

5G and PNT



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NAVISP Industry Days 2023

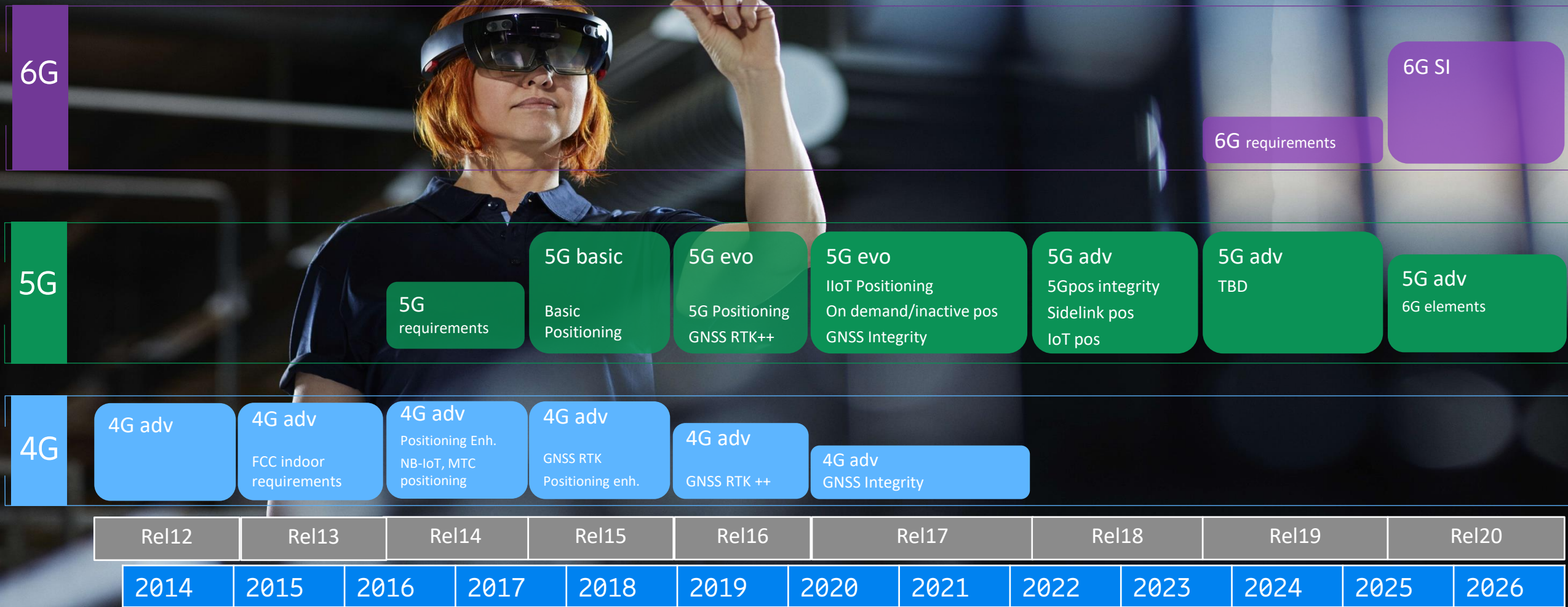
Outline



- 5G assisting GNSS PNT
- 5G as Alternative PNT
- 5G as use case enabler

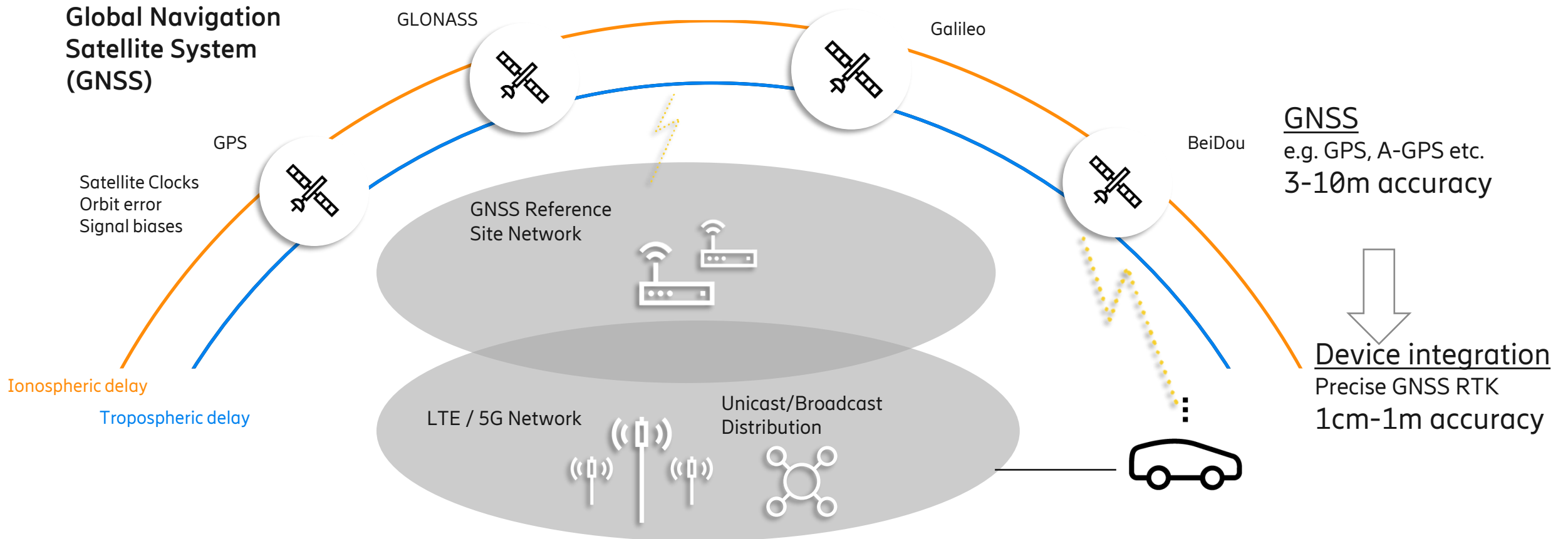


3GPP LTE and NR positioning timeline



5G GNSS assistance data distribution

Scalable sub-meter localization accuracy for vehicles, IoT devices, smartphones, ...

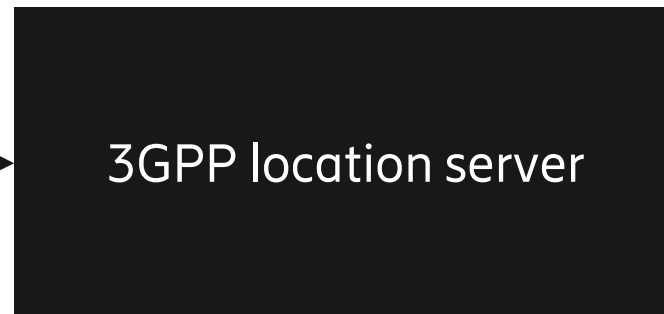


