

EGNOS Mission Studies for Rail

European GNSS Navigation Safety Services for Rail Project (EGNSS-R)



EGNOS WORKSHOP 2021
SESSION : EGNOS multimodal adoption II

DEFENCE AND SPACE

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AIRBUS



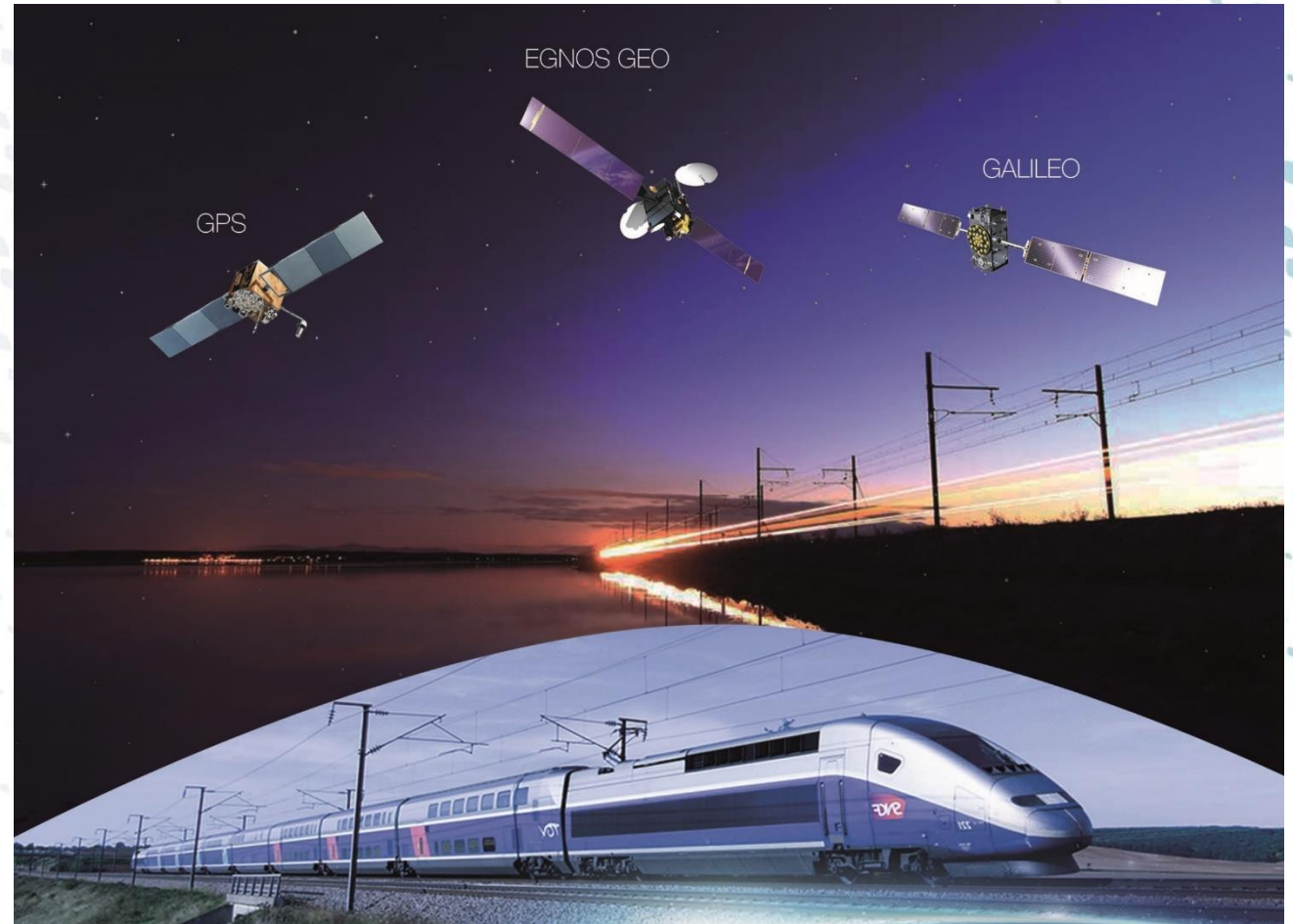
Agenda

Context

EGNSS-R project

Integrity Concept

EGNOS Service for Rail





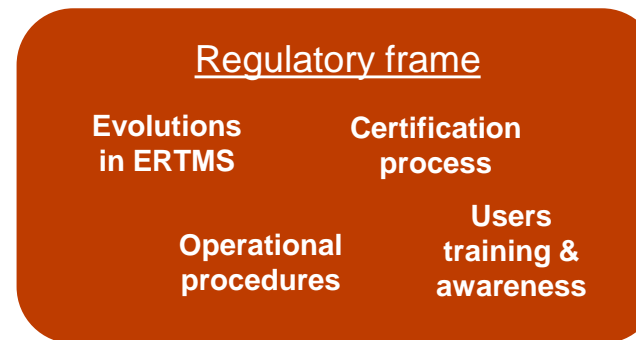
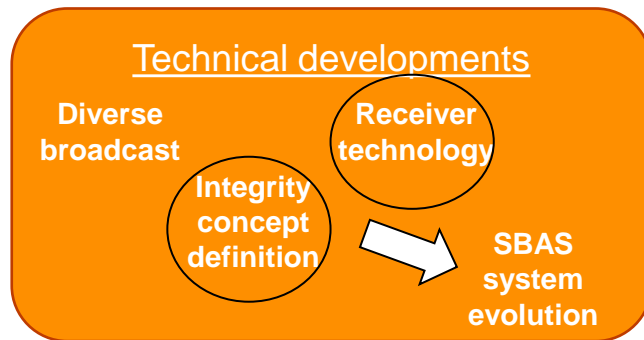
➤ GNSS already adopted by rail sector for non-safety applications



- Rail operators now planning to expand the use of GNSS for Safety of Life applications
- Continuous and safe localization function to provide reliable train position, velocity, acceleration
 - Decrease the cost of on-board and trackside equipment, including maintenance and operations
 - Foster new concepts / increase traffic capacity such as Moving block, ERTMS L3

This requires both

and



GNSS usage for safety rail applications

New localisation systems based on sensors hybridization and using GNSS under study

