



3GPP TSG RAN Meeting #85

Newport Beach, CA, USA, 16-20 September 2019

Agenda Item: 8.1.9 Positioning

Document For: Discussion

Views on Rel-17 Positioning Enhancements

Source: Swift Navigation



Overview of 3GPP High Accuracy Positioning

- Demand for high accuracy positioning in mobile is expanding
 - Regulatory (emergency services, E911)
 - Location Based Services (mapping, advertising, navigation)
 - Vehicular (V2X, navigation, road user charging)
 - IoT (asset tracking, logistics, wearables)
 - Aerials (UAVs, geo-imagery, transport)
 - Medical (patient/equipment location)
- High accuracy positioning via 3GPP extends to other verticals
 - Automotive, Rail, Agriculture, Robotics, Engineering etc

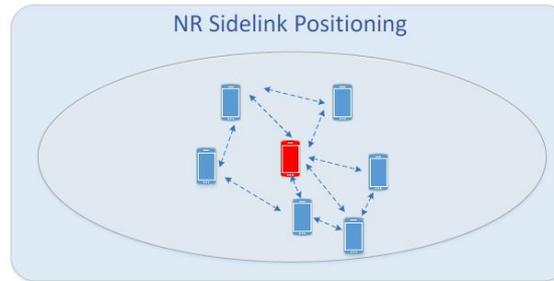
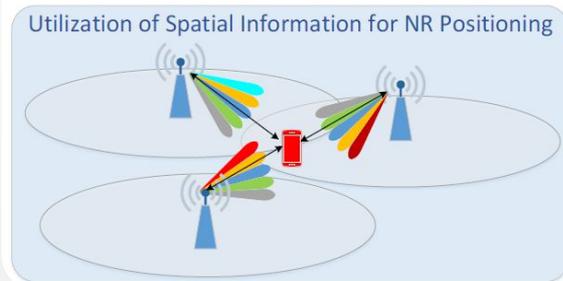
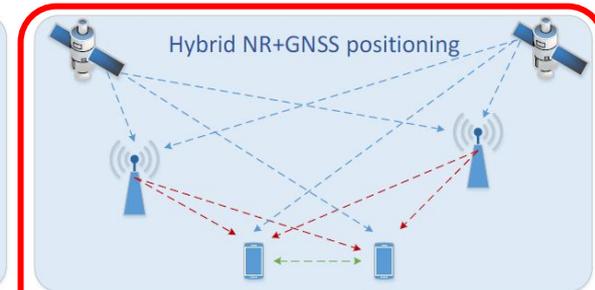
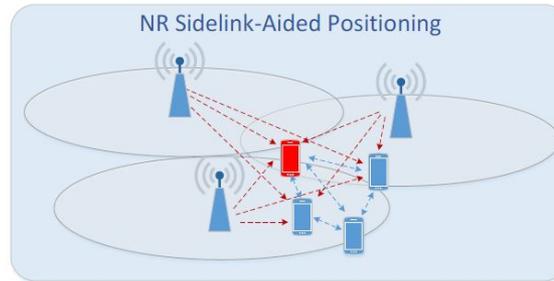
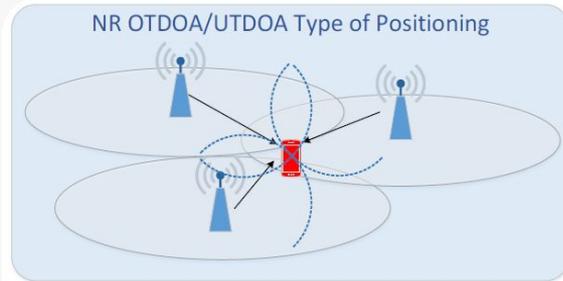


GSA GNSS Market Report 2017 [1]



Overview of 3GPP High Accuracy Positioning

- 3GPP provides hybrid positioning solutions
 - RAT Dependent (e.g. NR) & RAT Independent (e.g. Standalone GNSS)
- GNSS correction dissemination via NG-RAN enables high accuracy



