



Ordine degli Ingegneri
della Provincia di
Roma

Fondazione Ordine
Ingegneri Roma



GNSS Assisted by NTN Networks for Global Positioning

- Ing. Roberto Capua, Presidente della Commissione Navigazione Satellitare (GNSS)
- Ordine degli Ingegneri della Provincia di Roma
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Commissioni del Dip 3 Ingegneria Industriale

3. INGEGNERIA INDUSTRIALE Consiglieri di riferimento: Giovanni Nicolai Mauro Villarini Coordinatore di dipartimento: TBD	Industriale	Salvatore Andrea Sciuto	Building automation e processi industriali	Lorenzo Vanadia
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			Valutazione e mitigazione dei rischi negli impianti industriali	Fabrizio Paolacci
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			Progettazione integrata in ambito sanitario	Aldo Delia



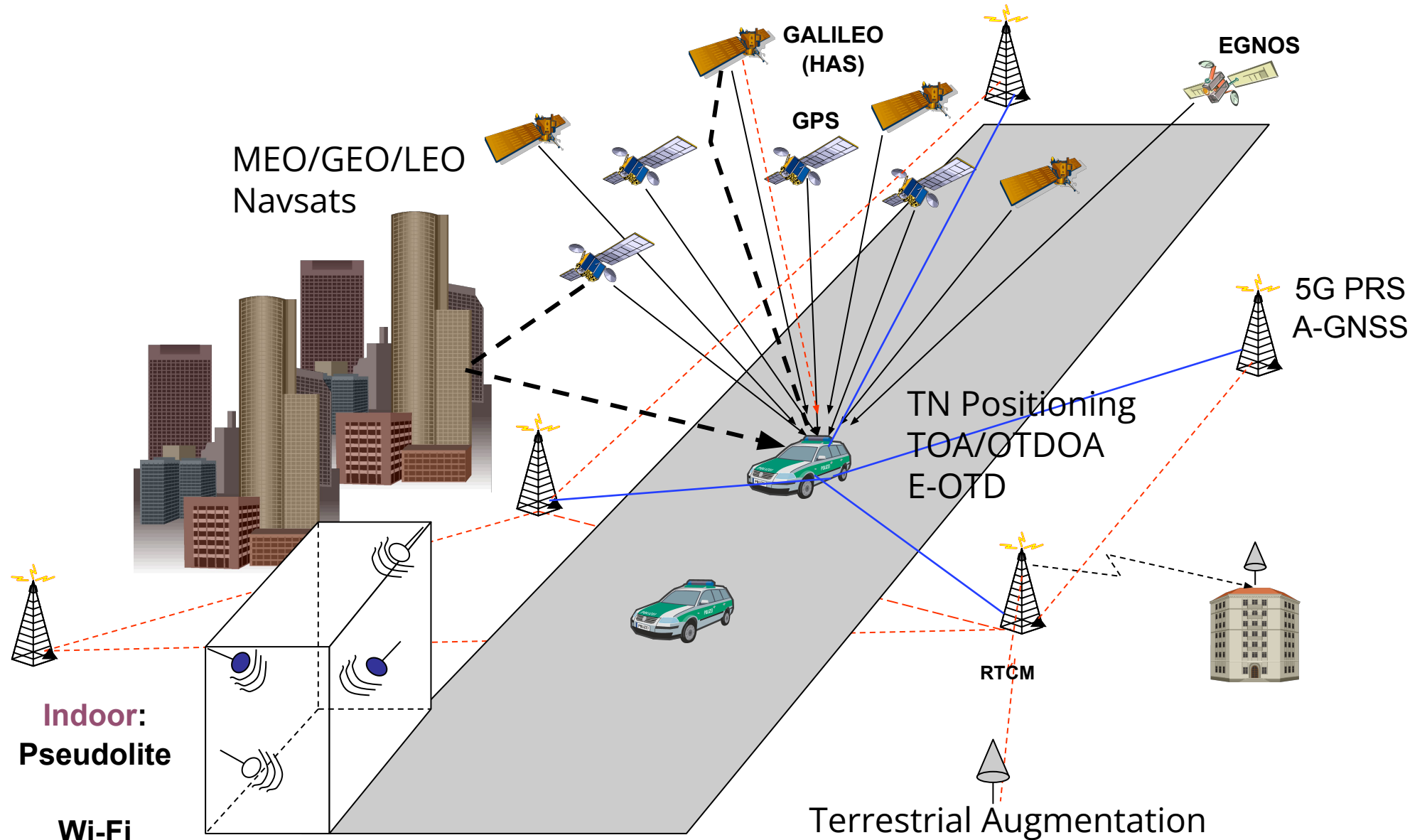
Antonio Franchi, Head of 5G/6G NTN Programme Office, ESA