Main challenge to use EGNSS for rail usage : integrity

EC roadmap for EGNSS programme evolution, including new services of Galileo and EGNOS



EGNSS-R

EGNSS Rail Safety service preliminary definition

Service not specific to a given train localisation solution

Integrity concept for rail

Elements for decision



Funded by the European Commission



Technical supervision by the Union Agency for the Space Programme (EUSPA)

<https://www.euspa.europa.eu/european-gnss-navigation-safety-service-rail>



18 months
September 2020 to March 2022



EGNSS-R project outcomes are discussed and validated with key representatives from railway operators, railway and GNSS industry.



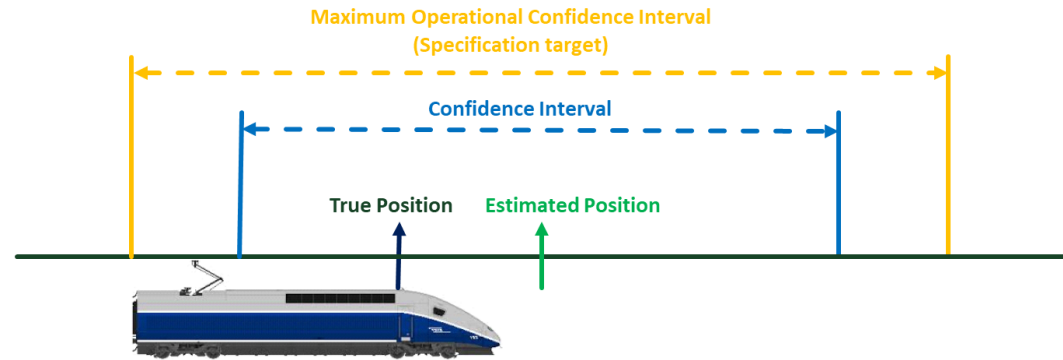


Requirement	Half Maximum Operational Confidence Interval (MOCI)	Tolerable Hazard Rate (THR)
Position	10 m up to 40 km/h linearly up to 140 m @ 500 km/h (pending operational constraints)	0.33 10 ⁻⁹ / h
Speed	2 km/h up to 30 km/h linearly up to 12 km/h @ 500 km/h	0.33 10 ⁻⁹ / h