Overview of 3GPP High Accuracy Positioning

- Relevant studies on high accuracy positioning in 3GPP
 - 22.862: New Services & Markets Technology Enablers [3]
 - 22.872: 5G_HYPOS, study on positioning use cases [4, 5]
 - 22.261: Service requirements for the 5G system [6]
- LTE Positioning Protocol (LPP) continues to evolve:
 - Rel-15 introduced GNSS RTK/NRTK & basic PPP [7]
 - Centimeter/decimeter, point-to-point, local coverage
 - Rel-16 is introducing GNSS SSR for high accuracy broadcast [8, 9]
 - Centimeter/decimeter, broadcast, optimized bandwidth, network & UE scalability
 - Generic support for PPP-RTK, scope for future extensions
- **Views on Rel-17 NR Positioning Enhancements [10, 11, 12]**



Views on Rel-17 positioning enhancements

- **Rel-17 User Story**

- Demand for high positioning performance is increasing in new markets
- Rel-16 establishes the 3GPP architecture supporting high accuracy and scalability, via SSR broadcast
- Despite advances in accuracy, LPP does not yet include integrity elements to ensure robustness and verify GNSS performance and compatibility for high accuracy services
- This will limit adoption for emerging applications, including mission critical
- Adding integrity enhancements for the UE & network can overcome these difficulties

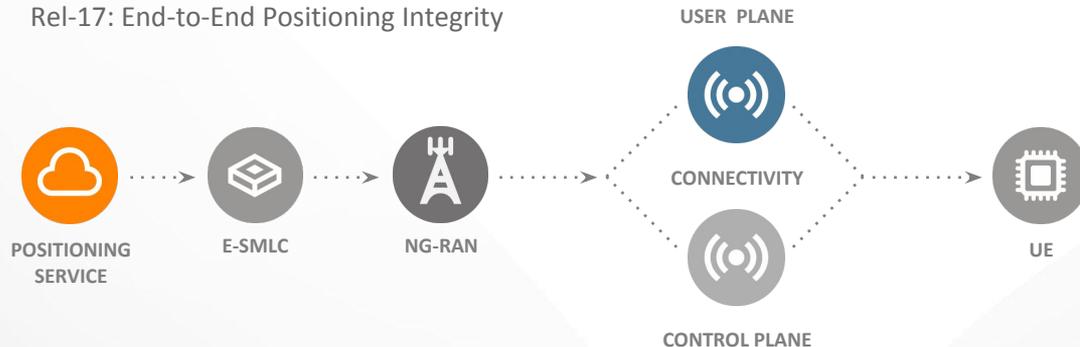
- **Study Recommendation**

- *Rel-17 to study KPIs and IEs for functional integrity (network & UE) for high accuracy positioning*



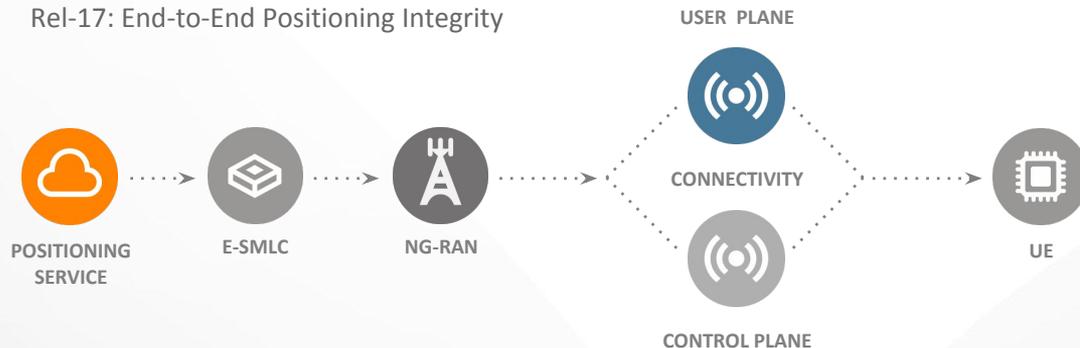
Views on Rel-17 positioning enhancements