*"The satellite community's proactive engagement in 3GPP has already led to the inclusion of NTN since Release 17, driving the active endorsement of NTN by terrestrial stakeholders and a wide range of verticals. From this baseline, industry must now focus on the development of **flexible, resilient technology solutions that are cost-effective, secure, providing global coverage, freely scalable and energy efficient, by extending the presence of NTN in 3GPP, including all satellite frequency bands, broadband and narrowband services**, with transparent and regenerative satellite payloads."*



Terrestrial and Non Terrestrial Positioning

Systems





OTDOA Concept

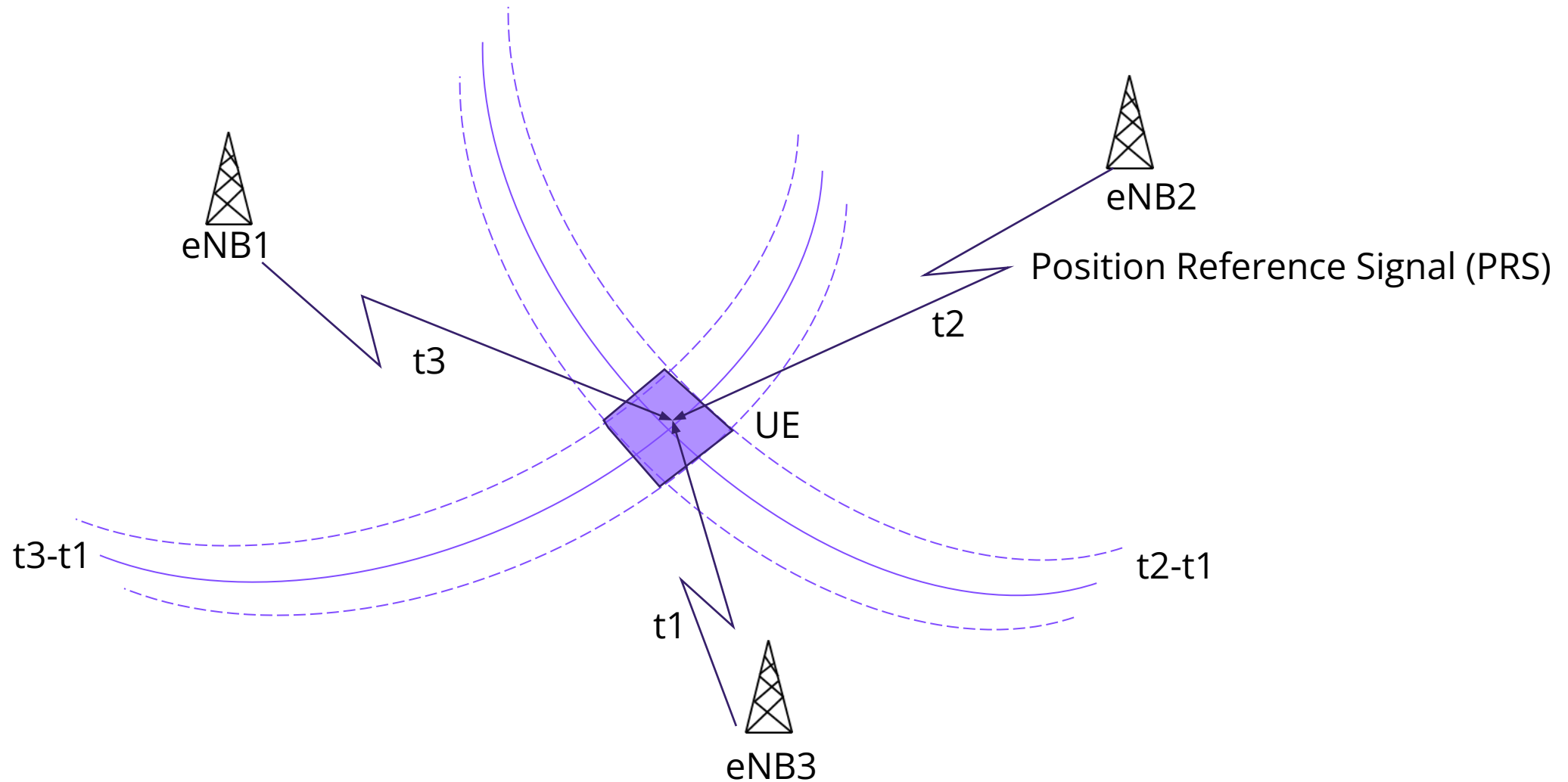




Table 1: 3GPP Summary of Positioning Methods (TS38.305)

Method	UE-based	UE-assisted, LMF-based	NG-RAN node assisted	SUPL ^{*8}
A-GNSS	Yes	Yes	No	Yes
OTDOA ^{*1, *2}	No	Yes	No	Yes
E-CID ^{*4, *7}	No	Yes	Yes	Yes for E-UTRA
Sensor	Yes	Yes	No	No
WLAN	Yes	Yes	No	Yes
Bluetooth	No	Yes	No	No
TBS ^{*5}	Yes	Yes	No	Yes (MBS)