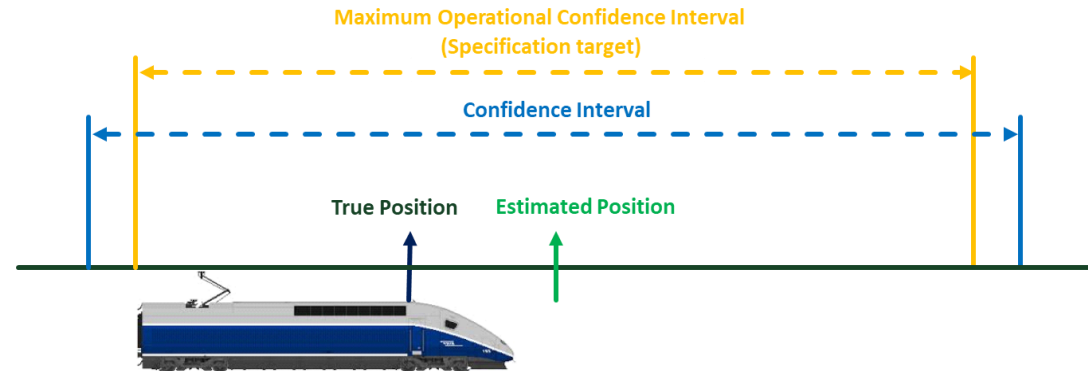
Integrity risk is a Safety issue
Probability of (speed or position outside of CI) < THR

Confidence Interval size is an operational concern
Impacts timely arrivals, traffic density...

Train Localisation Function considered as safe and available



Train Localisation function considered safe but degraded



MOCI = operational limit in case of increase of CI

Integrity Concept Requirements

Confidence Intervals for position and speed

Integrity Risk

Maximum Operational Confidence Interval



Confidence Interval Determination

Recommended PVT solution based on Kalman Filter using augmented GNSS pseudo-range

CI computation generic approach

CI algorithm dependant on localisation solution

Rail case approach

PVT based on Extended Kalman Filter (EKF) using GNSS pseudo-range data corrected by SBAS

Issue

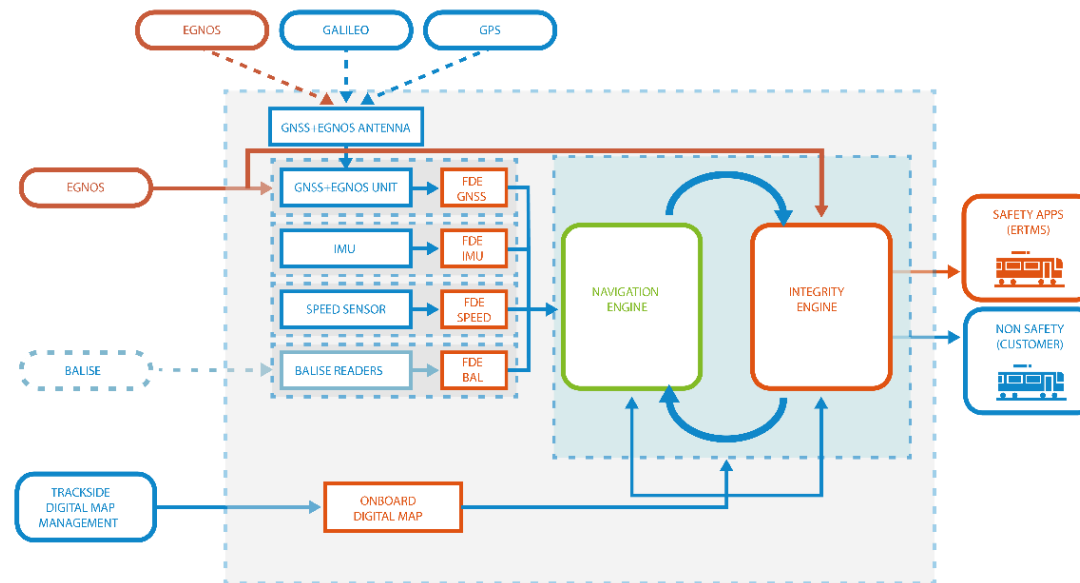
Pseudo-range errors are not in line with EKF hypothesis inducing Underestimated Confidence Interval ⇒ Unsafe Localisation