- **Positioning Integrity KPIs / IEs** (see Example 1):
 - Integrity assistance data enables network and UE positioning validation
 - e.g. Fault detection, error bounding (centimeter / decimeter accuracy), Alert Limits, Target Integrity Risk, Protection Levels etc
- **Signalling Integrity:**
 - Control Plane and User Plane integrity protection and confidentiality [6]
 - e.g. Control Plane integrity (Positioning Service → E-SMLC → NG-RAN → UE interfaces)



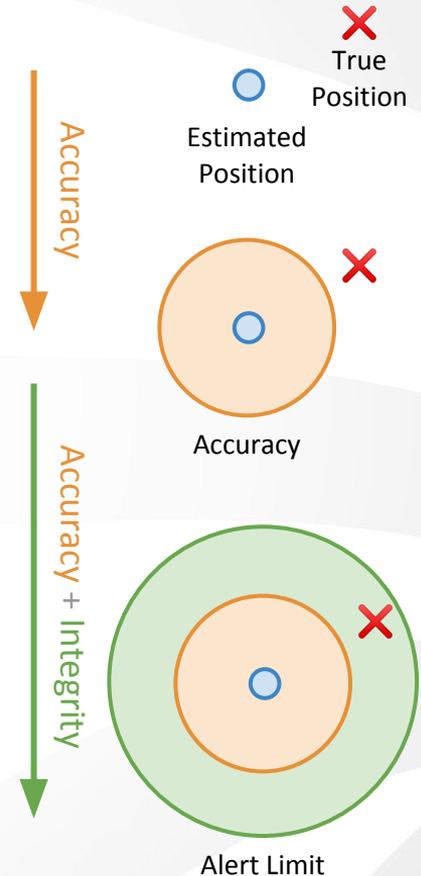
Views on Rel-17 positioning enhancements

- Implementation of the SSR Work Item (Rel-16) is a foundation for developing GNSS Integrity extensions to LPP
- Integrity is defined in 3GPP study on positioning use cases [4]:
 - “A measure of the trust in the accuracy of the position-related data provided by the positioning system and the ability to provide timely and valid warnings to the UE and/or the user when the positioning system does not fulfil the condition for intended operation”



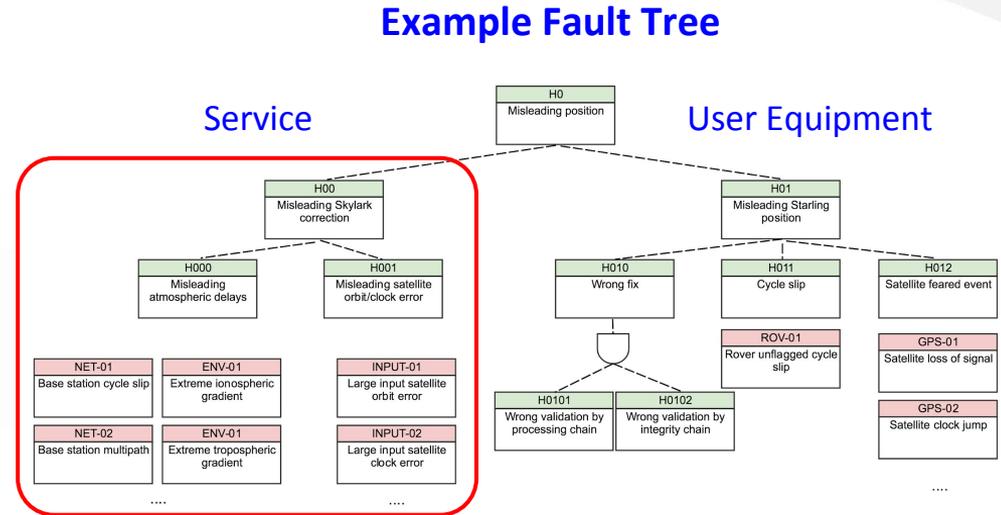
Example 1: Integrity for high accuracy GNSS