DL-TDOA	Yes	Yes	No	Yes
DL-AoD	Yes	Yes	No	Yes
Multi-RTT	No	Yes	Yes	Yes
NR E-CID	No	Yes	Yes	Yes (DL NR E-CID)
UL-TDOA	No	No	Yes	Yes
UL-AoA	No	No	Yes	Yes

*1: This includes TBS positioning based on PRS signals.

*2: In this version of the specification only OTDOA based on LTE signals is supported.

*3: Void

*4: This includes Cell-ID for NR method when UE is served by gNB.

*5: In this version of the specification only for TBS positioning based on MBS signals.

*6: Void

*7: Enhanced Cell ID based on LTE signals.

*8: This shows whether the positioning method is supported by SUPL ULP.



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**Satellite
Mobile
Communication**

GPS

GALILEO

Precise Orbit
Clock
corrections

Code and Phase
biases

**Terrestrial
Mobile
Communications**

**Satellite
corrections
(Galileo HAS)**

**PPP/PPP-RTK Services (SSR)
(Precise Point Positioning)**

Accuracy: < 10 cm

Convergence Time: 20-40 min / < 5 min

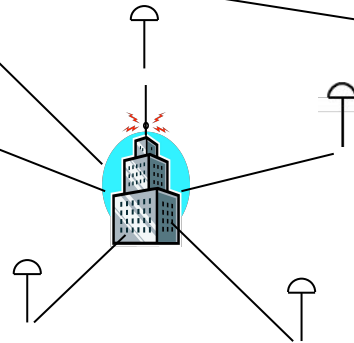
**RTK/NRTK Services (OSR)
(Real-Time Kinematics)**

