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| 3GPP TR 38.882 V18.0.0 (2022-06) |
| Technical Report |
| 3rd Generation Partnership Project;Technical Specification Group Radio Access Network;Study on requirements and use cases for network verifiedUE location for Non-Terrestrial-Networks (NTN) in NR(Release 18) |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document analyses the regulatory requirements (e.g. accuracy, privacy, reliability, latency) in terms of UE location service for a set of use cases/services (i.e. emergency call, lawful intercept, public warning, charging/billing). It identifies the possible need for network-verified UE location specification support in Rel-18.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 23.737: "Study on architecture aspects for using satellite access in 5G (Release 17)".

[3] 3GPP TR 22.926: "Guidelines for Extraterritorial 5G Systems; Stage 1".

[4] 3GPP S3i200056: "Response LS on the "LS OUT on Location of UEs and associated key issues""(Contact: Rogers).

[5] 3GPP TR 22.872: Study on positioning use cases; Stage 1 (Release 16).

[6] Standardisation Request for E112 (as regards hand-held mobile phones in support of Directive 2014/53/EU).

[7] "Indoor Location Accuracy Benchmarks", retrieved from [https://www.fcc.gov/public-safety-and-homeland-security/policy-and-licensing-division/911-services/general/location-accuracy-indoor-benchmarks on 20.10.2020](https://www.fcc.gov/public-safety-and-homeland-security/policy-and-licensing-division/911-services/general/location-accuracy-indoor-benchmarks%20on%2020.10.2020).

[8] 3GPP S3i210282 "Reply LS on UE location aspects in NTN" (contact = Tencastle)

[9] R2-2101150 Summary of [Post112-e][115][NTN] the Email Discussion on LCS for NTN, Fraunhofer IIS, Fraunhofer HHI.

[10] ETSI TS 103 625: "Transporting Handset Location to PSAPs for Emergency Calls - Advanced Mobile Location".

[11] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast) (See Official Journal of the European Union, Volume 61, 17th December 2018), https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1568104145936&uri=CELEX:32018L1972.

[[12] Official Journal C 329, 04/11/1996](http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=OJ:C:1996:329:TOC) p. 0001 - 0006 Council Resolution of 17 January 1995 on the lawful interception of telecommunications.

[[13] REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)](http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=OJ:C:1996:329:TOC) .

[14] 3GPP "SID on Study on expanded and improved NR positioning", RP-213588

[15] 3GPP TS 38.300 "NR; NR and NG-RAN Overall description; Stage-2".

[16] 3GPP TS 22.261 "Service requirements for the 5G system".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**example:** text used to clarify abstract rules by applying them literally.

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

EMS Emergency Services

GNSS Global Navigation Satellite Systems

GSO Geo Synchronous Orbit

HAPS High Altitude Platform System

LI Lawful Intercept

NAS Non Access Stratum

NGSO Non Geo Synchronous Orbit

NNSF NAS Node Selection Function

NTN Non-Terrestrial Network

PLMN Public Land Mobile Network

PWS Public Warning System

RAT Radio Access Technology

SMS Short Message Service

TN Terrestrial network

UE User Equipment

# 4 Use cases

## 4.1 Background from Rel-17 Discussions

When a UE attaches to the mobile network, the RAN selects the appropriate core network for the UE taking into account, among other things (TS 38.300 [15]):

- UE identifiers;

- UE's selected PLMN;

- UE location information (including the serving cell as known to the serving RAN node).

With NTN it is possible to deploy very large cells over large portions of a continent (possibly covering different countries), with the different core networks for the various countries connected to the same NTN RAN (MOCN network sharing scenario). In such a scenario, it may not always be possible to correctly determine the appropriate core network for a connecting UE, especially close to country borders, because the serving cell information may not be granular enough.

Furthermore, a malicious UE might "fake" its selected PLMN in order to attempt connecting to a different core network. Upon such an attempt the AMF will disconnect the UE and inform the RAN node via an appropriate NGAP cause value, so the RAN can take appropriate action on subsequent attempts by the same UE.

The UE may send GNSS measurements to the RAN over RRC, but this has at least the following drawbacks:

- In principle, just as a malicious UE could fake its selected PLMN, it could also fake its GNSS measurements;

- Sending GNSS measurements over RRC before AS security is set up raises security and privacy issues.

Because of the above, relying only on signalling GNSS measurements over RRC is not considered a viable solution to this issue.

As recommended in SA3 LS to RAN2 (R2-2204458) the location information is sent after NAS security is established. Even after NAS security establishment, user consent for obtaining UE location information may also be required depending on regional regulation and policy.

