Improvement of position determination for railway applications in the alpine region

Dr. Stefan Baumann, Dr. Paulo Mendes (Industrieanlagen-Betriebsgesellschaft)

Sebastian Ohrendorf-Weiss, Dr. Andreas Wenz (Swiss Federal Railways)

Dr. Michael Roth (German Aerospace Centre Institute of Transportation Systems)

Outline

- Climate impact of transport types
- Traffic in the Alps
- Importance of railway traffic in the Alps
- Safety requirements for future railway applications
- GNSS as important part of the system/sensor-mix for railway localisation
- EGNSS MATE

Climate Impact of Transport Types

Abbildung 1: Klimawirkung des Personenverkehrs in Deutschland 2017

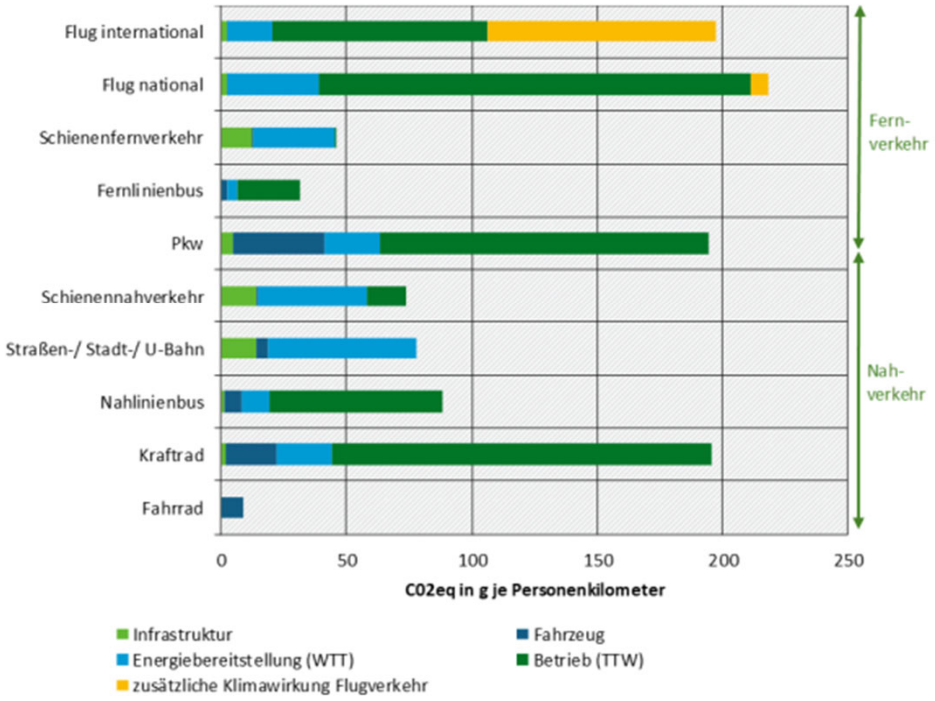
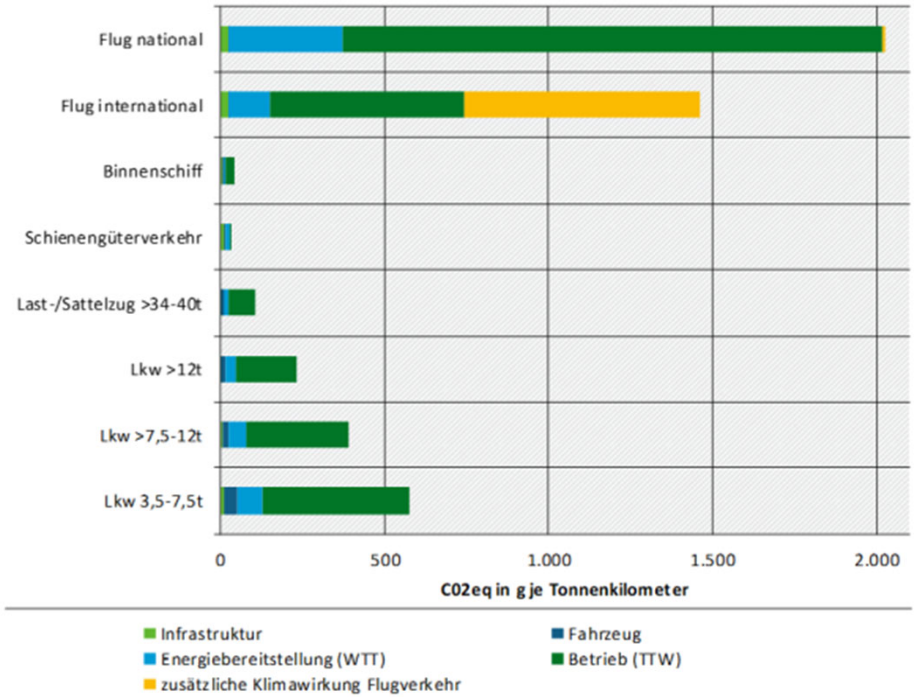


