



Technische  
Universität  
Braunschweig



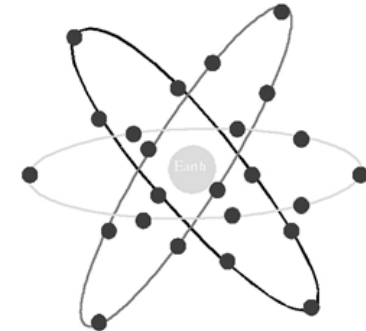
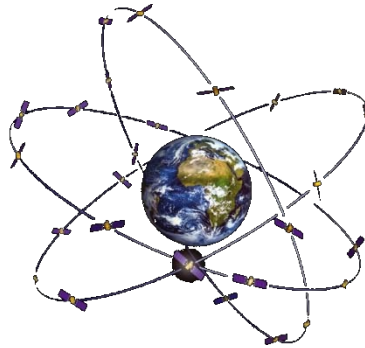
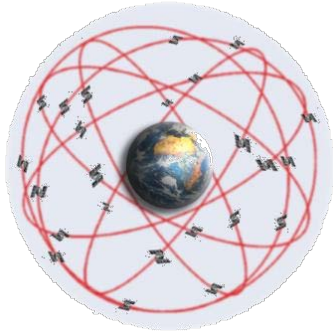
1. GNSS for transport
2. Generic Certification
3. Qualification of Accuracy
4. Supported by Terminology
5. Conclusion

## **Investigation of satellite based localization systems by means of terminology**

Dipl.-Ing. Hansjörg Manz

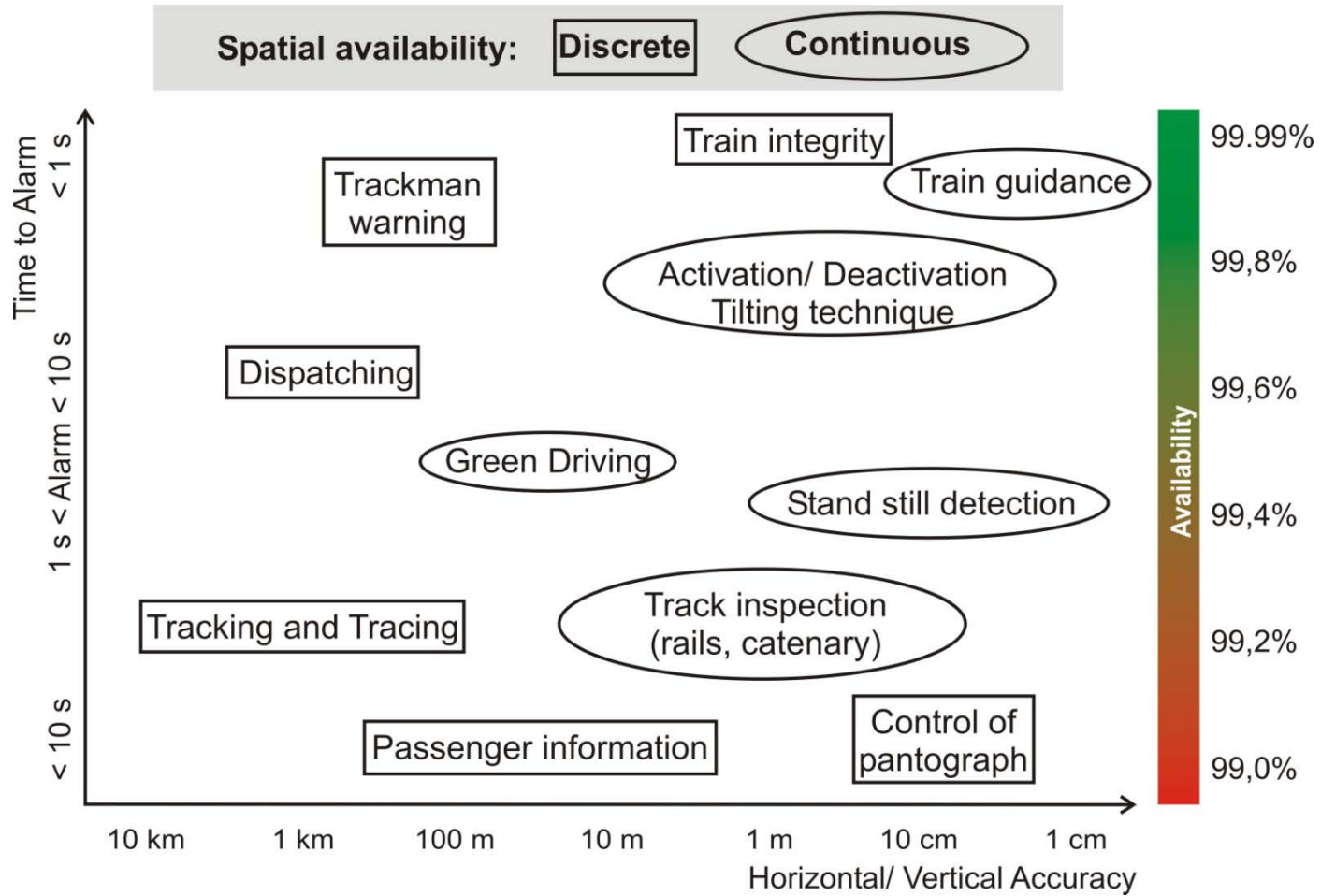
Institute for Traffic Safety and Automation Engineering