The RAN can also request radio measurements (intra-RAT neighbours, inter-RAT neighbours, WLAN, etc.) from the UE; these may be used to drive NNSF and to learn from the environment.

Some further observations:

a) At least some of the information the UE supplies to the network will have to be considered as trusted, to avoid extreme conclusions (at least RRC measurements cannot be faked);

b) Core networks connecting to the same shared RAN will always require some degree of common coordination / configuration: this is typically the case for network sharing (especially MOCN). For NTN, this may include e.g. specific timer settings/behaviour for UE connection attempts;

c) Due to mere traffic load considerations, it may not be desirable to cover whole portions of a continent, including multiple countries, with a single cell. Therefore, in real deployments the served cell information may typically be more granular than in the extreme case envisaged so far.

The above has been deemed sufficient to mitigate the issue in Rel-17.

## 4.2 NTN vs. Terrestrial Regulatory Requirements

A 5G system with satellite access shall be able to determine a UE's location in order to provide service (e.g. route traffic, support emergency calls) in accordance with the governing national or regional regulatory requirements applicable to that UE. (Sec. 6.3.2.3 of TS 22.261 [16]).

Because of this, even when providing services over entire continents with NTN, there is no "globally harmonized" set of requirements that overrules local ones. This is also valid for UE location information. In this respect, there is no difference between NTN and terrestrial networks.

Because of the above, for NTN the same required granularity for UE location information estimated via GNSS should be considered as for terrestrial networks.

## 4.3 Regulatory support of services in NTN

Network operators of 3GPP defined non-terrestrial network, have to know reliably the location information of a UE attached to the network in order to select the appropriate core network. Once the appropriate core network has been selected for a UE, it is possible to support some services subject to national regulations or other operational constraints.

In TR 23.737 [2], the list of such services has been identified in key issue #10:

- Public Warning System (PWS)

- Lawful interception (LI)

- Emergency services (EMS)

- Charging and Tariff notifications

In TR 22. 926 [3], it has been identified that "*To support regulated services and features (e.g. Public Warning System, Charging and Billing, Emergency calls, Lawful Intercept, Data Retention Policy in cross-border scenarios and international regions, Network access), 3GPP networks should have the capability to locate each UE in a reliable manner and determine the policy that applies to their operation depending on their location and/or context.*"

Furthermore, in [4], it is pointed out that "*any solution addressing extraterritorial (e.g. international maritime zone and aeronautical) use cases should provide means to notify the HPLMN on roaming in and out of those areas, including the cases when the serving PLMN has not changed.*"

Relying only on the GNSS based location information reported by the UE is not considered reliable by SA3-LI [4].

The UE reported location information (for example determined with its GNSS receiver), could be erroneous due to intentional (e.g. maliciously tampering by user or by 3rd party) or unintentional (e.g. interference) causes, hence it cannot be considered trusted by network operators.

Already 3GPP has defined a network based functionality to verify the reported UE location with the identifier of the serving cell. However, radio cells in non-terrestrial networks, may be larger than the ones of terrestrial networks and may cover borders between two or more countries. Therefore, such Cell Id information may not be sufficient to discriminate the country in which the UE is located.

It is expected that solutions combining both UE reported GNSS information and network based information for verification of UE location can improve the reliability of core network selection in non-terrestrial networks. This is important for

- Services subject to national regulations or other operational constraints. (e.g. Public Warning System (PWS), Lawful interception (LI), Emergency services (EMS), Charging and Tariff notifications).

- Cases where the UE reported location information (for example determined with its GNSS receiver), could be erroneous due to intentional (e.g. maliciously tampering by user or by 3rd party) or unintentional (e.g. interference) causes.

- NTN radio cells larger than terrestrial network radio cells and possibly covering borders between two or more countries.

In order to define an appropriate network based solution to verify UE location, it is necessary to determine requirements for the verification accuracy. Note that these requirements should not be assumed to be the same as the regulatory requirements applicable to the UE location in terms of Accuracy, Reliability (related to law enforcement and liability), Latency and Privacy as identified in Annex A.

As identified in annex A.2, SA3-LI recommends in S3i200056 [4] that "*The logical location shall unambiguously map to the geographical area of the UE physical location. Granularity of such geographical areas needs to be able to provide network location accuracy comparable with terrestrial networks.*"

In terrestrial networks, verification is based on Cell Id and hence, the targeted granularity is related to cell size. Similar granularity should be considered for NTN. Terrestrial macro cell size is assumed to be up to 5-10 km diameter.

