

European
Global Navigation
Satellite Systems
Agency

Autonomous Navigation challenges in the design of certification procedures in Autonomous Driving

Alberto Fernández Wyttenbach

Market Development - European GNSS Agency

HEADSTART Workshop, 13rd September 2019



NAVIGATION SOLUTIONS
POWERED BY EUROPE

Galileo is used today in the majority of professional devices and consumer platforms



+1,000 Mill. Galileo devices as of today



e112 Regulation (EU) mandates Galileo in emergency communications from mobile devices from 2022

USEGALILEO.EU
FIND A GALILEO-ENABLED DEVICE TO USE TODAY



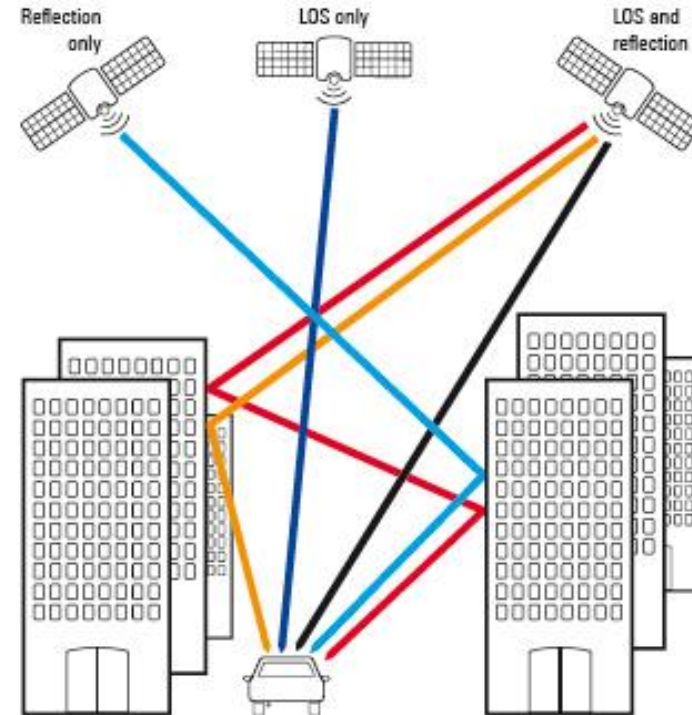
eCall regulation (EU) mandates Galileo in every new type of car/van sold in Europe from April 2018

➤ **3 Million vehicles**
(end-2019)