**Local GNSS Reference Station
Networks**

Accuracy: < 3 cm

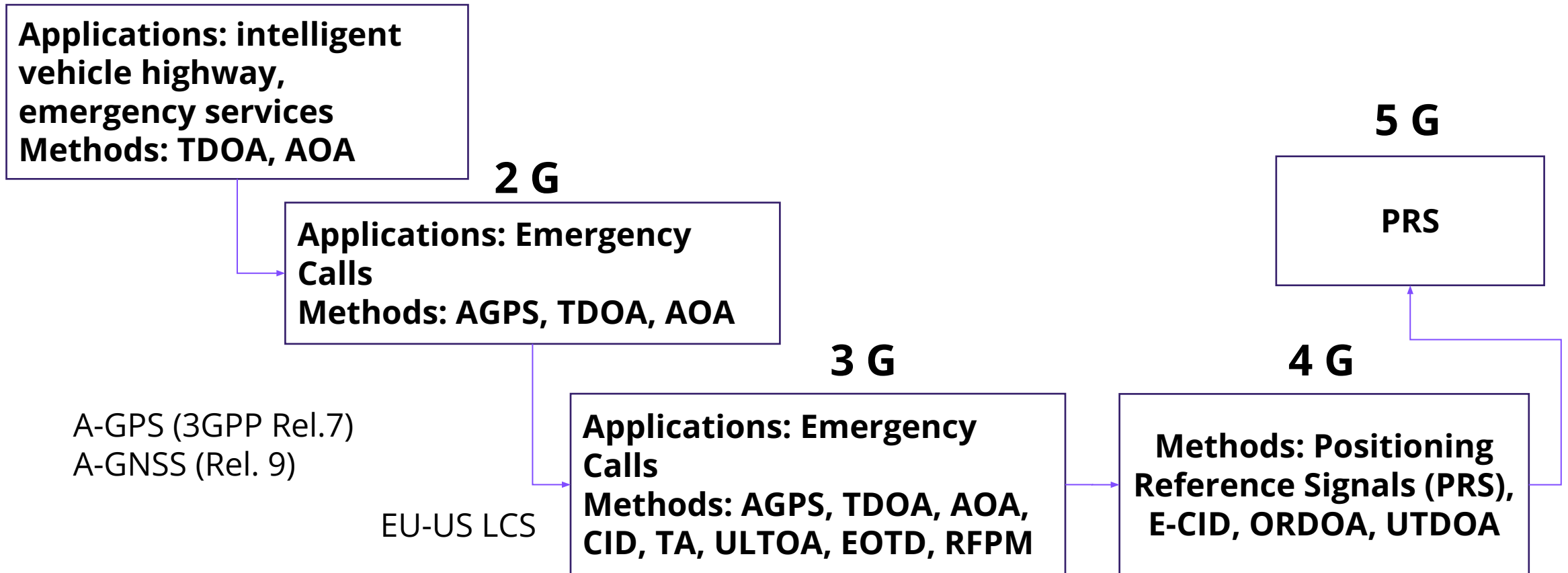
Convergence Time: s/min

AGNSS Services
Ephemeris, clock
HAS rebroadcasting





Location Method Evolutions within Terrestrial Networks





Previous ETSI Positioning Systems developments

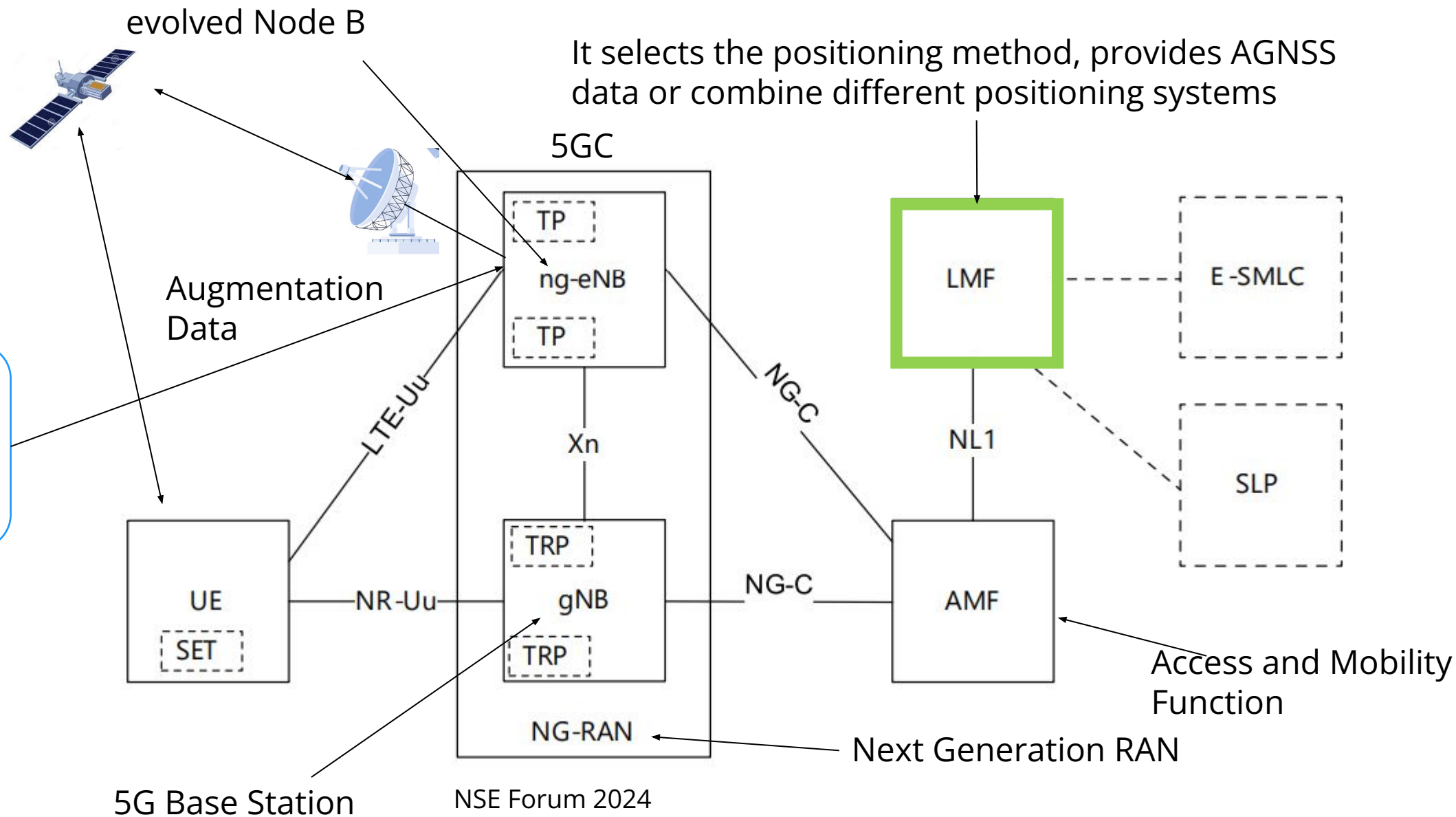
- Previous functions in 3GPP (e.g LTE/EPC) have basically defined **AGNSS** functions (ephemeris and clock error *rebroadcasting*, RTK augmentation, SSR corrections), to help GNSS users to reduce Time To First Fix or position accuracy
- Rel. 16 introduced multi-/single-cell and device-based positioning. PRS (**Positioning Reference Signal**) has been introduced, to be used by several 5G positioning techniques, including Roundtrip Time (RTT), Angle of Arrival/Departure (AoA/AoD), and Time Difference of Arrival (TDOA)
- Release 17 introduced:
 - **Precise indoor positioning** for industrial IoT
 - Real-time **Integrity** Message Assistance



New Positioning features introduced in Rel.