# GNSS – GPS – Galileo – GLONASS



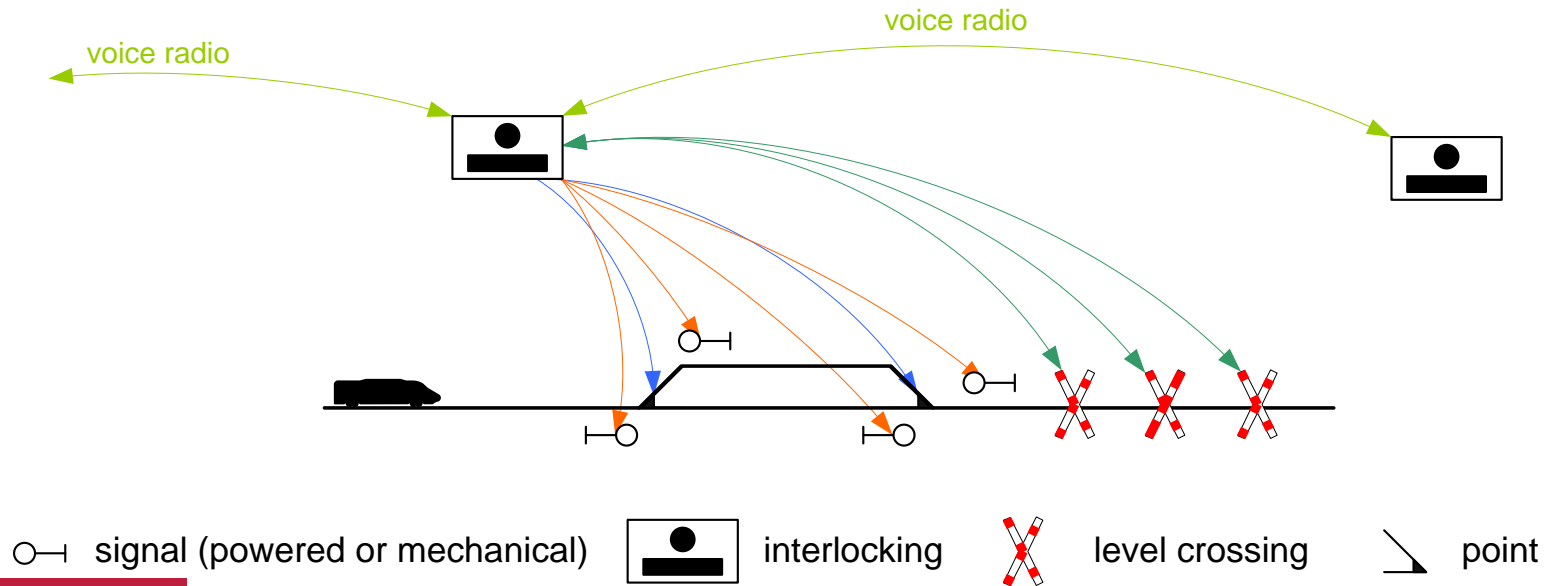
- Focus: Galileo
  - Safety of Life (SoL) service
  - Guarantees accuracy, continuity
  - Provides integrity information
- Feasible for applications in transport