AIRBUS new approach

Computation of a Confidence Interval for PVT based on Kalman filtering with GNSS measurement bounding at pseudo-range level (TRL 3)

EGNSS-R recommends :

- Multisensory architecture relying on EGNOS augmented GNSS, complemented by IMU, wheel encoders and digital track map
- Usage of integrity static parameters (conservative, larger CI) in the short term
- Usage of enhanced integrity dynamic values provided by SBAS in the mid-term



Example of solution (CLUG project)

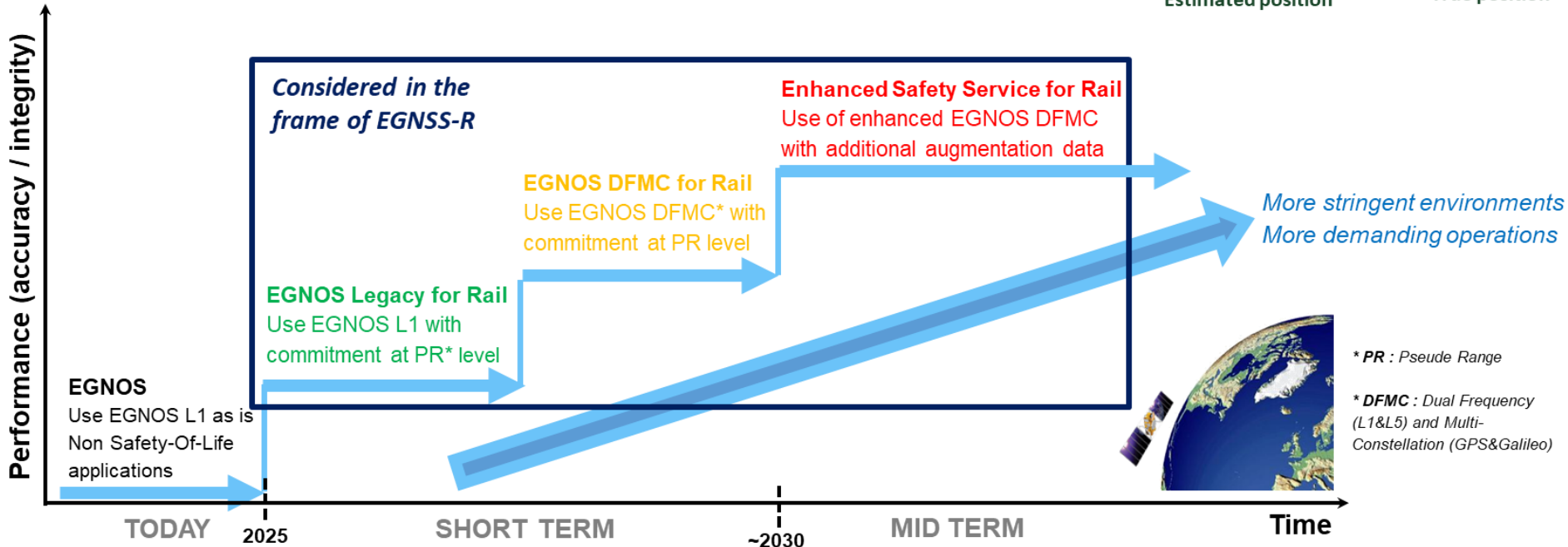
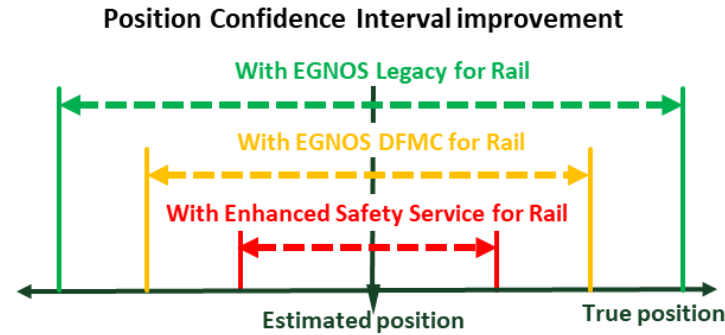