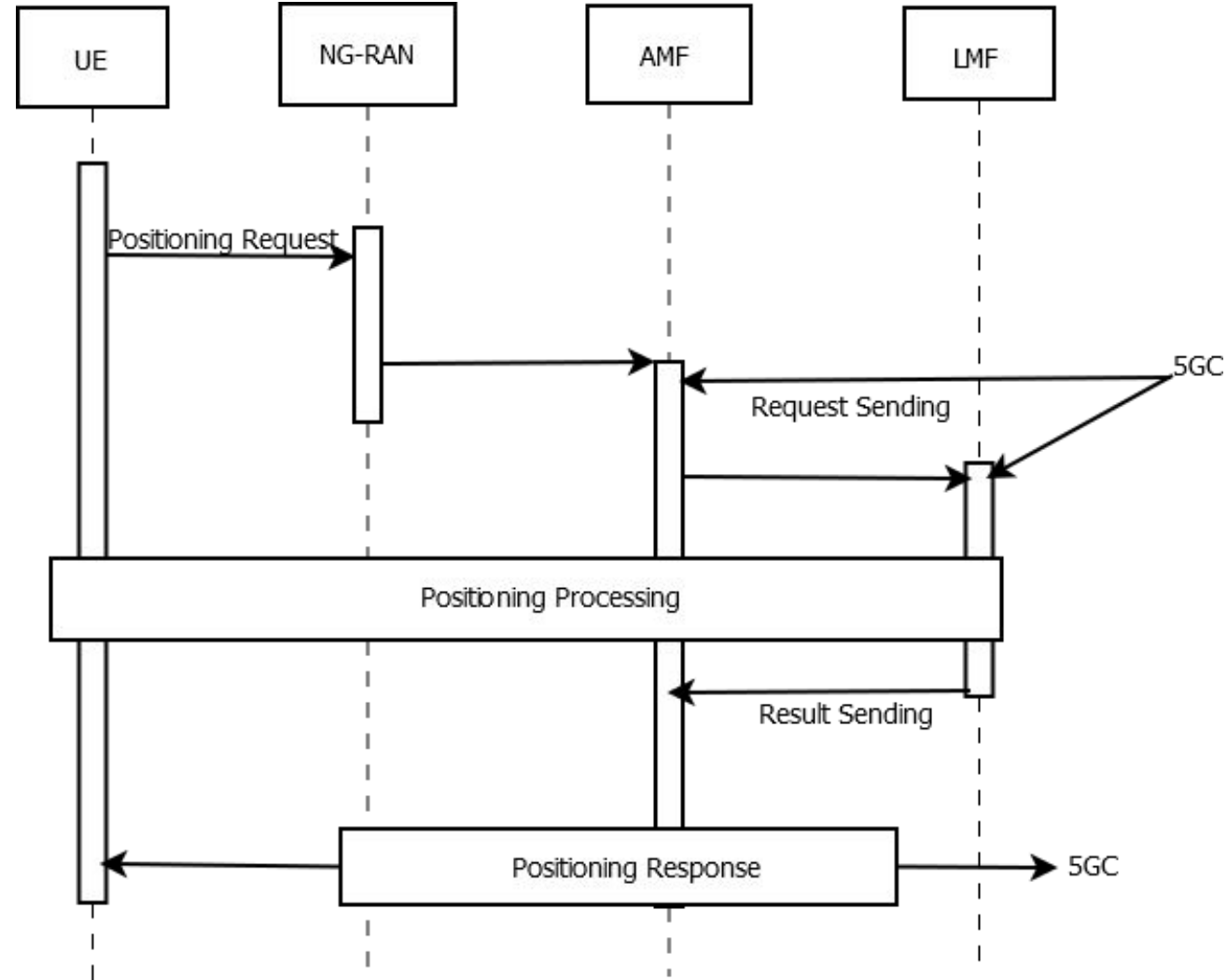
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- GMLC and LMF focus for supporting location services in a local area
- GNSS assistance data collection and provisioning
- Support of Positioning Reference units
- Location service continuity in case of UE mobility
- **Low Power and High Accuracy Positioning**
- **Sidelink Positioning** (Cooperative Positioning through neighbour users information exchange, required by Automotive)
- New Radio Carrier Phase Positioning
- Positioning for **RedCap** (Reduced Capability) UE (required by IoT)
- Positioning signalling transmission via user plane





Positioning Sequence Diagram





LEO-PNT advantage and disadvantages

- Advantages:
 - Growing commercial interest in LEO Communication services
 - Larger bandwidth, improved accuracy and reduced acquisition time
 - Higher SNR
 - Better and more dynamic satellite geometry than MEO GNSS
 - Reduced ionospheric effects
 - Frequent Satellite changes and multipath decorrelation
- Disadvantages:
 - Higher Doppler shift
 - Frequent handovers between satellites
 - Assistance data to be sent by the LMF has to change dynamically
- Future trends:
 - LEO as MEO GNSS relay, allowing faster positioning
 - LEO-PNT Services as primary source or secondary mean for resiliency



Conclusions

- The interoperability of MEO GNSS and **LEO-PNT** allows a seamless positioning system in remote areas and dense Urban Area
- **LEO satellites** can perform GNSS signal relay, improving SNR and location in constrained environments
- **NTN to be used for Assistance and Augmentation GNSS data (re)broadcasting**
- Broadcasting, both as transparent or regenerative payloads
- **Interoperability between ETSI and GNSS standardization Committees (e.g. RTCM)** are under development can lead to an harmonized and cross sector standard for *ubiquitous* positioning services
- **Cooperative positioning and Sidelink** concepts to be further investigated, with attention to the integrity for transport applications and reduced power sensors
- From TN and NTN Nav/Comm Integration (4G, 5G) to **TN and NTN Communication and Navigation Unification** (6G, Rel. 19)