# GNSS applications – example: Railways



# GNSS applications – example: Railways

- State of the Art of localization in railways
  - Localization by track side equipment
  - Discrete (not continuous) localization
  - Diverse localization systems in different European countries
  - Different localization systems are not compatible



## Disadvantages

of track side equipment

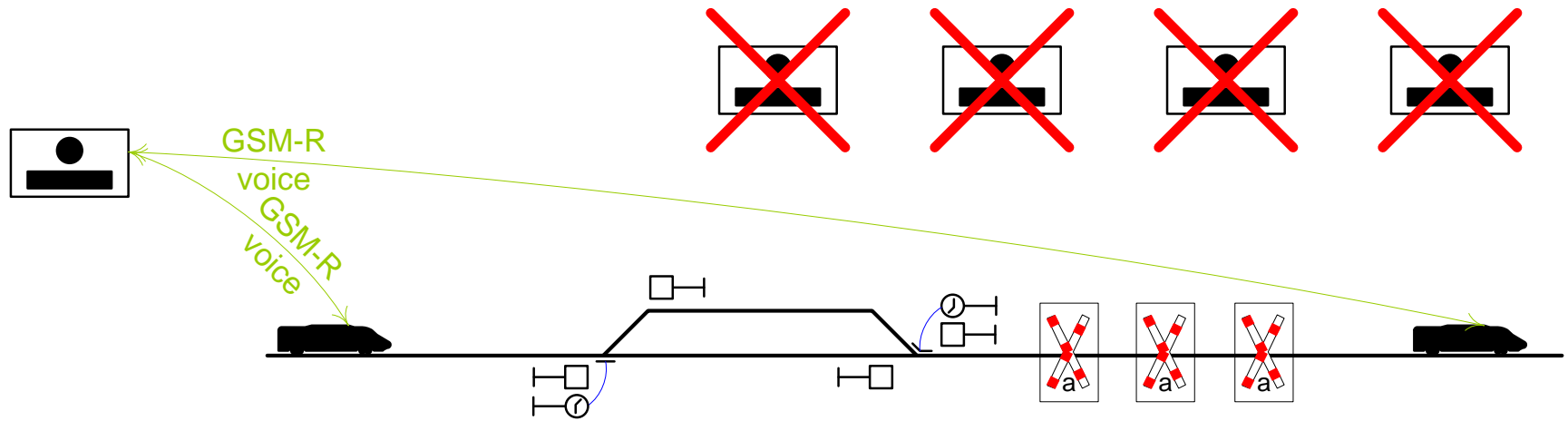
- High total costs of ownership
- Exposed to environment
- Constitutes a state of development
- Causes compatibility problems
- Allows only discrete but not continuous localization

## Advantages

of satellite based localization

- Reduces cost of ownership
- Increases capacity
- Enables precise safety relevant localization (e.g. positioning of the rear end of the train autonomously)
- Has to be produced in serial production in future as well