Abbildung 16: Klimawirkung im Güterverkehr in Deutschland 2017



Abschlussbericht Ökologische Bewertung von Verkehrsarten - Umweltbundesamt, 2022

Traffic in the Alps

Beförderte Mengen im alpenquerenden Güterverkehr (durch die Schweiz), 2021

Total Schiene und Strasse	**37,9 Mio. Tonnen[1]**
Anteil Schiene	75%
Anteil Strasse	25%
Veränderung Schiene seit 2000	+38%
Veränderung Strasse seit 2000	+7%
Anteil kombinierter Verkehr an Schienentransporten	76%

1) Ohne das Gewicht der Fahrzeuge und Transportbehälter (z.B. Container) im kombinierten Verkehr

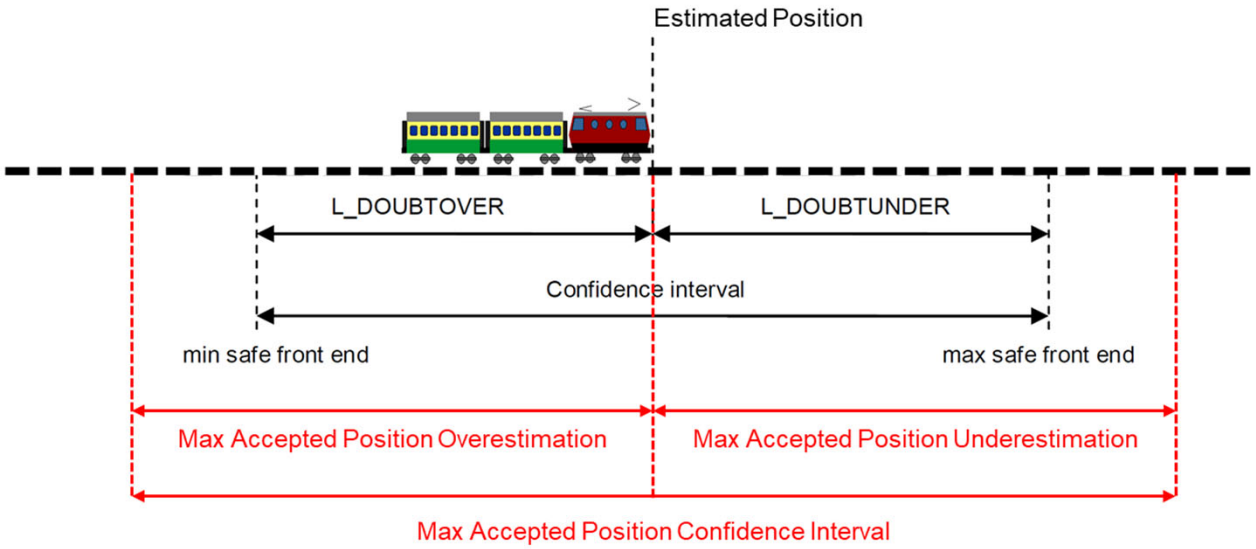
Quelle: BAV, ASTRA – Alpenquerender Güterverkehr

https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/gueterverkehr/alpenquerend.html

Importance of Railway Traffic for the Alps

- Railway is one of the most environmentally-friendly means of transport
- Already today railway traffic is very important in the alpine region
- The usage is still growing and, therefore, can support the reduction of the human footprint
- Especially in the Alps the rail network cannot be extend as desired
- New, efficient solutions have to be devised and applied to increase the capacity of the rail network (ERTMS, ETCS)
- GNSS plays an important role, but has to cope with special environmental conditions and physical constraints:
  - Signal blockage by mountains
  - Multipath due to close rock walls
  - Many and long tunnels
  - Extreme weather conditions
  - Sensor slips due to icing
  - etc.
- GNSS has to fulfil high safety & security requirements

Safe Train Localisation: High potential for traffic capacity improvement, but stringent safety requirements