5G GNSS assistance data distribution

Scalable sub-meter localization accuracy for vehicles, IoT devices, smartphones, ...



- userplane unicast 3GPP LPP*
- broadcast 3GPP LPP* migration
- service provisioning
- 5G hybrid positioning
- network application exposure



* LPP – LTE Positioning Protocol (4G/5G)

GNSS assistance data representation

Observation Space Representation (OSR) and State Space Representation (SSR)

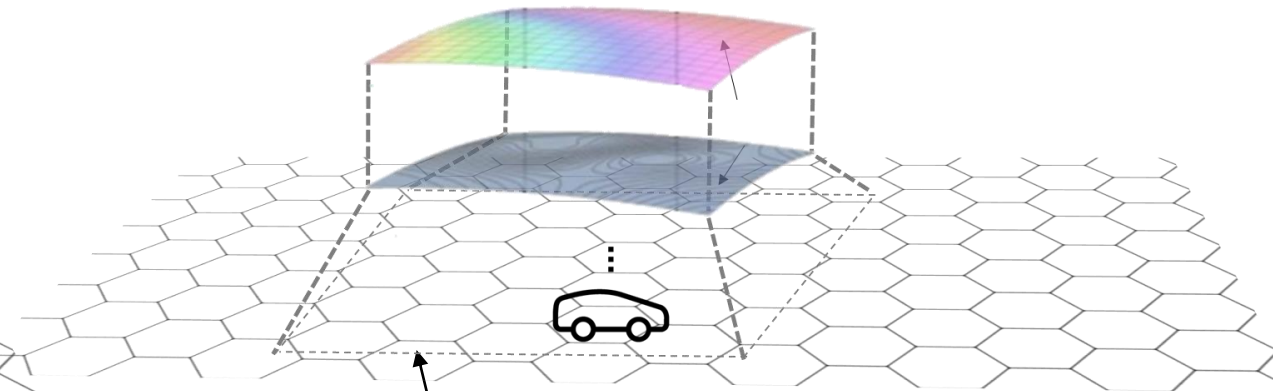
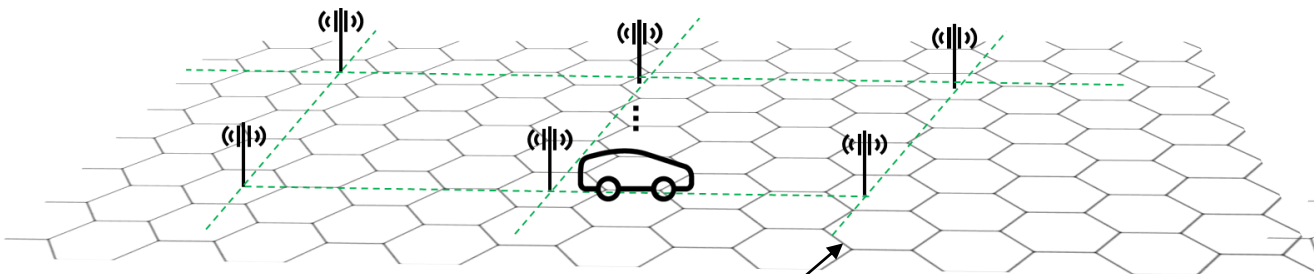