## 4.4 LCS and NTN

Most UE positioning functionality is typically UE-associated, i.e., it assumes that a UE context is present for the UE being positioned. This means that the UE itself has already completed the initial access procedures. Because of this, all observations and mitigations already discussed in Rel-17 are still relevant and applicable.

# 5 Recommendations

In this study, we have identified the need to define a network based solution which aims at verifying the reported UE location information.

The verification should be performed independently from the location information reported by UE.

The UE location information for the study is considered verified if the reported UE location is consistent with the network based assessment to within 5-10 km (similar to terrestrial network macro cell size), enabling country discrimination and selection of an appropriate core network in order to support all the regulatory services (i.e. emergency call, lawful intercept, public warning, charging/billing).

The solution should not impact significantly the latency of the targeted services nor infringe privacy requirements that apply to the UE location.

The study in [RAN2,RAN1,RAN3], which will study and evaluate solutions for the network to verify UE reported location information, shall consider the following aspects:

- The scenario of single satellite (or HAPS) in view by the UE at a time is considered with higher priority.

- Multiple satellite (or HAPS) in view by the UE may be considered if time allows

- Assume that the UE is attached to a network (so that its context has been set up in the network) for the purpose of positioning

- Different solutions or positioning methods for NGSO, GSO or HAPS are not precluded

- When considering solutions based on positioning methods, existing 3GPP defined RAT dependent positioning methods shall be considered as baseline. Other methods are not precluded.

- Solutions using existing NG-RAN architecture and procedures shall be considered

Annex A (informative):
Requirements for UE location verification

## A.1 Emergency calls

[It refers to a](https://www.lawinsider.com/dictionary/emergency-call) telephone request or text message request for emergency services (e.g. police, fire departments, or other first responders) which requires immediate action to prevent loss of life, reduce bodily injury, prevent or reduce loss of property and respond to other emergency situations determined by local policy.

*Accuracy*

Accuracy requirements for emergency calls have been identified in TR 22.872 [5], where the position accuracy is required to be [50m Horizontal, 3m Vertical] which are the most demanding of the regulated services in terms of accuracy requirements. This is in line with the requirements of two major regulatory bodies and summarized as follows:

Table A.1-1: Accuracy requirements for emergency calls

|  |  |
| --- | --- |
| Regulatory body | Accuracy requirements |
| EC [6]  | "capability to achieve a horizontal position error of maximum 5 metres in open sky conditions and maximum 25 metres in urban canyon conditions with a confidence level of 95 % (2s coverage factor), where open sky conditions and urban canyon conditions are as defined, respectively, in points 2.1.8 (Figure 1) and 2.2.4.2 (Figure 3) of Annex VI to Delegated Regulation (EU) 2017/793"The European directive is based on an assumption of use of GNSS as positioning technology as specified in ETSI TS 103 625 [10]. |
| FCC [7] | In 2020, the FCC specifies a 50-meter horizontal accuracy or provide a dispatchable location for 70 percent of all wireless 911 calls, which increases to 80 percent of all calls in 2021. From 2021 onwards, an additional requirement to achieve an accuracy with ±3m is applies in addition. |

*Reliability*

In this case, the mobile network operator may be liable for the provision of a "reliable" UE location (either network verified or network provided) that will be the basis to the organisation of personal assistance or rescue.

*Latency*

The delay to determine the UE location should be minimised to ensure timely assistance or rescue,

While a typical call set-up is less than a second, the delay for UE location determination should not impact significantly this communication set-up time.

## A.2 Lawful intercept (LI)

As a legally sanctioned official access to private communications, Lawful Interception (LI) is a security process in which a service provider or network operator collects and provides law enforcement officials with intercepted communications of private individuals or organizations.

LI implementation is required for example by the European Council Resolution from 1995 [12] which allows for LI to prevent crime, including fraud and terrorism.

*Accuracy*

For lawful intercept, SA3-LI recommends in [4] that "*The logical location shall unambiguously map to the geographical area of the UE physical location. Granularity of such geographical areas needs to be able to provide network location accuracy comparable with terrestrial networks.*"

Given that for such use cases, the location accuracy in terrestrial networks is mostly based on cell ID, it directly relates to the typical cell size. Hence a macro cell size granularity (accepted granularity by SA3-LI) should be sufficient to detect country border crossings.

*Reliability*

In this case, Law enforcement applies, and therefore the mobile network operator shall be able to provide a "reliable" UE location (either network verified or network provided).