Galileo Open Service improves positioning performance **WORLDWIDE** for **FREE**

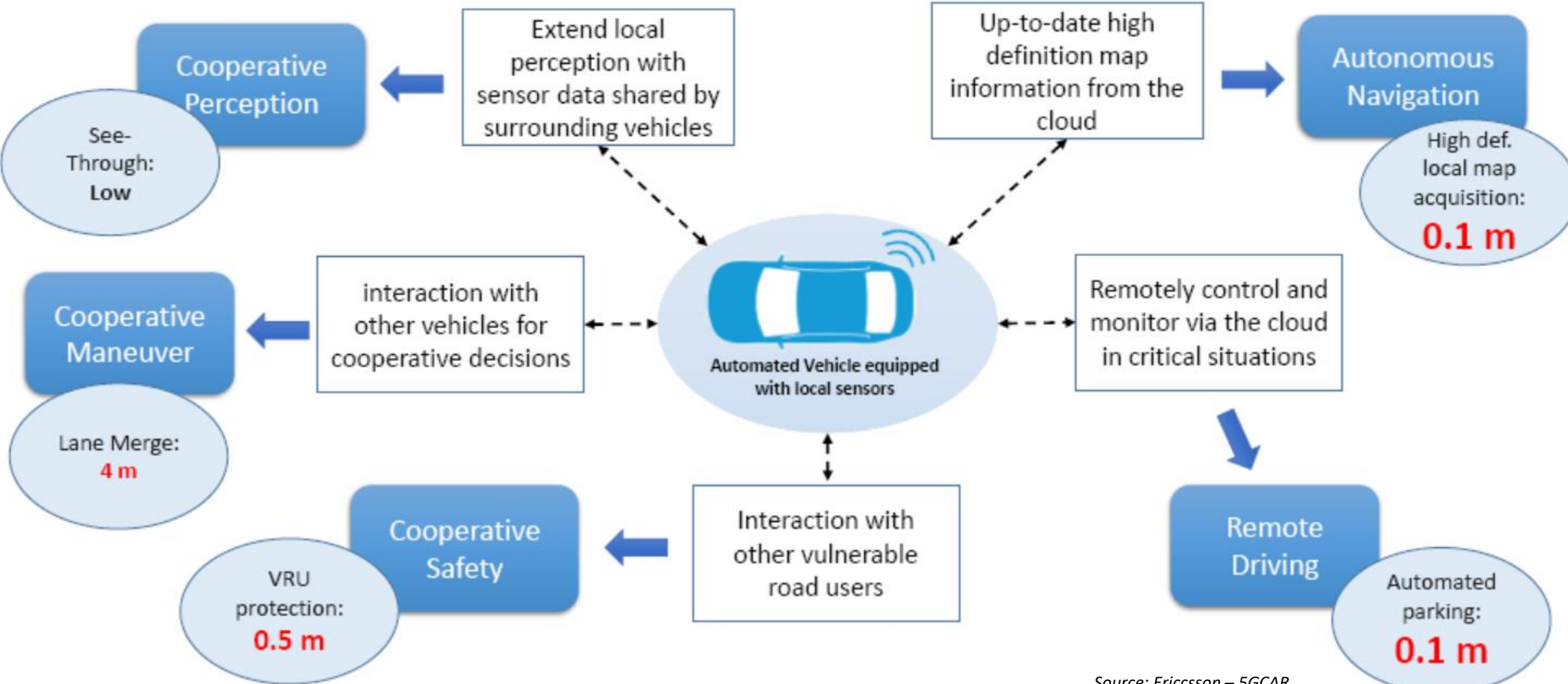


Multiple GNSS: more satellites visible in harsh environment (urban canyons, tree canopy,...)



Multiple frequencies remove ionospheric errors and mitigate multipath reflections

Operational functions in CCAM include (*Autonomous*) Navigation



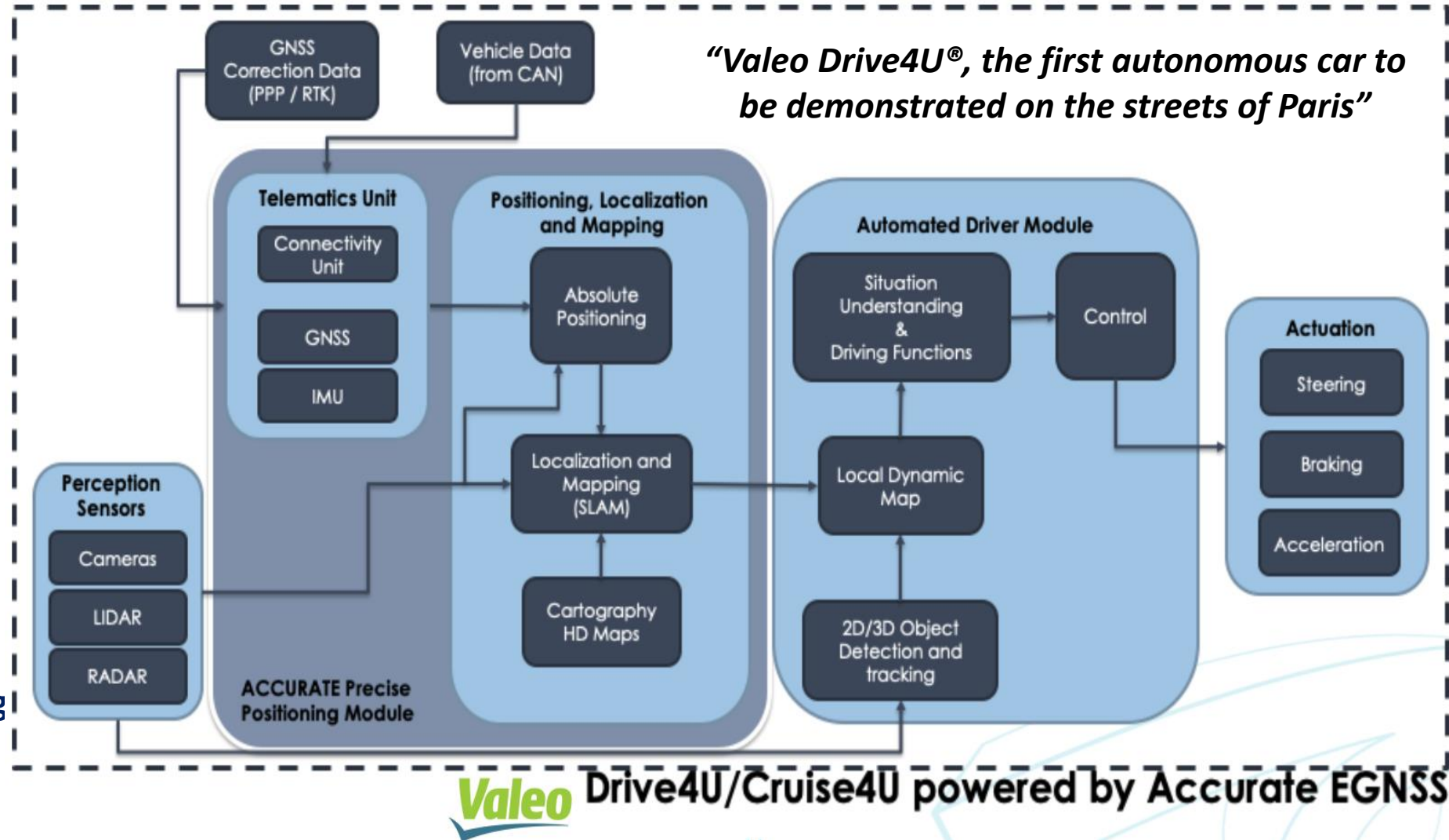
Industrial similarities in the design of Autonomous Navigation