Observation Space Representation

Interpolated to a grid of non-physical reference stations

State Space Representation

Satellite Clocks
Orbit error
Signal biases
Regional ionosphere delay model
Regional troposphere delay model



Non-physical reference station

SSR region/segment/tile

GNSS integrity

Error source over-bounding and integrity parameters



- Overbound error sources
- Define Do Not Use flags
- Provide target integrity risk, alert limit, time to alert

State Space Representation

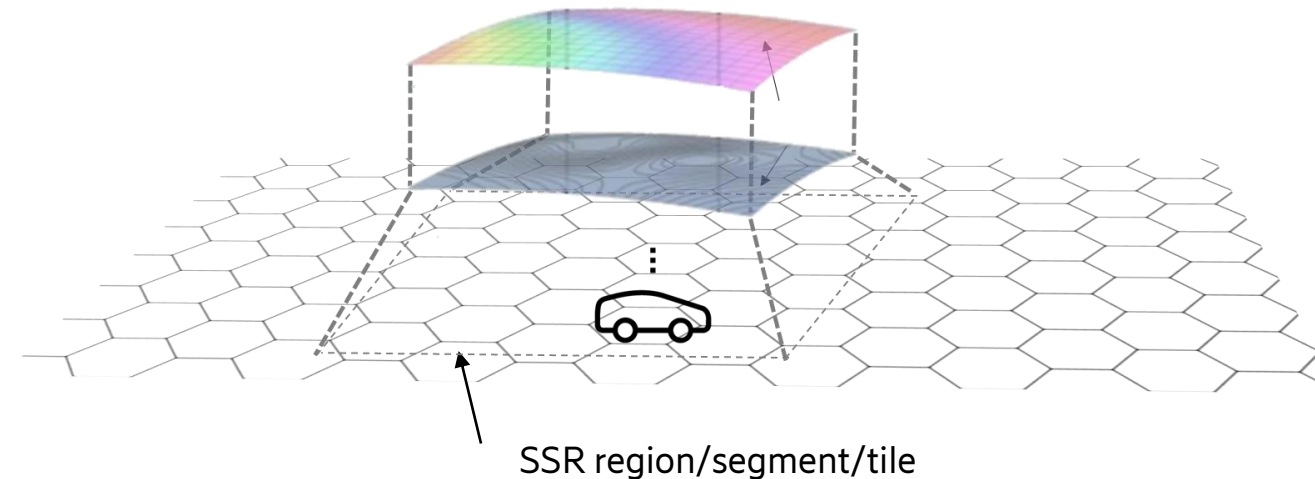
Satellite Clocks

Orbit error

Signal biases

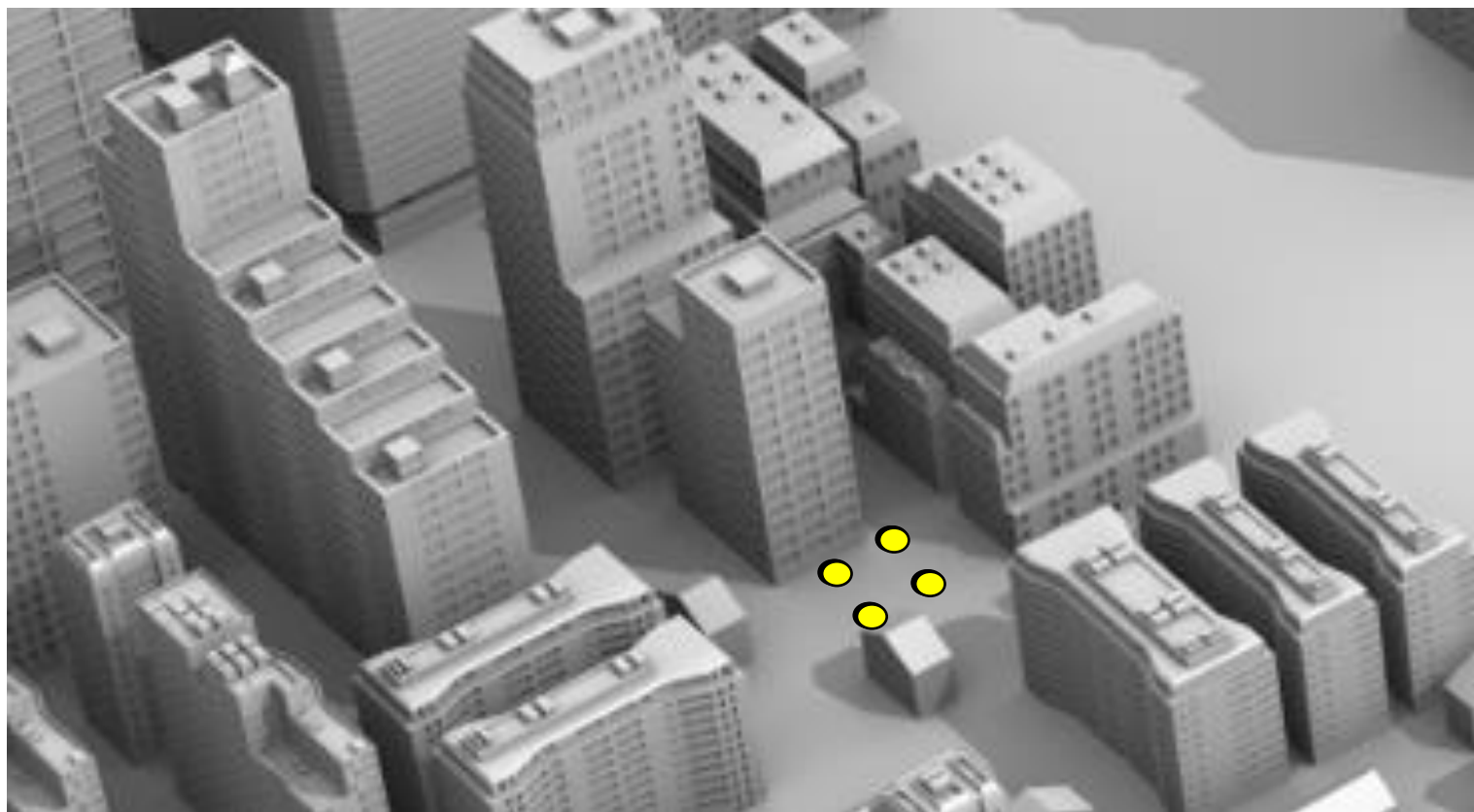
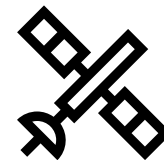
Regional ionosphere delay model