In S3i210282 [8], it is noted that "*any method which relies solely on UE-generated location information is unlikely to be considered reliable for network selection purposes. Therefore, a method such as GNSS/A-GNSS cannot be considered as reliable or trusted unless the information provided by the UE can be verified by the network.*"

*Latency*

No regulatory requirement have been identified for this. Despite this, NTN location determination should not significantly impact the LI service as provided by an TN network.

## A.3 Public warning Service (PWS)

PWS is usually realised (based on country regulator rules) by CellBroadcast, which provides a direct selectivity by cellID (sends the message to all devices registered in a base station) but can reach sector accuracy (each of the antenna emitters in the same cellID) to provide geographical accuracy. E.g. to alert half of the city that is getting an imminent flood bout not the other half which is on a higher positions.

Alternatively Location-Based SMS may be used, and same selectivity shall be employed. That will rely on reliable location, and at least cellID is expected to be necessary.

In its Directive (EU) 2018/1972 [11], the European Union states in (293) that

"*Diverging national law has developed in relation to the transmission by electronic communications services of public warnings regarding imminent or developing major emergencies and disasters. In order to approximate law in that area, this Directive should therefore provide that, when public warning systems are in place, public warnings should be transmitted by providers of mobile number-based interpersonal communication services to all end-users concerned. The end-users concerned should be considered to be those who are located in the geographic areas potentially being affected by imminent or developing major emergencies and disasters during the warning period, as determined by the competent authorities.*"

*Accuracy*

One can assume that the service should be provided over the targeted area with an equivalent granularity as obtained in terrestrial networks that is cell size related. Hence a macro cell size granularity should be sufficient.

*Reliability*

There are no explicit regulatory requirement for this. Despite this, NTN location determination should follow same reliability requirements as the PWS systems.

*Latency*

No regulatory requirement have been identified for this. Despite this, NTN location determination should not impact significantly the PWS service as provided by an TN network.

## A.4 Charging and Tariff notifications

Tariff refer to the set of parameters defining the applied charge for the use of a particular bearer /session / service.

*Accuracy*

As per Public warning service, knowing the context of the UE (country or aeronautical/maritime) is sufficient for charging and tariff notifications.

One can assume that the accuracy of the UE location service should be similar to the one in typical terrestrial mobile networks that is cell size related. Hence a macro cell size granularity should be sufficient.

*Reliability*

It is the responsibility of the Mobile network operator to ensure via reliable methods that the UE is effectively in a given context for appropriate charging/billing.

*Latency*

No regulatory requirement have been identified for this. Despite this, NTN location determination should not significantly impact the charging/tariff service as provided by an TN network.

## A.5 All regulated services

*Privacy*

In [13], it is stated in article (71) that "*The data subject should have the right not to be subject to a decision, which may include a measure, evaluating personal aspects relating to him or her which is based solely on automated processing and which produces legal effects concerning him or her or similarly significantly affects him or her, such as automatic refusal of an online credit application or e-recruiting practices without any human intervention. Such processing includes 'profiling' that consists of any form of automated processing of personal data evaluating the personal aspects relating to a natural person, in particular to analyse or predict aspects concerning the data subject's performance at work, economic situation, health, personal preferences or interests, reliability or behaviour, location or movements, where it produces legal effects concerning him or her or similarly significantly affects him or her.* "

Therefore the UE location shall be protected to preserve the privacy of the users.

In [13], it is further stated in article (71) that "*However, decision-making based on such processing, including profiling, should be allowed where expressly authorised by Union or Member State law to which the controller is subject, including for fraud and tax-evasion monitoring and prevention purposes conducted in accordance with the regulations, standards and recommendations of Union institutions or national oversight bodies and to ensure the security and reliability of a service provided by the controller, or necessary for the entering or performance of a contract between the data subject and a controller, or when the data subject has given his or her explicit consent.*"

Therefore, the user location can be processed if it is to comply with regulations for example in order to provide safety to the citizen (emergency calls, public warning services), to prevent crimes (Lawful intercept) or frauds (Charging and Tariff notifications).

Annex B (informative):
Change history

|  |
| --- |
| Change history |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 06-2022 | RP-96 | RP-221847 |  |  |  | first version of the TR, created at RAN #96 | 0.1.0 |
| 06-2022 | RP-96 | RP-221859 |  |  |  |  | 0.2.0 |
| 06-2022 | RP-96 | RP-221860 |  |  |  |  | 0.3.0 |
| 06-2022 | RP-96 | RP-221875 |  |  |  | provided for approval to RAN #96 | 1.0.0 |
| 06-2022 | RP-96 | - | - | - | - | approved by RAN #96 and put under change control | 18.0.0 |