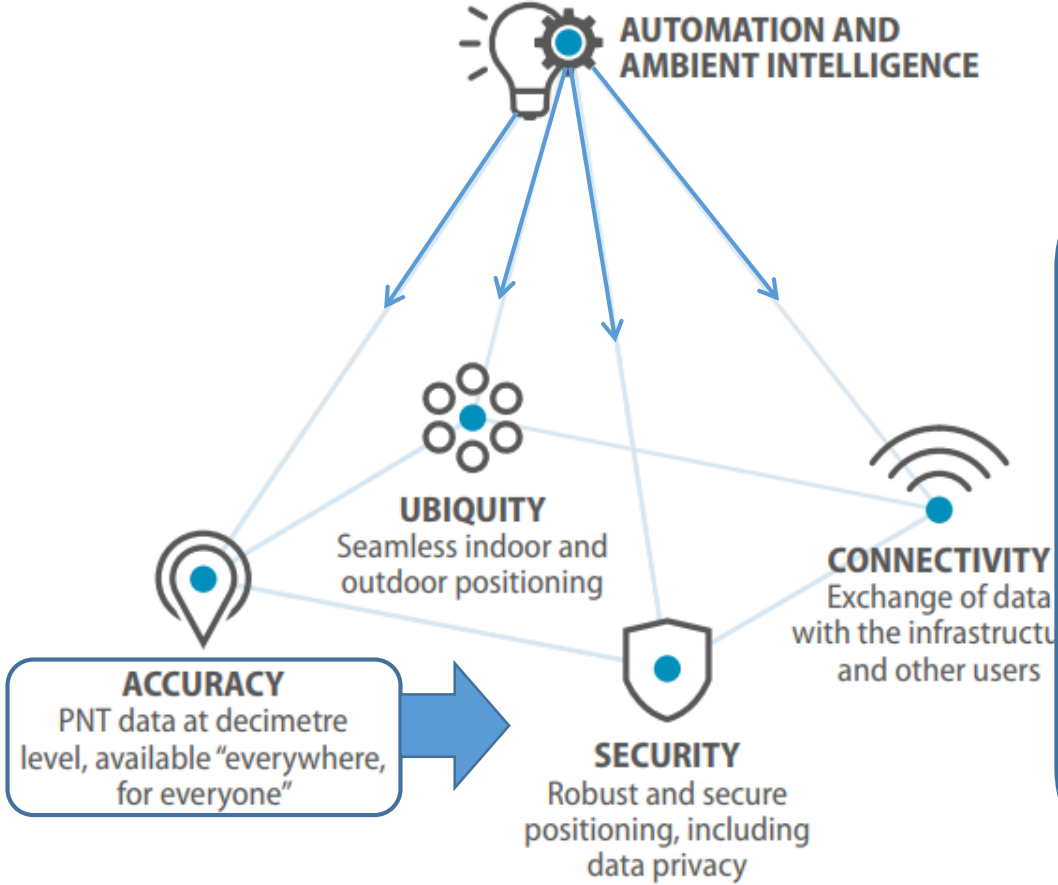
- INS
- Odometry/SLAM
- HAD maps
- Map matching
- Dead reckoning
- ...

+ (level 5)

- **Artificial Intelligence:**
 - Machine Learning
 - Deep Learning
 - Big data analytics
- **Augmented Reality**
- **Natural Language Processing**



Main challenges in relation to Navigation Technology



Contribution of Galileo High Accuracy

“GNSS is essential for the automated cars industry. Being able to determine the position of vehicles will enable predicted driving and increase security”

“The positioning accuracy of 20 cm from Galileo will be essential in urban areas”

Joost Vantomme, Director in the European Car Manufacturers Association (ACEA)