# GNSS applications – example: Railways

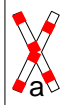


①— signal for trailable one-way point

□— signalboard

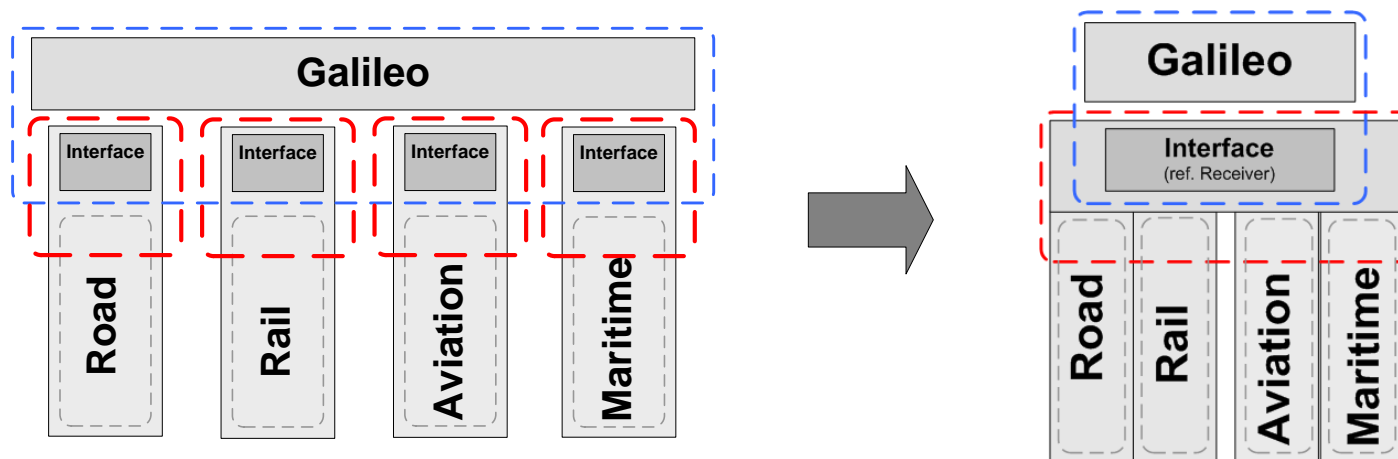
 interlocking

—/— trailable one-way point

 level crossing (automatic)

# Generic Certification for transport applications

- Today
  - Certification process is different for each transport domain
  - Localization device/ receiver built separately for each domain
- Future
  - Common receiver
  - Reached by common certification process & terminology



# Generic Certification: Unified for all domains

- Base for various safety-critical applications in transport
  - Railways
    - Flexible train control and protection
    - Trackman warning
    - Control of train integrity
  - Automotive
    - More efficient and safe traffic flow
    - Automatic lane changing
    - Congestion/ road work warning
  - Aviation
    - Direct flight and approach
  - Maritime
    - Precise docking

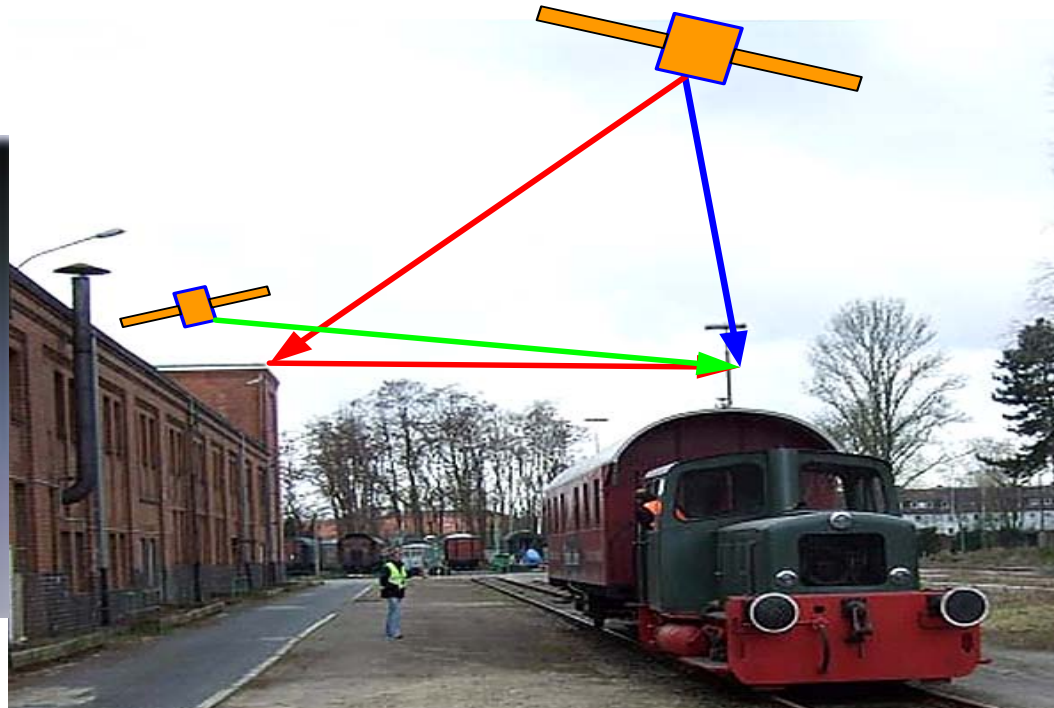


# Generic Certification: Parameters of railway system

- To allow certification of GNSS for railways:
  - GNSS has to be analyzed according to railway standards
  - GNSS parameters have to be determined and crosschecked with requirements of railway standardization
    - Reliability of GNSS in railways
    - Availability of GNSS in railways
    - Maintainability of GNSS in railways
    - Safety of GNSS in railways
  - ... have to be analyzed
- This has to be done within a unique scheme to guarantee comparability between domains