- The primary UE output is the user's estimated position
 - This estimate will contain some error compared to the true position
- To indicate the quality of position, the accuracy is also estimated, e.g. typically given as a 1 sigma (68%) value:
 - Indicates 68% of position outputs are better than the reported accuracy
 - 32% of positions worse than the stated accuracy - how much worse?
- For high-assurance positioning, we want to bound the error to a much higher level of certainty, this is the concept of **Integrity**
 - Define **Alert Limit (AL)** as an upper bound on position error
 - Alert Limit is calculated for a **Target Integrity Risk (TIR)**
 - TIR gives an allowable rate of occurrence of error greater than the Alert Limit e.g. less than once per 100,000 hours ($< 10^{-5}$ /hour)



Example 1: Integrity for high accuracy GNSS

- To compute the Alert Limit for a low TIR it's not sufficient to consider just nominal performance
- Rare fault conditions and “feared events” must be considered
 - e.g. degradation / failure of the GNSS satellite
- These faults can be difficult to detect on the UE alone
- **To achieve necessary integrity KPIs, it's essential for the GNSS network to monitor for certain faults and provide assistance data to the UE to support integrity computation**



Network side faults must be monitored and communicated, e.g. satellite feared events, atmospheric events, network events



Example 2 - Road Use Charging (RUC)

Problem

- RUC typically requires expensive fixed infrastructure
- Can replace with high accuracy GNSS
- *How to assure user is charged correctly?*

Opportunity

- High Integrity can assure that positioning errors don't result in incorrect billing
- Applicable to road networks with LTE/5G
- Tamper / fraud proof with high confidence



Benefits

- Improve traffic flow and planning
- Correct billing
- Optimized routing and road maintenance



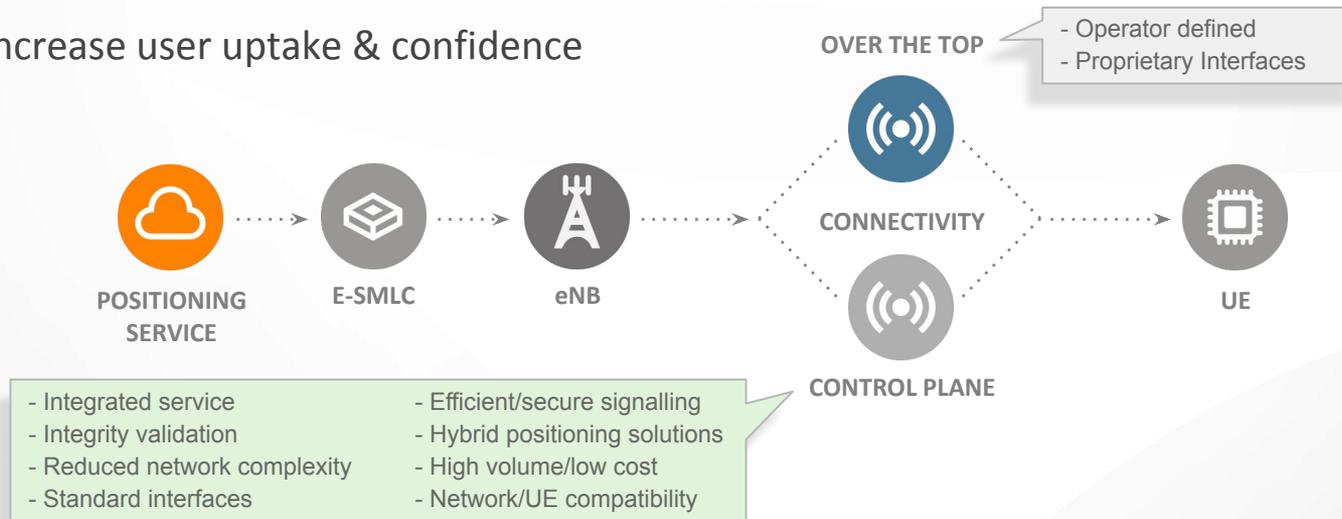
Rel-17 Justification

- Integrity is an important KPI for 3GPP high accuracy GNSS positioning
- Integrity requires assistance data from the network beyond that already under consideration
 - e.g. New IEs for fault flags on SSR, correction alert limits, auxiliary corrections
- Correction providers and UE vendors already support this functionality, but there is no existing industry standard for interoperability for mass market adoption