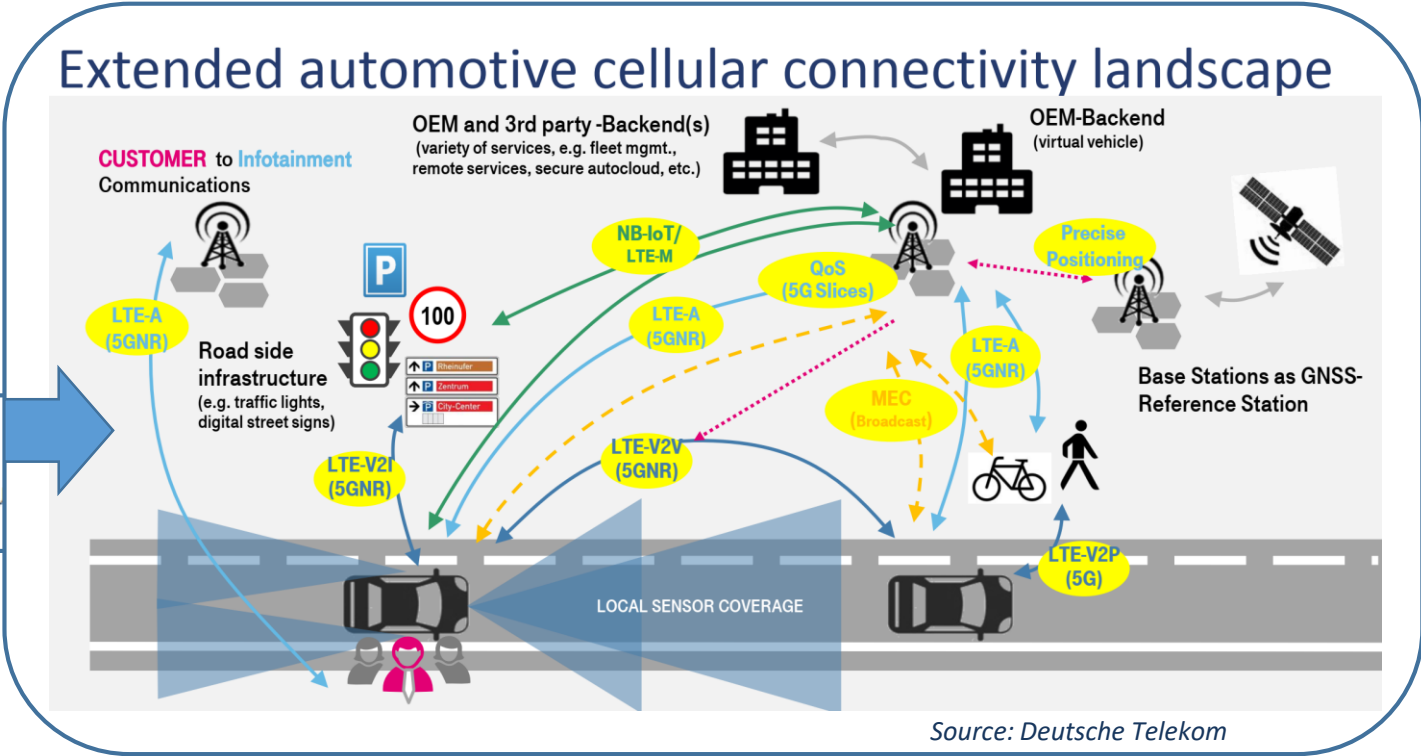
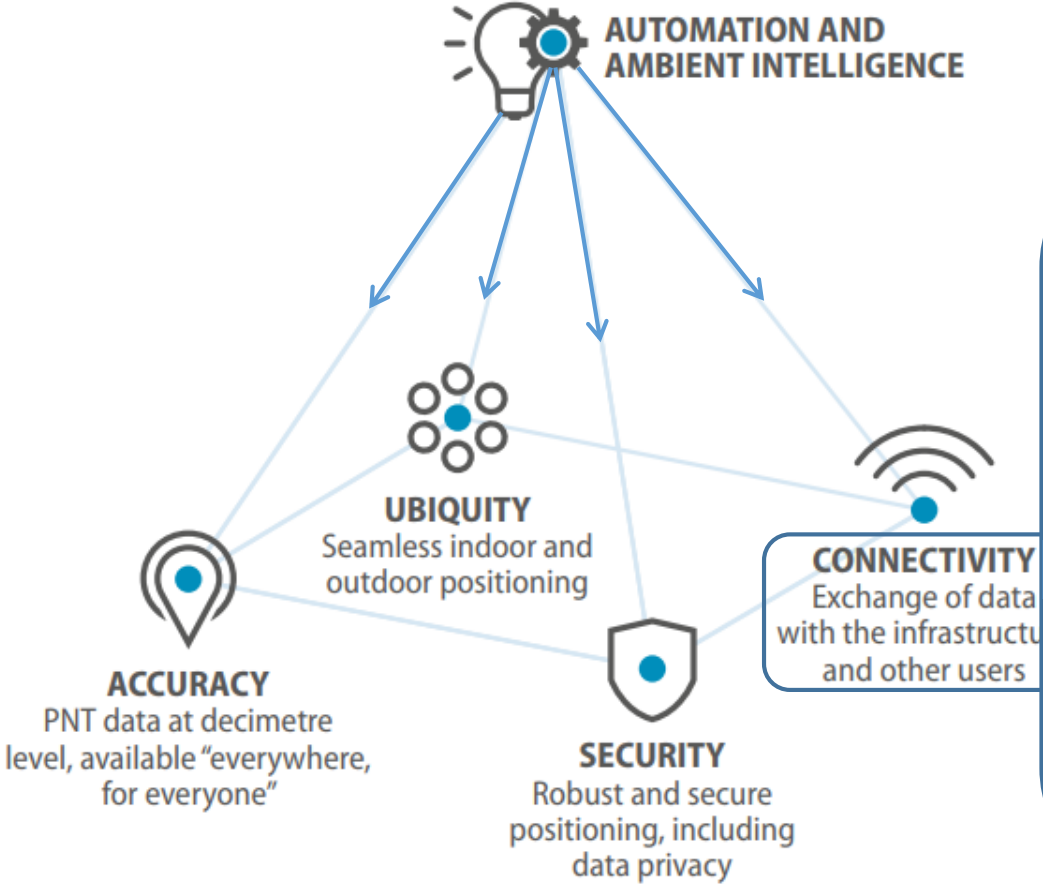
* Source: EuroActiv, December 2018