# Qualification of accuracy: errors of GNSS in railways

- Atmospheric Effects
- Time Error
- Reflection
- Multipath
- Shadowing



# Qualification of accuracy: static measurement

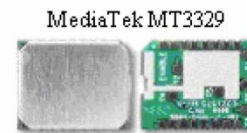
- Measurements in Slovakia
- Estimation of errors (type and value) during static measurement

Type of error	Error value
Atmospheric effects	$\pm 6$ m
Shifts in satellite orbits	$\pm 2.5$ m
Clock errors	$\pm 2$ m
Multipath effects	$\pm 1$ m
Rounding errors	$\pm 1$ m
<b>Total</b>	<b><math>\sim \pm 13</math> m</b>

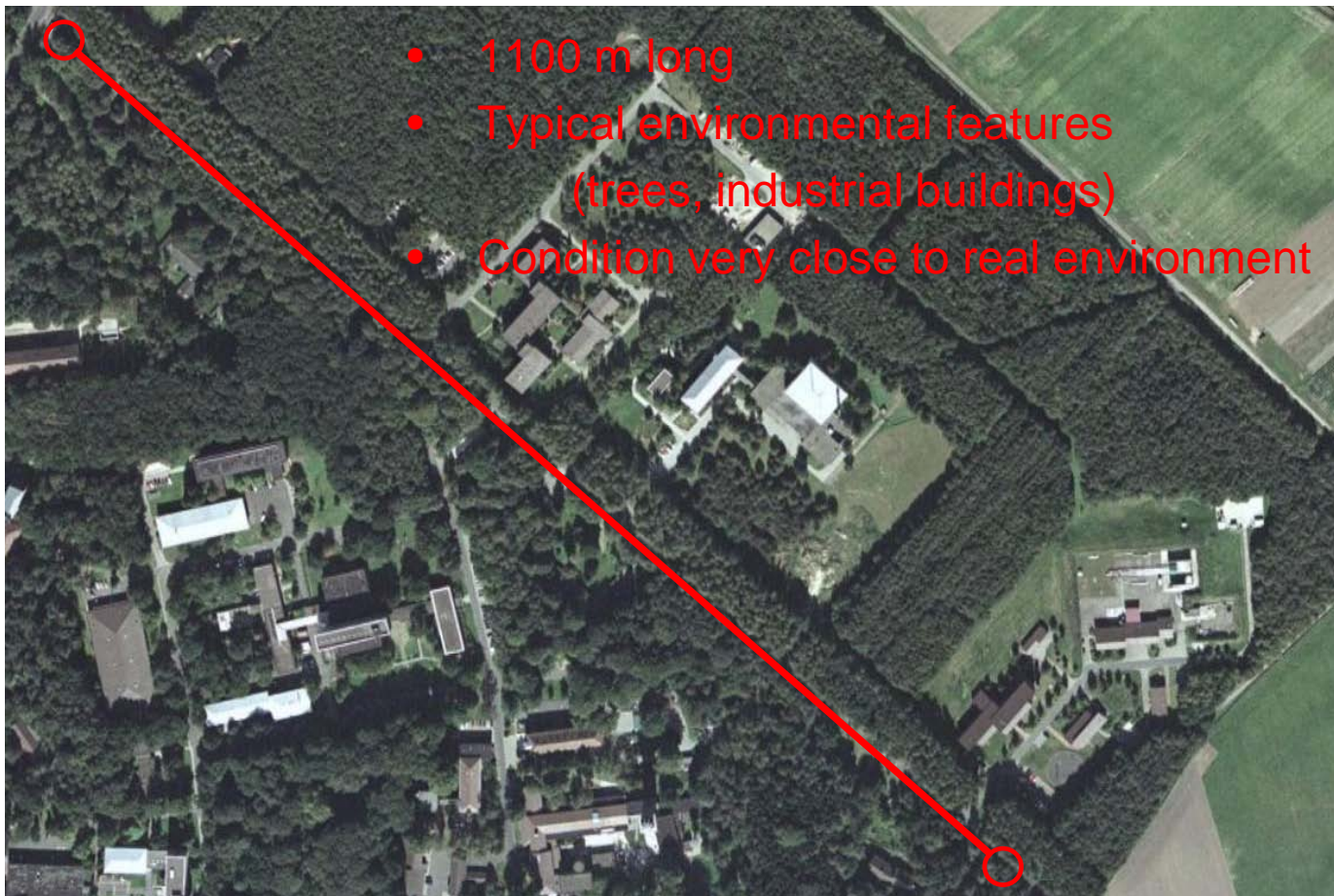
# Qualification of accuracy: static measurement