Regional troposphere delay model



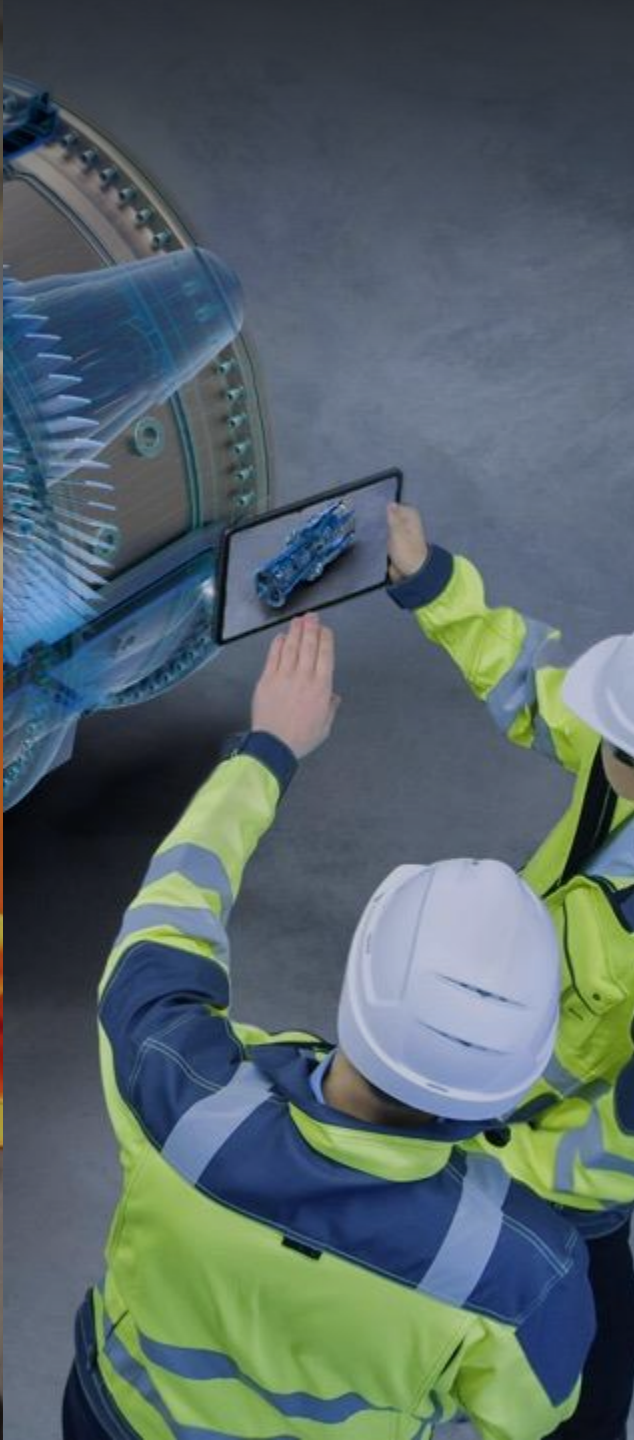


3GPP GNSS Spatial LoS/NLoS indications

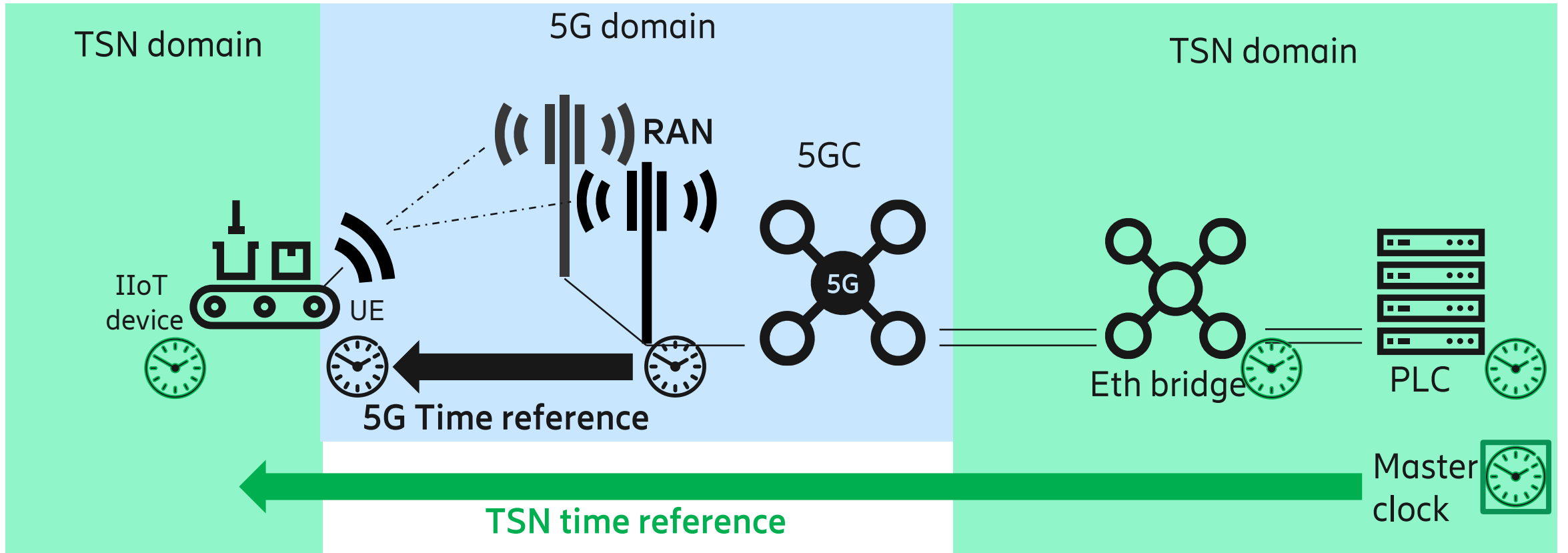