Source: Deutsche Telekom

Main challenges in relation to Navigation Technology



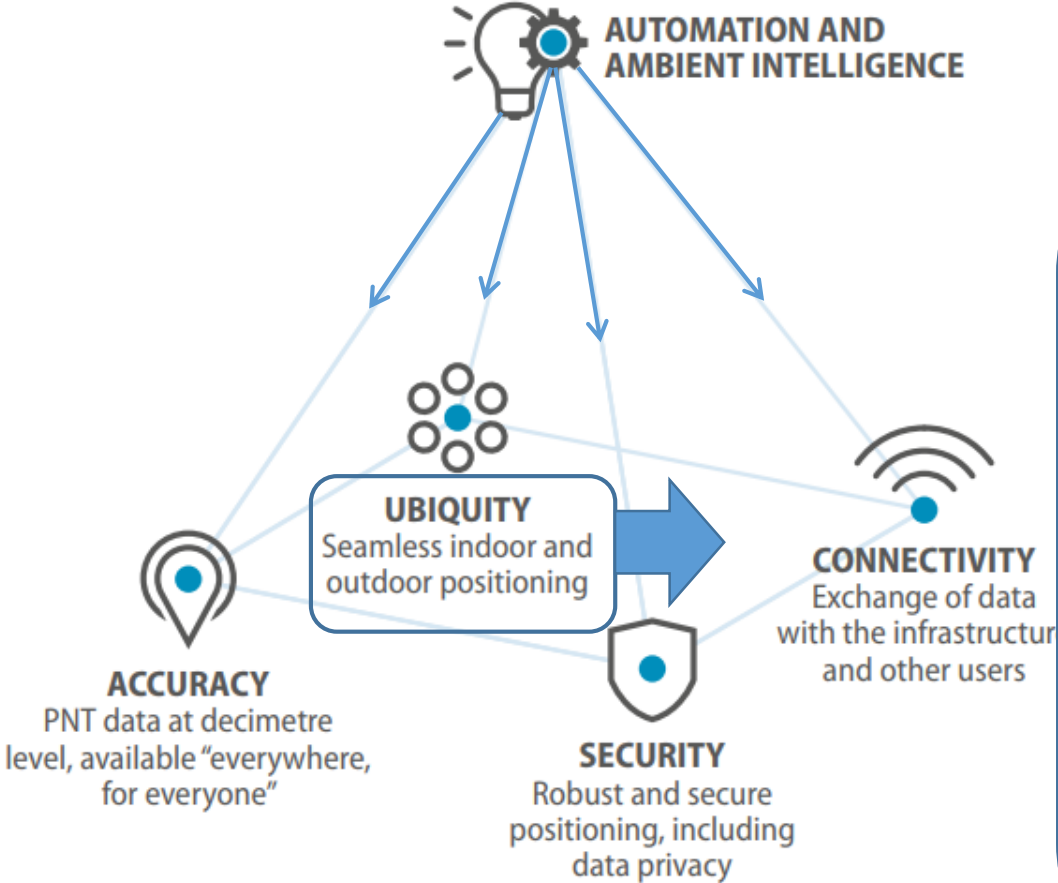
GNSS Integrity/High Accuracy corrections via 5G



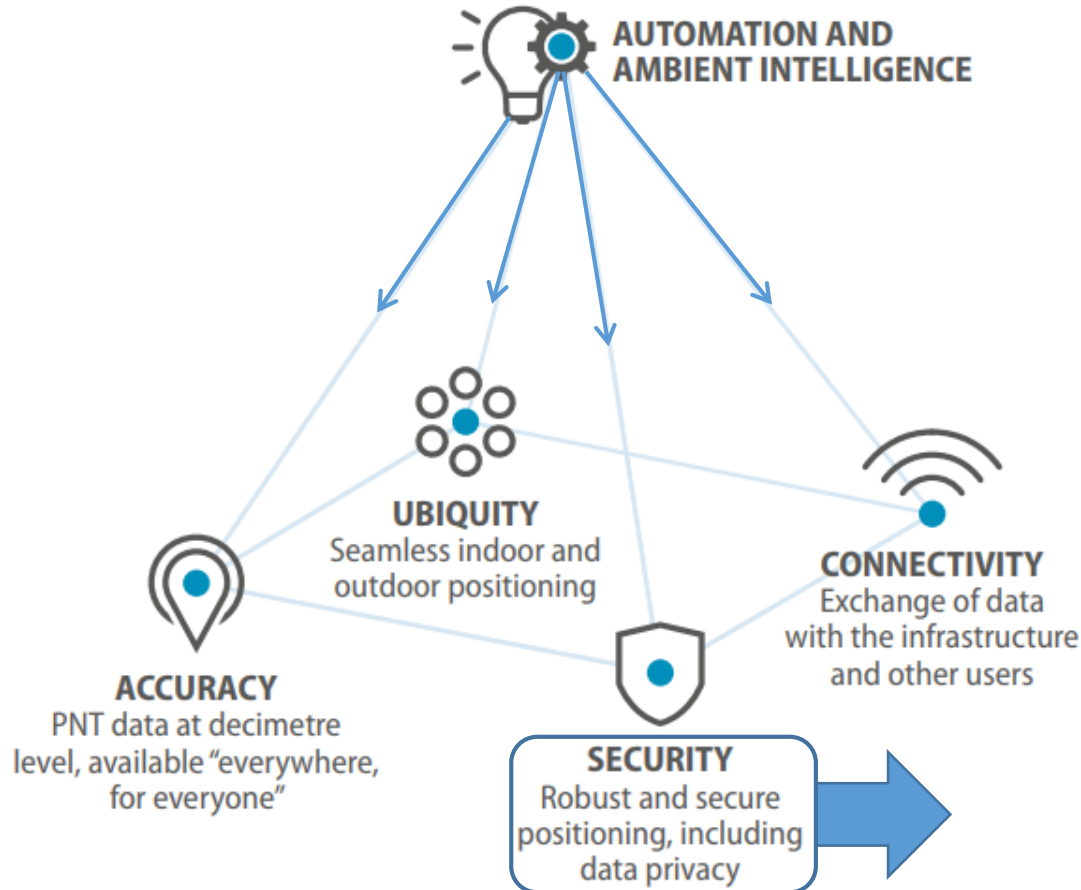
Main challenges in relation to Navigation Technology



