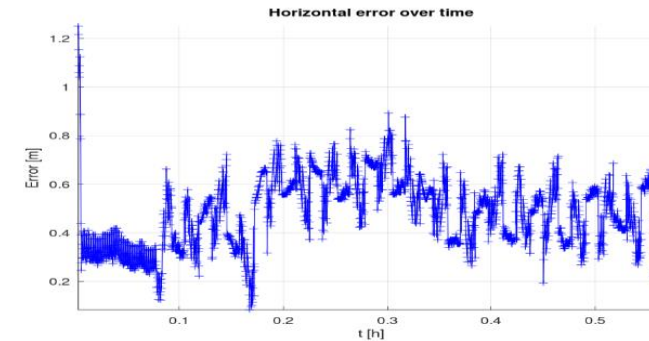
Excerpt from VAGAD project (see Paulo Mendes et al., 2022, Certification of automotive GNSS receivers using aerial image data)

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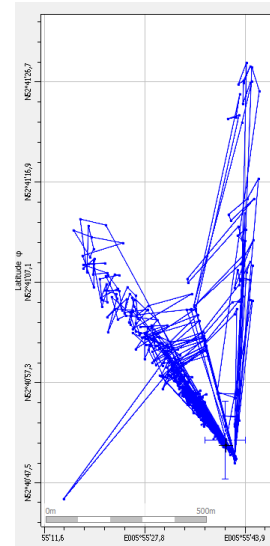
# Evaluation and Conclusion

## ● Outcome of validation- GNSS-Receiver

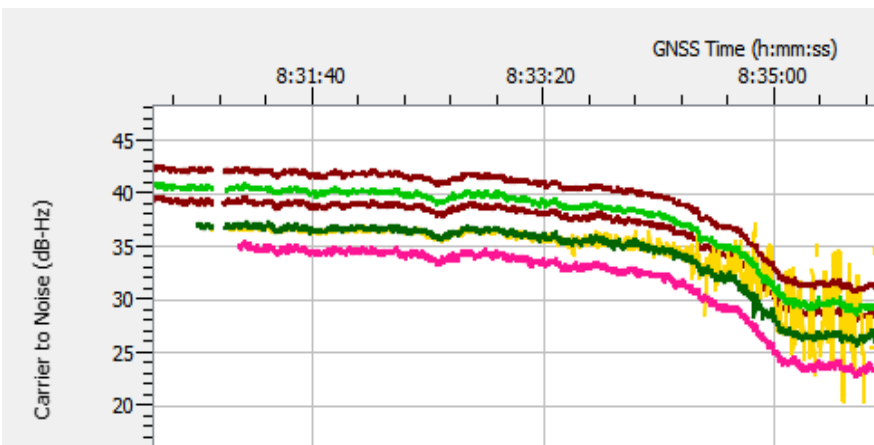
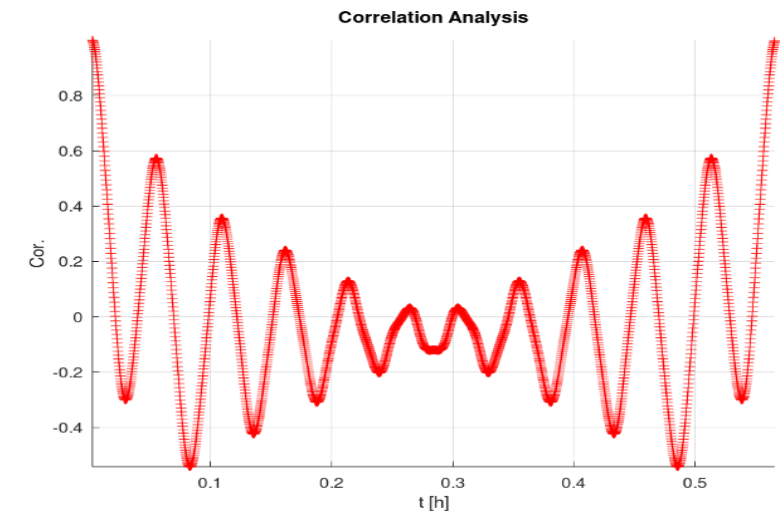
- Time quality: 10 ms
  - Position quality: <1m
  - Speed : < 0.25 m/s
  - Distance: <3 cm
- > Within expected range