- NLoS
- LoS
- Uncertain

5G as Alternative PNT



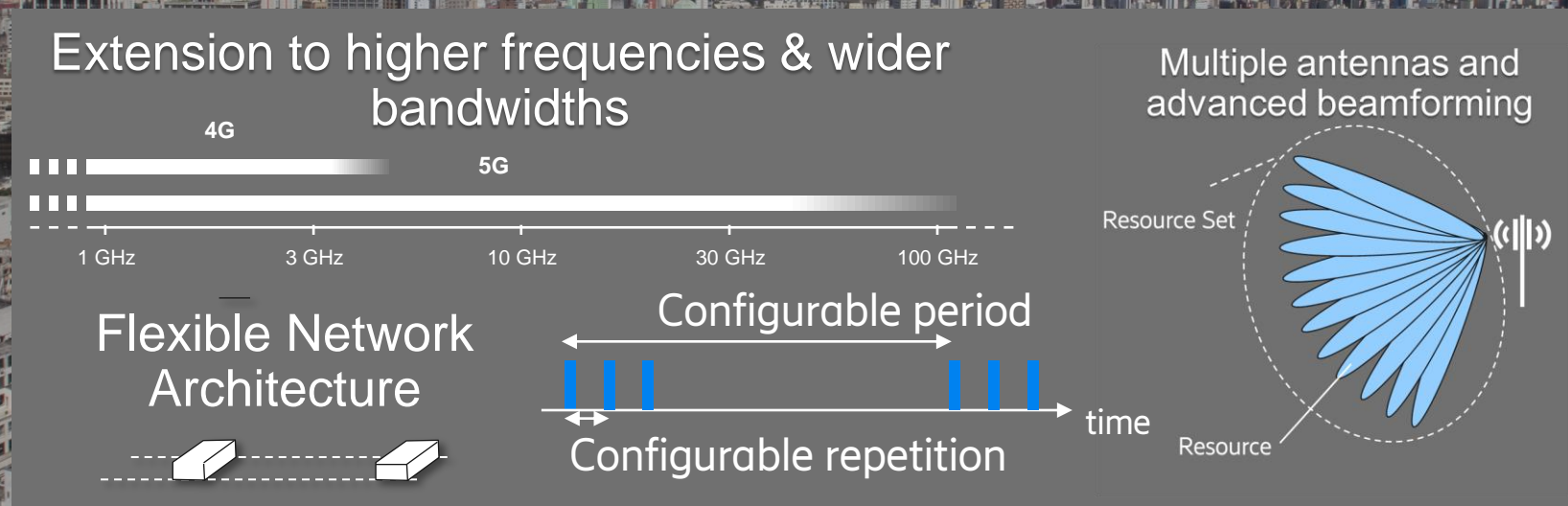
5G Time reference provisioning overview



5G Positioning (Rel 15-16)