GNSS Integrity/High Accuracy corrections via 5G



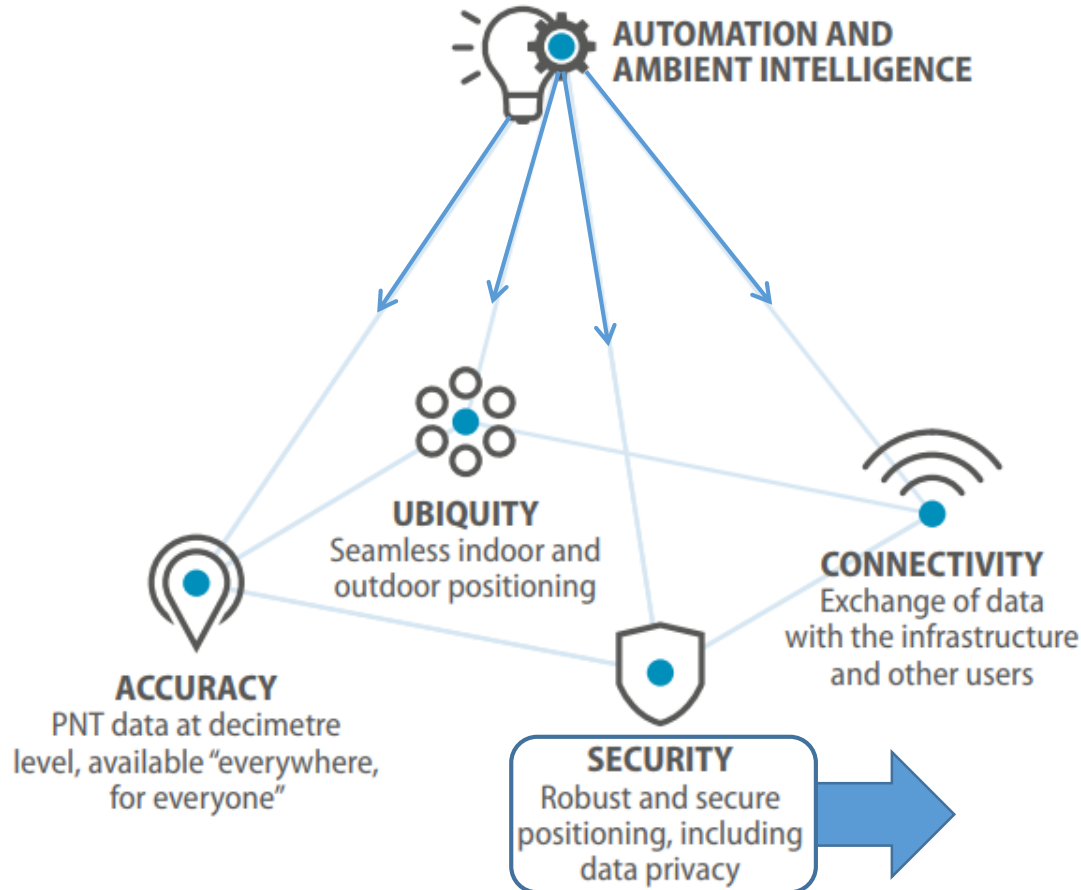
Main challenges in relation to Navigation Technology



NON-INTENTIONAL INTERFERENCES (SPECTRUM)

- CEPT-ECC confirmed **high-power IMT base stations** in the 1492-1517 MHz band might impact the GNSS L-band (1559-1610 MHz) and will be interference in the commercial mobile-satellite service (MSS) bands which lies between 1525-1559 MHz (between IMT and GNSS L-band).
This is relevant for 5G Space services for Connected Cars.
- FCC is investigating the waiver for the **new UltraWideband (UWB)** technology for autonomous vehicles. UWB ground-penetrating radar system will peer beneath the surface of a road to map the features under the pavement.

Main challenges in relation to Navigation Technology



INTENTIONAL INTERFERENCES (CYBER ATTACKS)

EU Cybersecurity Act entered into force in 27 June 2019
NIS Directive: Transport OES (road authorities, ITS operators)
ENISA study on Cyber Security and Resilience of Smart Cars

GNSS Authentication provides a secure and reliable location, by detecting interference (spoofing) attacks