EGNOS usage for safe train localization

EGNOS with integrity commitment at pseudo-range level open for use by train localization solutions will enable safety of life operations for rail community

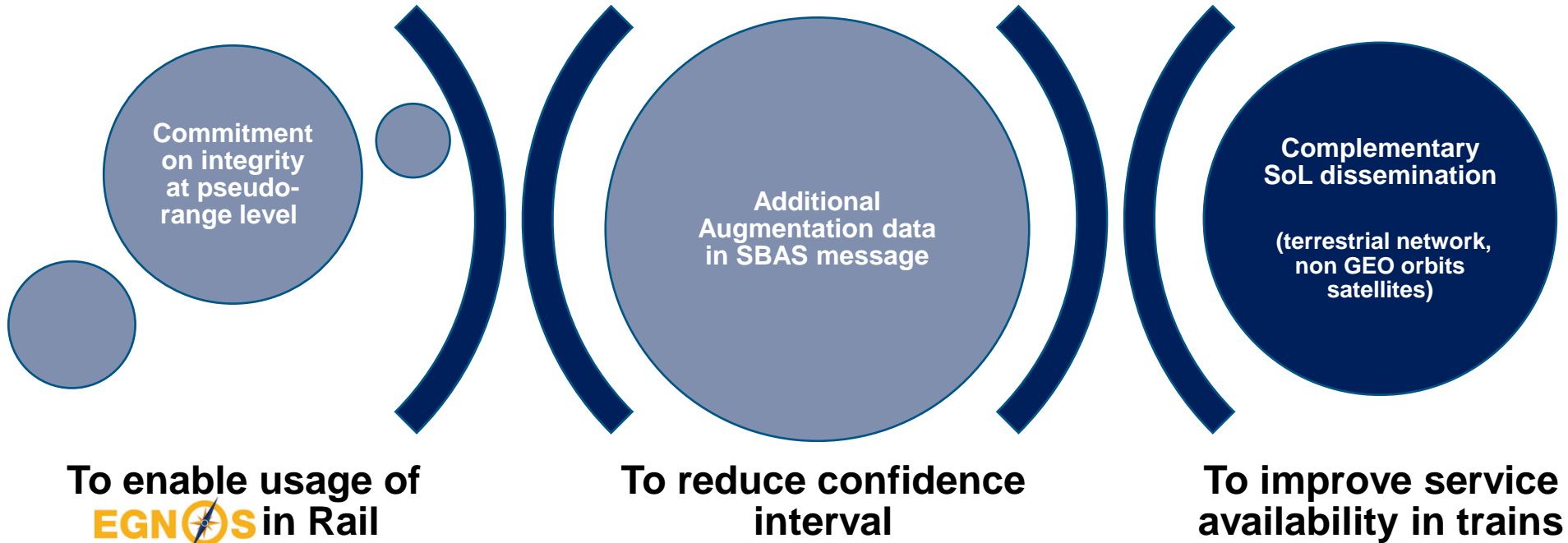
Performances of a solution depend on EGNOS system capability

Evolution of EGNOS DFMC to provide additional augmentation parameters to reach highest integrity performance target