- Basic positioning functionality to support:
 - E-CID
 - UL TDOA
 - DL TDOA
 - Multi-RTT (new compared to LTE)
 - DL AOD (new – but possible in LTE)
 - UL AOA (new – but possible in LTE)
- These methods (except E-CID) require specification of
 - UL and DL reference signals for positioning
 - Timing measurements
 - Power measurement
 - Angular measurements
 - Support for beamforming

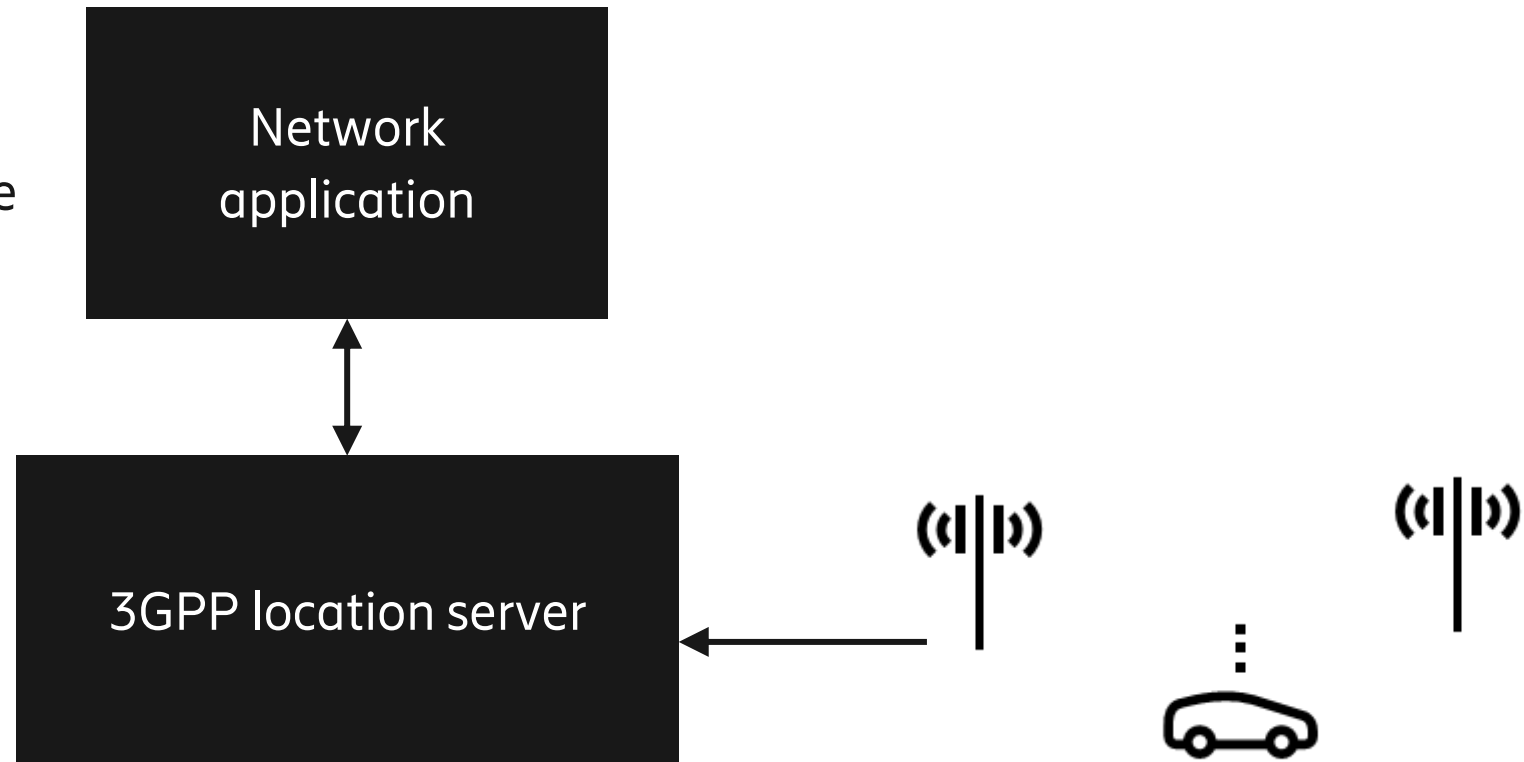


5G device assisted positioning

Enabling network application PNT



- Emergency call positioning
- asset tracking use cases
- network application exposure
- device can subscribe also

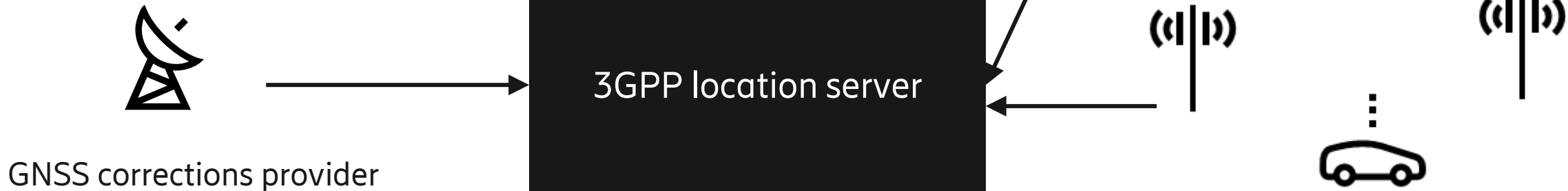


5G device assisted positioning with GNSS

Enabling network application PNT



- Emergency call positioning
- asset tracking use cases
- network application exposure
- device can subscribe also
- network position verification