- Static Measurements with EGNOS enabled/ disabled
- Duration:4 hours
- Location: Žilina (Slovakia)

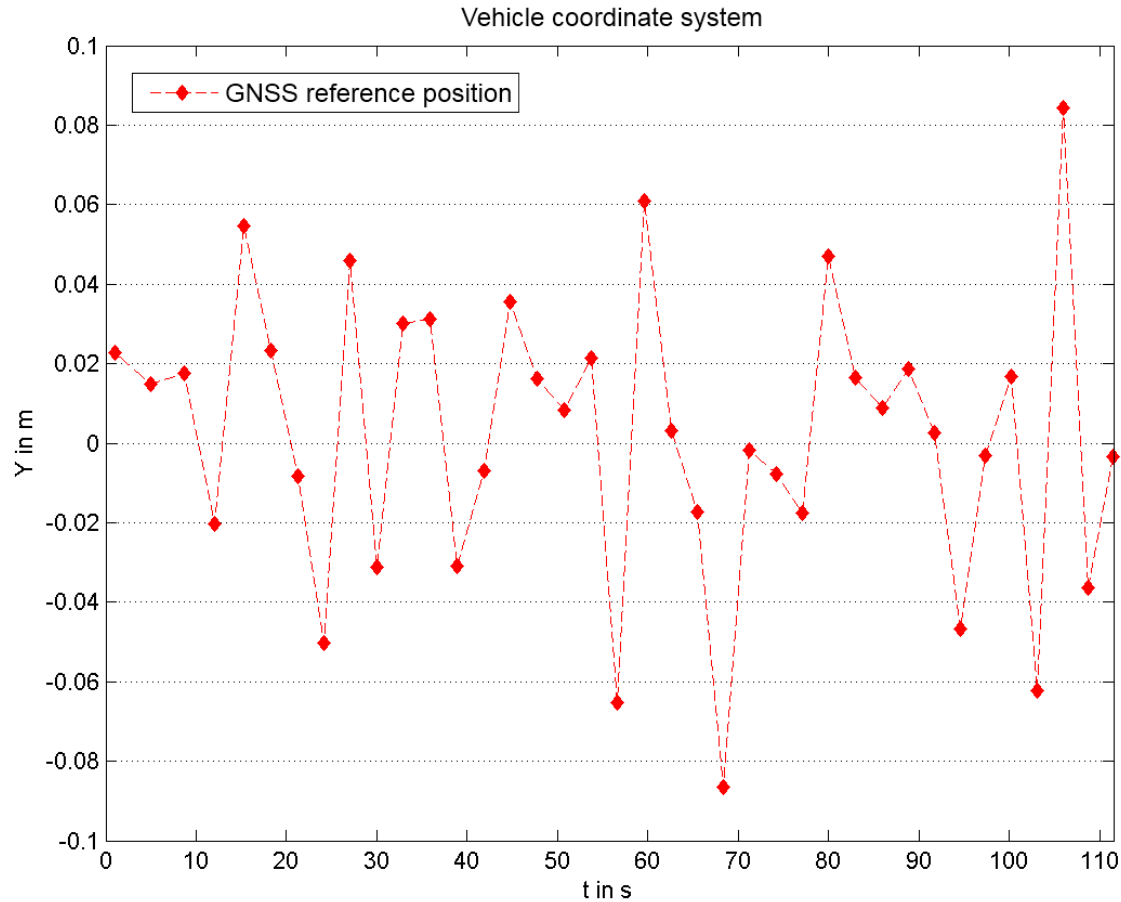
	Latitude	Longitude
Reference Point	49° 12' 22.000''	18° 45' 28.000
EGNOS disabled	49° 12' 22.1796''	18° 45' 28.1484''
EGNOS enabled	49° 12' 22.0896''	18° 45' 28.0944''