Improvement of performance in terms of CI along the roadmap

Same Integrity Concept principles and associated architecture along the roadmap



EGNOS system possible evolutions

To enable usage in Rail

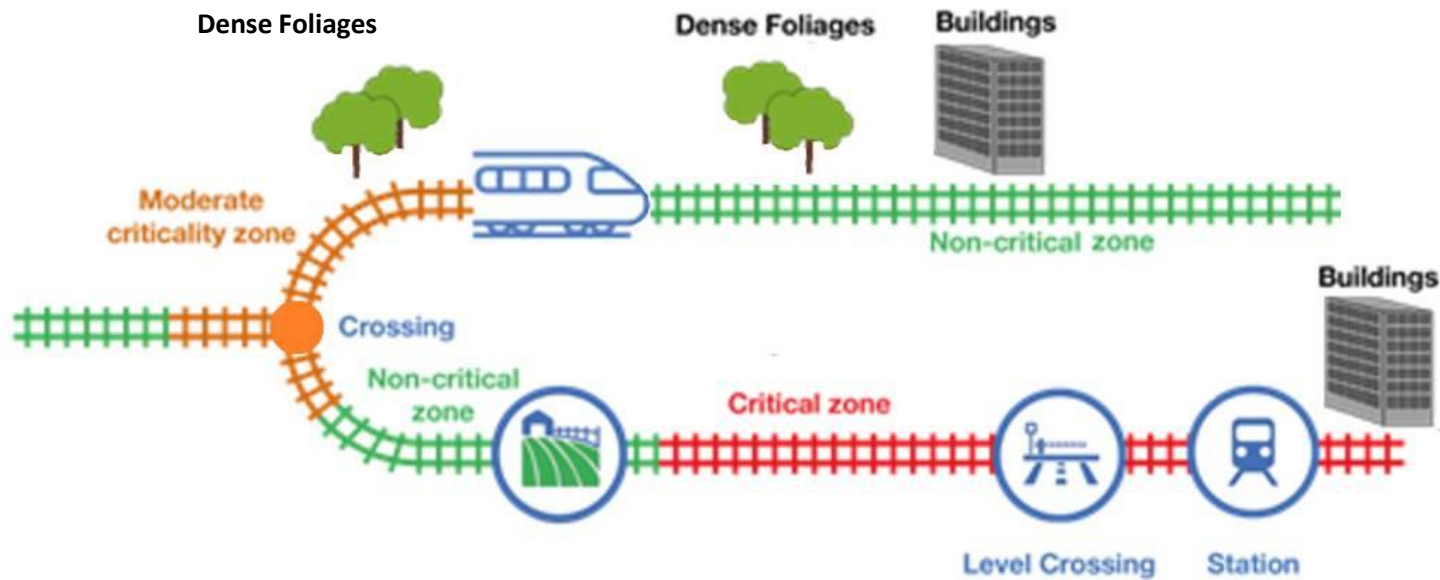
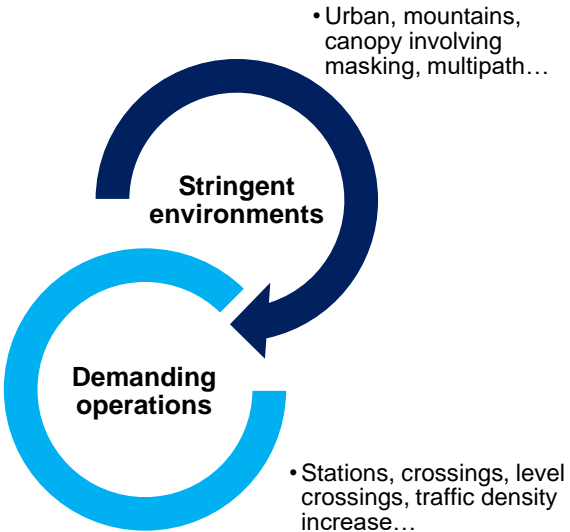
To reduce confidence interval

To improve service availability in trains



Performances at user level depend on EGNOS system capability and on local environment degrading GNSS signals

Maximum Operational Confidence Interval requirements likely to depend on operations criticality or area (operational criteria to be defined by rail operators and authorities)



EGNSS an enabler for Rail / Service

SBAS Roadmap to improve performance for reaching requirements of more demanding operations and in more stringent environments

Any questions ?

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 <https://www.linkedin.com/company/european-gnss-navigation-safety-service-for-rail-egnss-r>

Thank you

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