5G device-based positioning



“Observation Space Representation (OSR) and State Space Representation (SSR)”

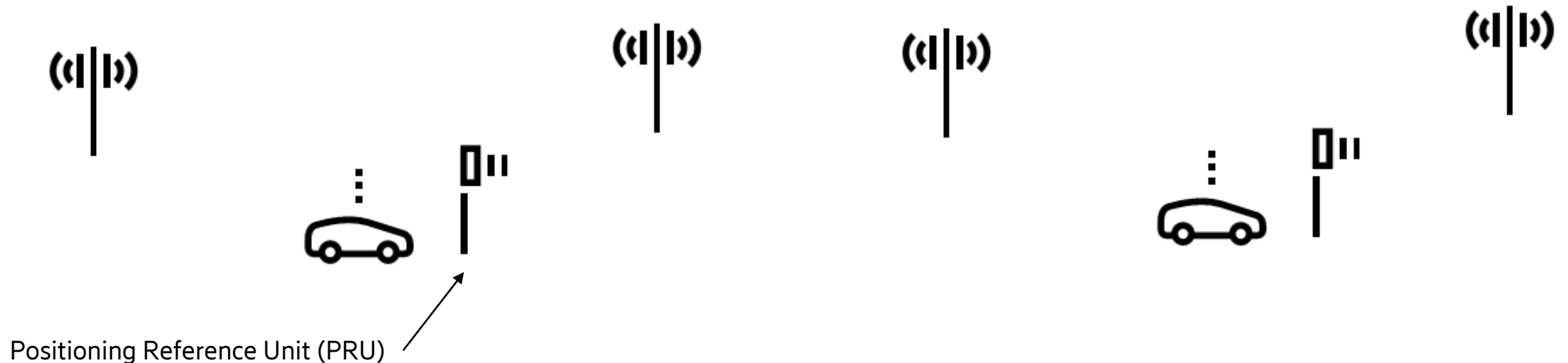


Observation Space Representation

- Antenna location
- Antenna beam information
- Carrier phase observations (Rel-18)

State Space Representation

- Antenna location
- Antenna beam information
- Antenna relative time difference
- Antenna TX timing error/panel



5G positioning integrity

Error source over-bounding and integrity parameters



- Overbound error sources
- Define Do Not Use flags
- Provide target integrity risk, alert limit, time to alert