# Qualification of accuracy: Road Reference System



# Qualification of accuracy: Road Reference System



# Qualification of accuracy: Further steps

- Satellite independent localization unit
- Accuracy ~ 5cm
- Automatic driven vehicle
  - To guarantee repeatable measurement
  - To enable different test tracks
  - For tests under different environmental conditions
- Project under development

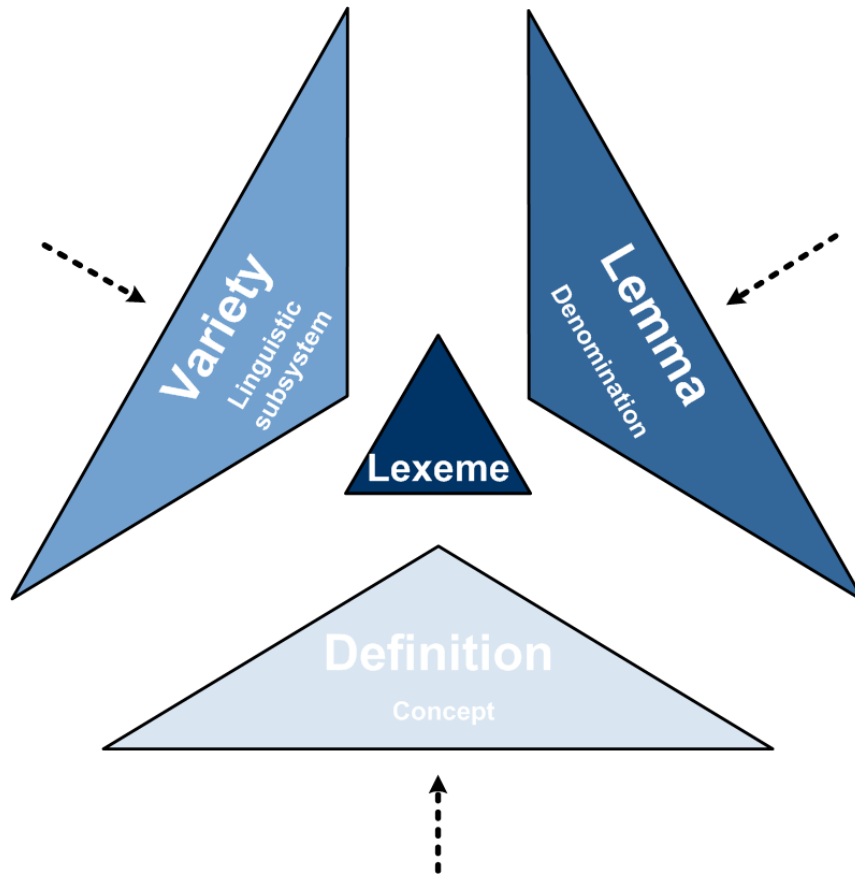


a new terminological approach

- ▶ **Universality** – universally applicable for a multitude of terminologies
- ▶ **Flexibility** – flexible design for new requirements
- ▶ **Connectivity** – high degree of terminology connectivity
- ▶ **Practice** – integration into the daily user processes



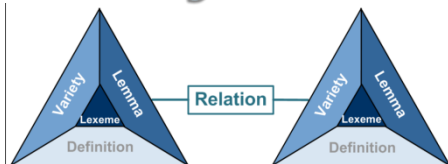
# Terminological approach: *iglos* – the intelligent glossary



- ▶ A lexeme comprises three constituent parts:
1. **Lemma:** The denomination, a sequence of sounds or letters
  2. **Definition:** A natural language description of the mental unit, the concept
  3. **Variety:** The subject field, or rather the special language context in which the lexeme is used

# Terminological approach: *iglos* – the intelligent glossary

## theory:



- ▶ Lexemes are always related to other lexemes within the **system of lexemes**
- ▶ **Comprehensibility** is perceivably improved by provision of **lexeme relations**