Source: NavCert-2021/2022



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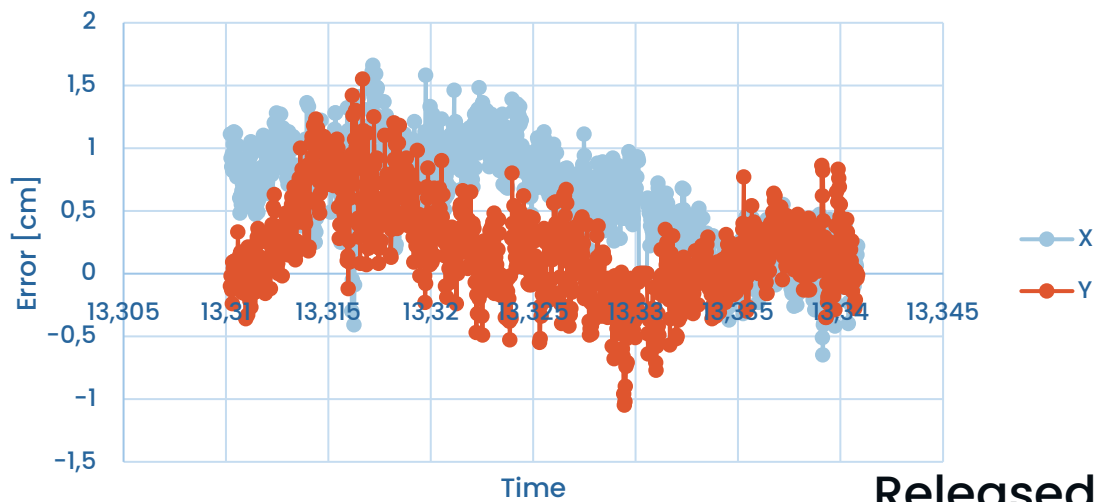
Source: NavCert-2022



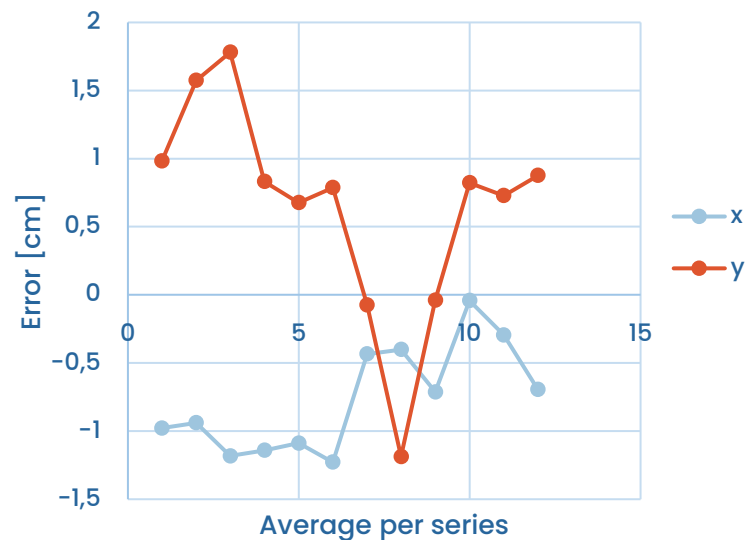
# Evaluation and Conclusion

## Outcome of validation-Correction Service

- Own service for validation of scheme
- Dynamic and static scenarios
- Accuracy hor. ~ 2cm
- Availability and Continuity 100% during test campaign



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Source: NavCert-2021



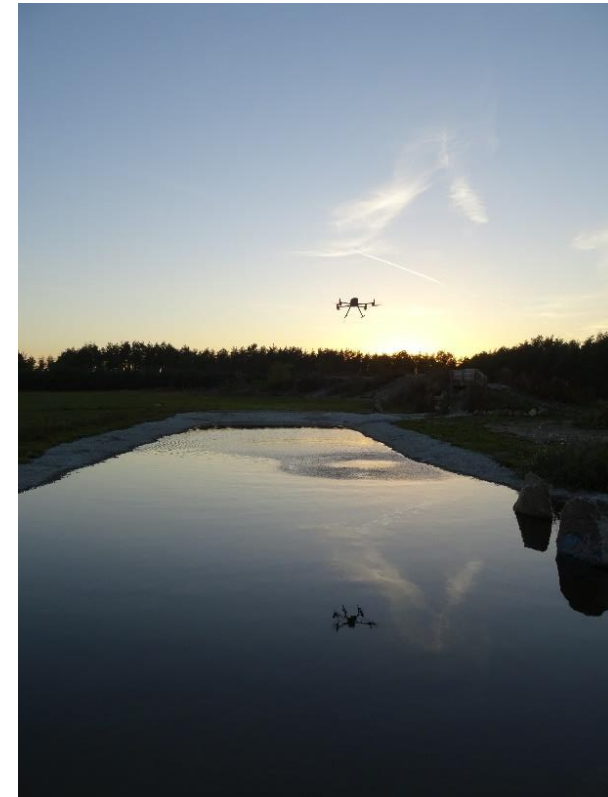
Source: NavCert-2021

## Application and extension

- Further data levels (e.g. RINEX)
- Further use cases (e.g. UAS)
- Elaboration of critical scenarios
- .....



Source: NavCert-2022



Source: NavCert-2021

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# Any further questions?

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