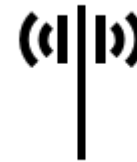
State Space Representation

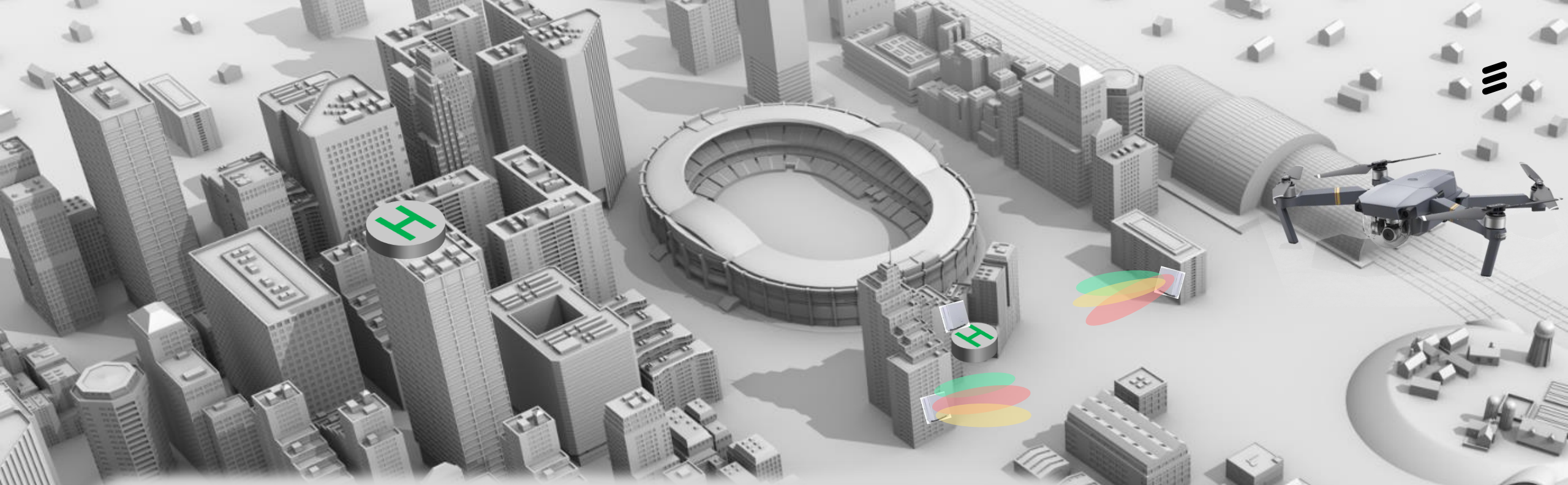
Antenna location

Antenna beam information

Antenna relative time difference

Antenna TX timing error/panel





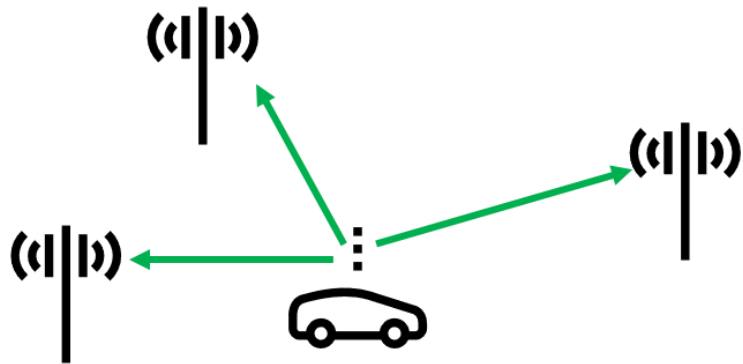
Example use case of hybrid positioning

- 3GPP-based GNSS RTK with integrity for drone navigation and UTM
- 5G positioning to provide network validation of provided drone positions
- 5G positioning in street canyons and obstructed sky environments
- Crowd sourced information for 3D coverage and population location for mission planning
- API Exposure of reliable position to network applications in U-SPACE

Positioning vs. Sensing

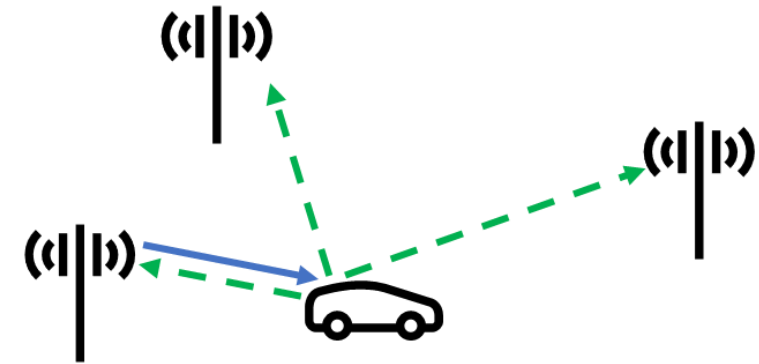


Positioning



- Determine location of active (communication-enabled) objects and devices
- DL-TDOA, UL-TDOA, UL-AOA, multi-cell RTT, hybrid positioning methods utilizing sensor fusion, etc.

Sensing



- Derive properties of the environment
- Detect and track location/velocity/direction of passive objects
- Multibeam technology helps to communicate and sense simultaneously

ISAC is Coming to 3GPP





—3GPP

- SA1: [FS Sensing](#) SID (S1-220191)
- *"ISAC in a 3GPP 5G system means that the sensing capabilities are provided by the same 5G NR system and infrastructure as used for communication, and the sensing information can be derived from RF-based and/or non-RF based sensors."* (S1-220191)
- 30+ use cases are identified and described (smart home, smart cities, automotive, uncrewed aerial vehicles, XR streaming, integrated sensing and positioning, etc.)

—[Ericsson blog on ISAC use cases](#)



3GPP TR 22.837 V19.1.0 (2023-09)	
<i>Technical Report</i>	
3rd Generation Partnership Project; Technical Specification Group TSG SA; Feasibility Study on Integrated Sensing and Communication (Release 19)	
	 A GLOBAL INITIATIVE
<small>The present document has been developed within the 3rd Generation Partnership Project (3GPP™) and may be further elaborated for the purposes of 3GPP. The present document has not been subject to any approval process by the 3GPP Organizational Partners and shall not be implemented. This Specification is provided for future development work within 3GPP only. The Organizational Partners accept no liability for any use of this Specification. Specifications and Reports for implementation of the 3GPP™ system should be obtained via the 3GPP Organizational Partners' Publications Offices.</small>	

Some takeaways

- 5G for PNT
 - Providing GNSS assistance data
 - Network verify GNSS
 - 5G positioning
 - 5G exposure to network applications
 - Smooth user service provisioning
- 5G has technology potential for
 - Time sensitive networking
 - Precise positioning
 - Integrity
 - Network exposure
- 6G discussions have started



Imagine Possible Perspectives

- <https://www.ericsson.com/en/about-us/new-world-of-possibilities/imagine-possible-perspectives/>

Towards the cyber physical continuum

- <https://www.ericsson.com/en/6g>
- <https://www.ericsson.com/en/about-us/new-world-of-possibilities/imagine-possible-perspectives/digital-twins>
- <https://www.ericsson.com/en/about-us/new-world-of-possibilities/imagine-possible-perspectives/the-impact-of-connectivity>