Views on Rel-17 justification

- Positioning continues to benefit from tighter integration with the control plane in 3GPP, for example:
 - Scenarios and Requirements for Next Generation Access Technologies [13]
 - New IEs for Integrity assistance data
 - Increase UE & vendor diversity / compatibility
 - Increase user uptake & confidence



Objectives of this SI:

- Identify / evaluate positioning Integrity KPIs
 - Alert Limit, Target Integrity Risk, Protection Level etc
- Identify feared events
 - Satellite feared events, atmospheric events, network events etc
- Identify an approach to network assisted Integrity
- Investigate extensions to LPP to support Integrity
- Map the functional dependencies to UE and network equipment
- Examine the primary use cases and timeline



References

- [1] European GNSS Agency (GSA), GNSS Market Report, Issue 5, 2017
- [2] RP-171815, “Motivation for SI - Study on NR Positioning Support”, RAN#77, Intel, 2017
- [3] TR 22.862, “Feasibility Study on New Services and Markets Technology Enablers for Critical Communications”
- [4] TR 22.872, “Study on positioning use cases”
- [5] RP-170210, Motivation to study high accuracy positioning of NR, RAN#75, European Space Agency (ESA), Deutsche Telekom, Fraunhofer IIS, DOCOMO, Toyota InfoTechnology Center, 2017
- [6] TR 22.261, “Service requirements for the 5G system”
- [7] TS 36.355, "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol (LPP)"
- [8] RP-190752, “New WID: NR Positioning Support”, RAN#83, March 2019
- [9] R2-1906782, “Running LPP CR for PPP-RTK support (SSR)”, Qualcomm Incorporated, RAN2#106, 2019
- [10] RP-191230, “View on 3GPP RAN Rel-17 focus & content”, Deutsche Telekom, RAN#84, 2019
- [11] RP-191418, “On Rel-17 NR positioning”, Ericsson, RAN#84, 2019
- [12] RP-190855, “Motivation for SI on Integrity Support for NR Positioning”, Swift Navigation, RAN#84, 2019
- [13] TR 38.913, “Study on Scenarios and Requirements for Next Generation Access Technologies”



Appendix

5G_HYPOS - Study on positioning use cases [4]

- Positioning Integrity applies to many use cases but is not yet supported by 3GPP standards

Use cases		Potential requirements per use cases							Proposal
		Environment of Use	Position Accuracy	Velocity	Avail.	Update rate or interval	TTFB	Latency	Rel-17 Integrity Study Item
5.2.1	Bike Sharing	5G positioning service area - Outdoor	2m Horizontal		90 %		10s	1s	✓
		Enhanced positioning area - Outdoor	0.2m Horizontal		99 %		10s	1s	✓
5.2.2	Augmented Reality	Outdoor - 5G positioning service area	1-3m Horizontal 0.1-3m Vertical	2 m/s 10deg.	80 %	1 - 10 Hz	10s	1s	
5.2.3	Wearables	5G positioning service area - -Outdoor/Indoor	2m Horizontal 1-3m Vertical		90 %	30s - 300s	10s		
		5G positioning service area - -Outdoor/Indoor	2m Horizontal 1-3m Vertical		99 %	1s - 30s	10s	1s	

Table 6.1-1 – Use cases synthesis [4]

Integrity requirements can be examined & added to the table



5G_HYPOS - Study on positioning use cases [2]