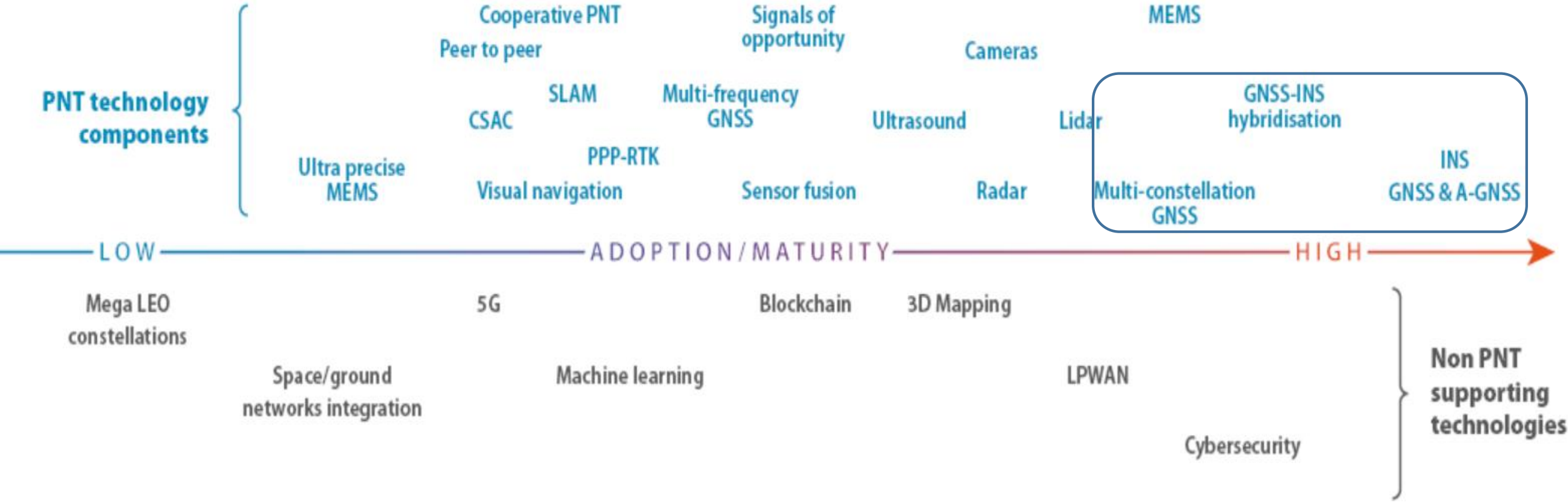


- The UNECE World Forum for automotive regulations declared the need of clear **cybersecurity rules**:
 - ✓ GNSS authenticated message is recommended

Main challenges in relation to Navigation Technology



Different state of maturity for PNT and non-PNT technologies (**complementarity is always needed!**)



Status of European standards today



- Development of **base standards** in relation on C-ITS
Secure Communications and VRU:

2020/21

CEN/ISO TS 21176: Cooperative ITS – Position, Velocity and Time service in the ITS station

2019/20

ETSI TS 103 300: Intelligent Transport Systems – Vulnerable Road Users

- GNSS authentication will be widely used in urban mobility services, which require trustability:

2019/20

ETSI TS 103 246: Satellite Earth Stations and Systems; GNSS based location systems: Functional requirements, Reference architecture, Performance requirements

EN 16803: Use of GNSS-based positioning for road Intelligent Transport Systems (ITS)

2016

- Part 1: Definitions and system engineering procedures for the establishment and assessment of performances:** overall framework and operational procedures for the establishment of GNSS-based performances for ITS

2019/20

- Part 2: Assessment field tests for basic performances of GNSS-based positioning terminals:** testing procedures to assess the basic performances (Availability, Accuracy and Integrity)

2020/21

- Part 3: Assessment field tests for security performances of GNSS-based positioning terminals:** testing procedures to assess the performances submitted to RF attacks such as spoofing or jamming

2021/22

- Part 4: Methodology for the recording of relevant data sets (Record & Replay):** define the way the data files are built and validated

Conclusion (I): Technology is overcoming the main challenges, supported by standardized designs and industry/infrastructure innovation



- GNSS is crucial to get **decimetre/centimetre-level** absolute location and **timing synchronization** in combination with inertial navigation, odometry, HD maps, Machine-Learning and Artificial Intelligence.



High Accuracy service will bring a decimeter level error ($\approx 20\text{cm}$):

- *based on the Galileo E6b signal*



- The UN World Forum for automotive regulations declared the need of clear **cybersecurity rules**, and GNSS authenticated messages are recommended.



Authentication service will detect interference (spoofing) attacks:

- *Galileo E1 Navigation Message Authentication*
- *Galileo E6 Spreading Code Authentication*



BMW and General Motors/Cadillac autonomous vehicles models expected in 2021 will be Galileo compatible