## application:

iglos start Lexem Lexemrelation(en) Varietät(en) Relationstypen Log Administration TEP Hilfe  
Suche: Lemma enthält in den Sprachen de, en, fr suche  
Aktive Instanz: devel (ändern) Benutzte Instanzen: devel (ändern) Editierbare Instanzen: basis, devel, famos, gauss

mehr...  
Security initial risk  
Security tolerable risk  
Security residual risk  
Security necessary risk reduction  
Security actual risk reduction  
Security risk  
Security distribution of extent of damage  
Security distribution of frequency of occurrence  
Security Damage  
Security environmental harm  
Security human harm  
Security commercial harm / financial detriment  
Security minor injury  
Security major injury  
Security fatality

risk (Varietät: Security (de) 27.2010-05-19 16:37:52.4)  
Definition 312.2010-05-24 22:18:14.4  
Risk concerns the deviation of one or more results of one or more future events from their expected value. Technically, the value of those results may be positive or negative. However, general usage tends to focus only on potential harm that may arise from a future event, which may accrue either from incurring a cost ("downside risk") or by failing to attain some benefit ("upside risk").  
Eingefügt von Christian Sauer, 2010-05-24 22:18:14

screenshot of *iglos* in a webbrowser

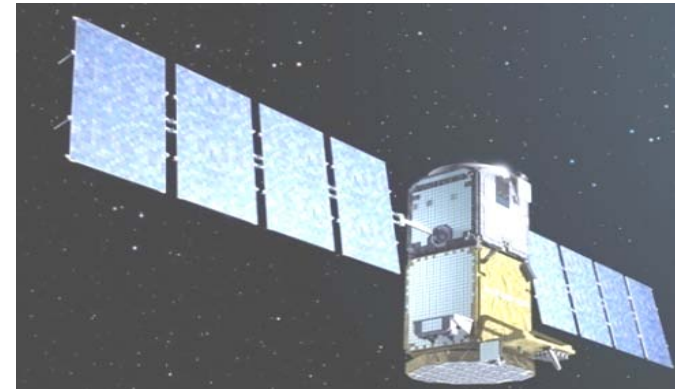
# Terminological approach: *iglos* – the intelligent glossary

- *iglos* implementation into databases under development
- Current terminological issues can be overcome
- *iglos* is soon available
- Funded by DIN and DFG
- Applied in GAUSS and FAMOS
- Terms are verified and approved
- Specific responsibilities ensure quality
- Terms contain additive information



# Terminological approach: iglos

Term	Integrity (of a bulk power system)	Integrity
Reference	IEC 191-21-04	[GAL02B]
Domain	Railways	Aerospace
Definition	Ability of a bulk power system to preserve interconnected operations.	Integrity is the ability of a system to provide a warning to the user that an error whatever the source might lead to the failure of the system to meet certain margins of accuracy (alarm limits) within a given time to alarm.

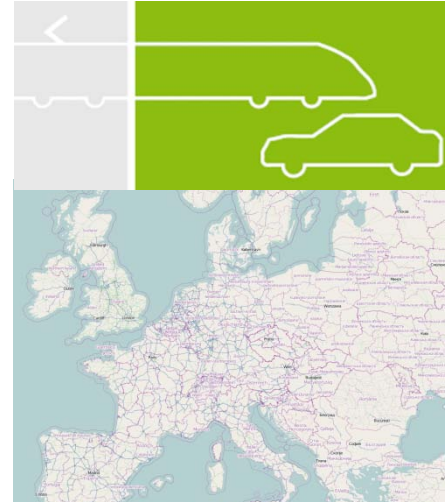


# Conclusion

- Generic certification
  - Suitable base for applications in all transport domains
  - Requires generic terminology
  - Requires comparable processes
  - Will give a broad base for innovative applications
- GNSS Qualification
  - Accuracy, Integrity, Continuity has to be determined
  - Satellite independent localization system required
  - Static determination of accuracy is state of the art
  - Dynamic determination of accuracy: first steps are done
    - To be continued in further projects

## 8th Symposium on Formal Methods for Automation and Safety in Railway and Automotive Systems

When? 2<sup>nd</sup> and 3<sup>rd</sup> December 2010  
Where? Braunschweig, Germany  
Further Information? [www.forms-2010.de](http://www.forms-2010.de)





Contact:

Institute for Traffic Safety and Automation Engineering

[h.manz@tu-bs.de](mailto:h.manz@tu-bs.de)



Technische  
Universität  
Braunschweig

21.10.2010 | Dipl.-Ing. Hansjörg Manz | Investigation of satellite based localization systems by means of terminology | ENC GNSS | Slide 23

Institut für Verkehrssicherheit  
und Automatisierungstechnik **iva**

Prof. Dr.-Ing. Dr. h.c. mult. E. Schnieder