Use cases		Potential requirements per use cases							Integrity Study Item
		Environment of Use	Position Accuracy	Velocity	Avail.	Update rate or interval	TTFF	Latency	
5.2.4	Advertisement push	5G positioning service area - Outdoor/Indoor	3m Horizontal 3m Vertical		90 %			60s	
5.2.5	Flow Management	Enhanced positioning- Outdoor/Indoor	10m Horizontal		80 %	10s	10s		
5.3.1	Person and Medical Equipment location in Hospital	Enhanced positioning- Outdoor/Indoor	3m Horizontal 2m Vertical		99 %			60s	✓
5.3.2	Patient Location (outside Hospital)	5G positioning service area Outdoor/Indoor	10m Horizontal 3m Vertical (floor)		99 %				✓



5G_HYPOS - Study on positioning use cases [2]

Use cases		Potential requirements per use cases							Integrity Study Item
		Environment of Use	Position Accuracy	Velocity	Avail.	Update rate or interval	TTFF	Latency	
5.3.3	Trolley	Enhanced positioning- Outdoor/Indoor	0.5m Horizontal 1-3m Vertical		99 %			20ms	✓
5.3.4	Waste Management	5G positioning service area - Outdoor	3m Horizontal		99 %	2h - 1 day		60s	
5.4.1	Emergency Call	5G positioning service area Outdoor/Indoor	50m Horizontal 3m Vertical		95 %		30s	60s	✓
5.4.2	Accurate Positioning for First Responders	Outdoor	1m Horizontal, 0.3 m Vertical		98 %		10s	5s	✓
		Indoor	1m Horizontal, 2 m Vertical		95 %		10s	1s	



5G_HYPOS - Study on positioning use cases [2]

Use cases		Potential requirements per use cases							Integrity Study Item
		Environment of Use	Position Accuracy	Velocity	Avail.	Update rate or interval	TTFF	Latency	
5.4.3	Alerting nearby Emergency Responders	5G positioning service area Outdoor/Indoor	50m Horizontal 3m Vertical (floor)		99%		10s		✓
5.4.4	Emergency Equipment loc. Outside Hospitals	5G positioning service area Outdoor/Indoor	10m Horizontal 3m Vertical (floor)		95%		10s		✓
5.5.1	Traffic Monitoring & Control	5G positioning service area - Outdoor	1-3m Horizontal 2.5m Vertical		95 %	10 Hz	10s	30ms	✓
5.5.2	Road User Charging	5G positioning service area - Outdoor Enhanced positioning-Tunnels	<1m (across track) 3m (along track)	2 m/s	99 %	1 Hz	10s		✓



5G_HYPOS - Study on positioning use cases [2]

Use cases		Potential requirements per use cases							Integrity Study Item
		Environment of Use	Position Accuracy	Velocity	Avail.	Update rate or interval	TTFB	Latency	
5.6.1	Asset Tracking and Management	5G positioning service area - Outdoor	10-30m Horizontal	5 m/s	99 %	300s-1day			✓
		Enhanced positioning - Outdoor	1m Horizontal		99 %	1s	1s in enhanced positioning area		
5.7.1	UAV (Data analysis)	5G positioning service area - Outdoor	0.1m Horizontal 0.1m Vertical	0.5 m/s 2 deg.	99 %		10s		✓
5.7.2	UAV (Remote control)	5G positioning service area - Outdoor	0.5m Horizontal 0.3m Vertical		99 %			150ms	✓
		Enhanced positioning area - Outdoor	0.5m Horizontal 0.1m Vertical		99.9 %			150ms	✓



5G_HYPOS - Study on positioning use cases [2]

Use cases		Potential requirements per use cases							Integrity Study Item
		Environment of Use	Position Accuracy	Velocity	Avail.	Update rate or interval	TTFF	Latency	
5.8.1	Support multiple different location service	5G positioning service area - Outdoor	2m Horizontal		90 %		10s	1s	✓
		Enhanced positioning area - Indoor	0.1m Horizontal		99 %		10s	1s	
5.8.2	Support location method negotiation	5G positioning service area Outdoor/Indoor							✓
Note: most use cases also feature potential requirements on modes of operation, intended for the UE, the Network or for the 5G system.									