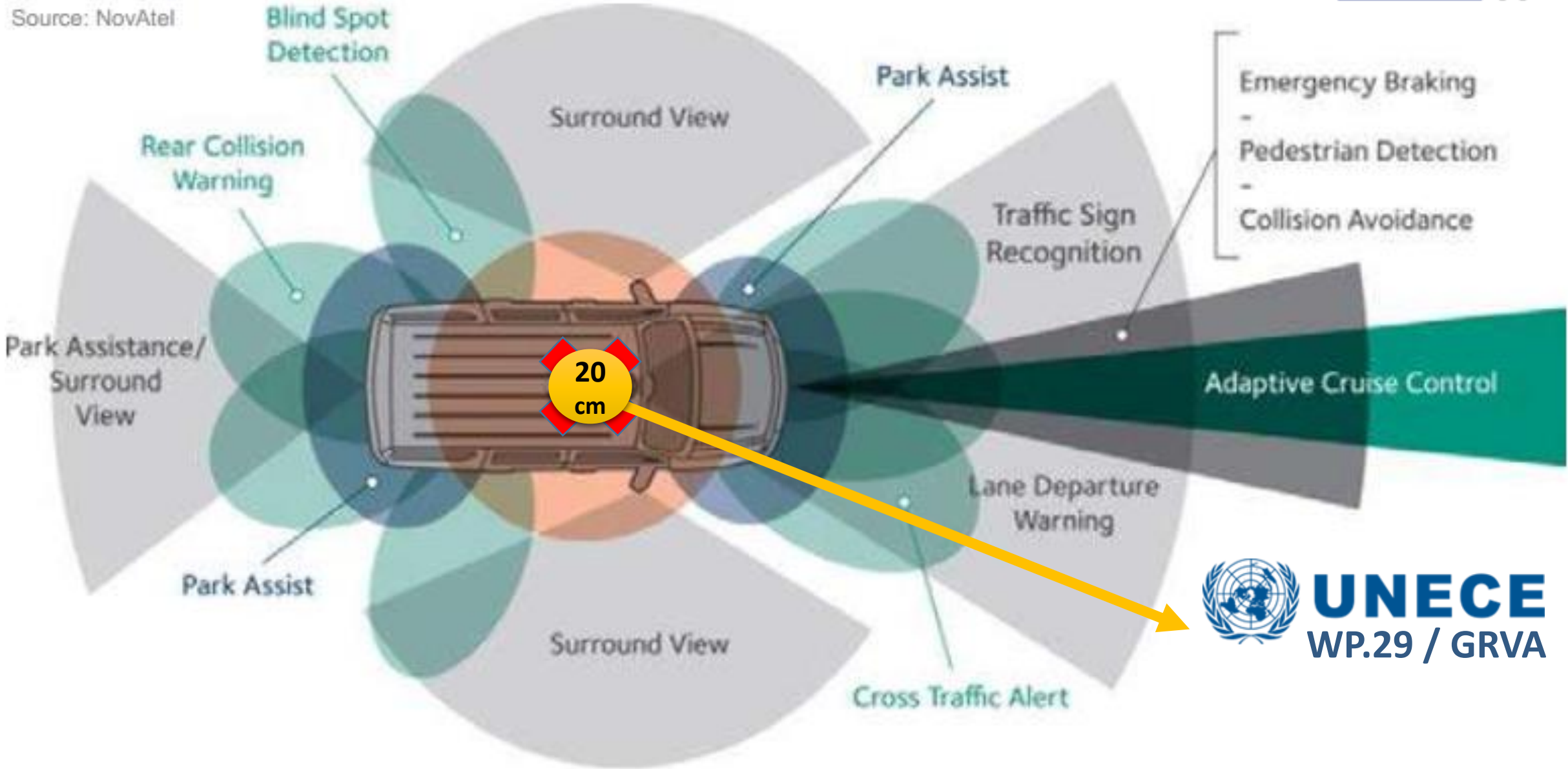


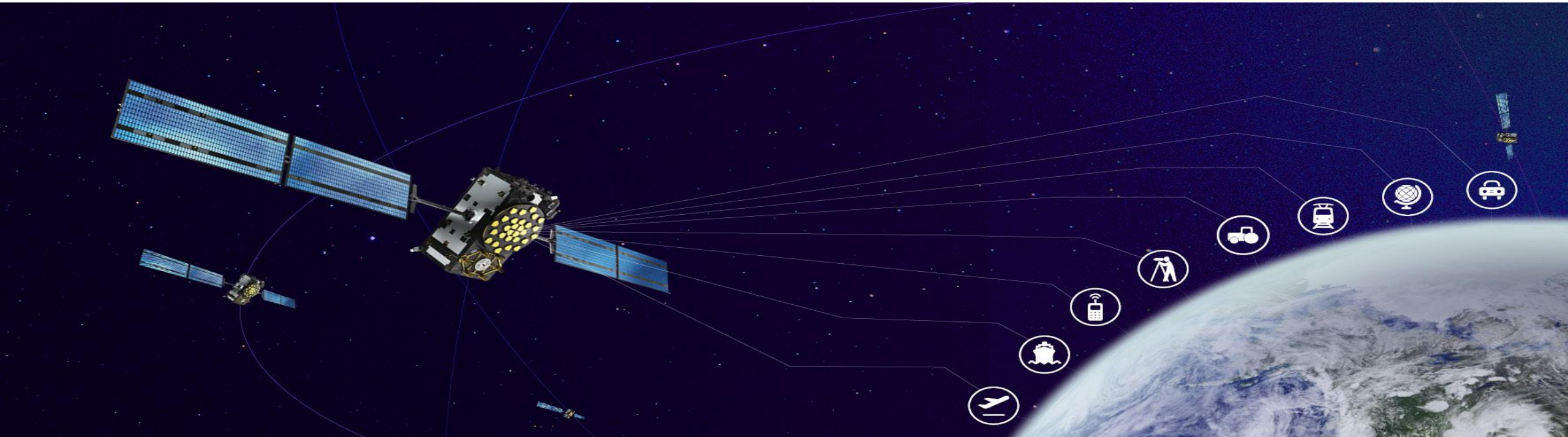
... and the key European car makers (**Mercedes-Benz, Fiat-Chrysler, Scania, Renault, Volkswagen, Volvo...**) confirmed the interest to test the Galileo High Accuracy and Authentication once available

Conclusion (II): (Autonomous) Navigation is a Safety function!



Source: NovAtel





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