7.1.3 - 3D train position performance

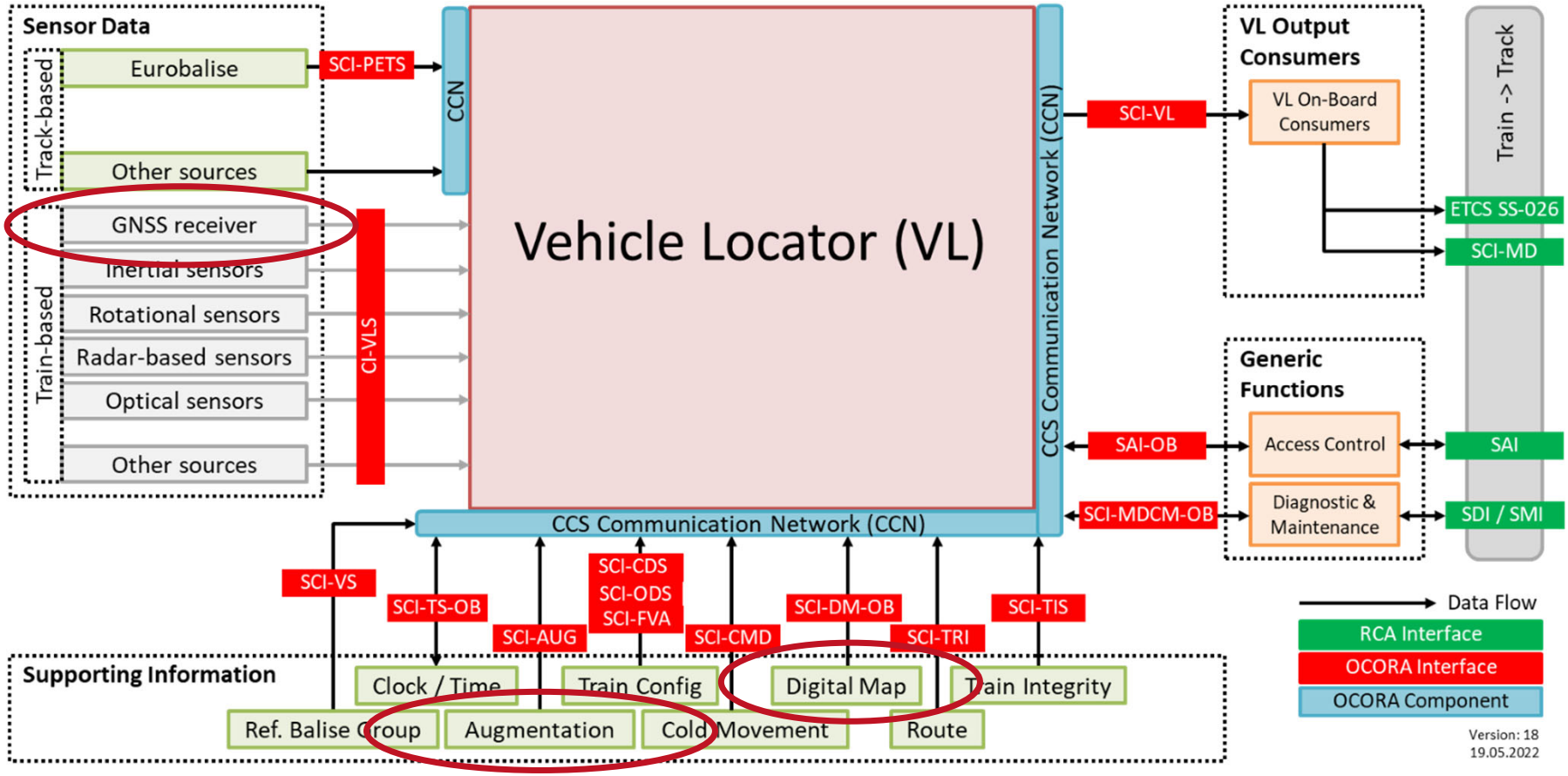
The LOC-OB shall provide a 3D train front end position with an uncertainty of 1m on the x-axis and 0.5 m on the y and z-axis of the carriage reference frame with at least a probability of 95.4%.

7.1.4 3D train velocity performance

The LOC-OB shall provide a 3D train velocity with an uncertainty of 2 km/h on each axis of the carriage reference frame with at least a probability of 95.4%

Source: EUG Localisation Working Group and OCORA

GNSS one (important!) puzzle in the Railway Localisation System



European Global Navigation Satellite System based Map Assisted Train localisation for ERTMS (EGNSS MATE)

- ESA NAVISP Project (2023 – 2024)
- Focus on
  - GNSS Improvements
    - Galileo HAS
    - Galileo OS-NMA/CAS
    - Robustness against jamming/spoofing
  - Augmentations of complementary sensors/methods
    - Improved odometers (against slip and slide effects)
    - Improved digital maps (different sources, quality checked -> “safe map”)
    - Enhanced map assisted fusion algorithms
  - Test campaign
    - Long term data collection
    - Specific measurements campaign
  - Preparation of standardisation and related testing leading to a certification scheme
  - First results next year.

Questions?