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Technical Specification

**Universal Mobile Telecommunications System (UMTS);
Requirements for support of
Assisted Global Positioning System (A-GPS);
Frequency Division Duplex (FDD)
(3GPP TS 25.171 version 6.0.0 Release 6)**

Reference

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Contents

Foreword

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

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1 Scope

The present document establishes the minimum performance requirements for A-GPS for FDD mode of UTRA for the User Equipment (UE).

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 TS 25.101: "User Equipment (UE) radio transmission and reception (FDD)".

[2] 3GPP TS 25.104: "Base Station (BS) radio transmission and reception (FDD)".

[3] 3GPP TS 34.121: "Terminal Conformance Specification, Radio Transmission and Reception (FDD)".

[4] 3GPP TS 25.331: "Radio Resource Control (RRC) protocol specification".

[5] 3GPP TS 25.302: "Services provided by the physical layer".

[6] 3GPP TS 25.215: "Physical layer; Measurements (FDD)".

[7] ETSI TR 102 273-1-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 1: Uncertainties in the measurement of mobile radio equipment characteristics; Sub-part 2: Examples and annexes".

[8] Navstar GPS Space Segment/Navigation User Interfaces, ICD-GPS 200, Rev. C.

[9] P. Axelrad, R.G. Brown, "GPS Navigation Algorithms", in Chapter 9 of "Global Positioning System: Theory and Applications", Volume 1, B.W. Parkinson, J.J. Spilker (Ed.), Am. Inst. of Aeronautics and Astronautics Inc., 1996.

[10] S.K. Gupta, "Test and Evaluation Procedures for the GPS User Equipment", ION-GPS Red Book, Volume 1, p. 119.

3 Definitions, symbols, abbreviations and test tolerances

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TS 25.101 [1], 3GPP TS 25.104 [2] and the following apply:

Horizontal Dilution Of Precision (HDOP): measure of position determination accuracy that is a function of the geometrical layout of the satellites used for the fix, relative to the receiver antenna

Node B: logical node responsible for radio transmission / reception in one or more cells to/from the User Equipment. Terminates the Iub interface towards the RNC

3.2 Symbols

Void

3.3 Abbreviations

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

A-GPS	Assisted - Global Positioning System
AWGN	Additive White Gause Noise
CPICH	Common Pilot CHannel
DCH	Dedicated CHannel
DPCH	Dedicated Physical CHannel
DUT	Device Under Test
ECEF	Earth Centred, Earth Fixed
FACH	Fast Access CHannel
FDD	Frequency Division Duplex
GPS	Global Positioning System
GSS	GPS System Simulator
HDOP	Horizontal Dilution Of Precision
LOS	Line Of Sight
PICH	Paging Indicator CHannel
RRC	Radio Resource Control
RSCP	Received Signal Code Power
SFN	System Frame Number
SMLC	Standalone Mobile Location Center
SRNC	Serving Radio Network Controller
SS	FDD System simulator
TDD	Time Division Duplex
TLM	TeLeMetry word. It contains an 8-bits preamble (10001011)
TOW	Time Of Week
TTFF	Time To First Fix
UE	User Equipment
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
WLS	Weighted Least Square

3.4 Test tolerances

The requirements given in the present document make no allowance for measurement uncertainty. The test specification 3GPP TS 34.121 [3] defines test tolerances. These test tolerances are individually calculated for each test. The test tolerances are then added to the limits in the present document to create test limits. The measurement results are compared against the test limits as defined by the shared risk principle.

Shared Risk is defined in ETR 273-1-2 [7], subclause 6.5.

4 General

4.1 Introduction

The present document defines the minimum performance requirements for both UE based and UE assisted FDD A-GPS terminals.

4.2 Measurement parameters

4.2.1 UE based A-GPS measurement parameters

In case of UE-based A-GPS, the measurement parameters are contained in the RRC UE POSITIONING POSITION ESTIMATE INFO IE. The measurement parameter in case of UE-based A-GPS is the horizontal position estimate reported by the UE and expressed in latitude/longitude.

4.2.2 UE assisted A-GPS measurement parameters

In case of UE-assisted A-GPS, the measurement parameters are contained in the RRC UE POSITIONING GPS MEASURED RESULTS IE. The measurement parameters in case of UE-assisted A-GPS are the UE GPS Code Phase measurements, as specified in 3GPP TS 25.302 [5] and 3GPP TS 25.215 [6]. The UE GPS Code Phase measurements are converted into a horizontal position estimate using the procedure detailed in Annex F.

4.3 Response time

Max Response Time is defined as the time starting from the moment that the UE has received the final RRC measurement control message containing reporting criteria different from "No Reporting" sent before the UE sends the measurement report containing the position estimate or the GPS measured result, and ending when the UE starts sending the measurement report containing the position estimate or the GPS measured result on the Uu interface. The response times specified for all test cases are Time-to-First-Fix (TTFF) unless otherwise stated, i.e. the UE shall not re-use any information on GPS time, location or other aiding data that was previously acquired or calculated and stored internally in the UE. A dedicated test message 'RESET UE POSITIONING STORED INFORMATION' has been defined for the purpose of deleting this information and is detailed in subclause B.1.10.

4.4 Time assistance

Time assistance is the provision of GPS time to the UE from the network via RRC messages. Currently two different GPS time assistance methods can be provided by the network.

a) Coarse time assistance is always provided by the network and provides current GPS time to the UE. The time provided is within ±2 seconds of GPS system time. This allows the GPS time to be known within one GPS navigation data sub-frame.

b) Fine time assistance is optionally provided by the network and adds the provision to the UE of the relationship between the GPS system time and the current UTRAN time. The accuracy of this relationship is ±10 µs of the actual relationship. This addresses the case when the network can provide an improved GPS time accuracy.

The time of applicability of time assistance is the beginning of the System Frame of the message containing the GPS Reference time.

4.4.1 Use of fine time assistance

The use of fine time assistance to improve the GPS performance of the UE is optional for the UE, even when fine time assistance is signalled by the network. Thus, there are a set minimum performance requirements defined for all UEs and additional minimum performance requirements that are valid for fine time assistance capable UEs only. These requirements are specified in subclause 5.1.2.

4.5 RRC states

The minimum A-GPS performance requirements are specified in clause 5 for different RRC states that include Cell_DCH and Cell_FACH. Cell_PCH and URA_PCH states are for further study. The test and verification procedures are separately defined in annex B.

4.6 2D position error

The 2D position error is defined by the horizontal difference in meters between the ellipsoid point reported or calculated from the UE Measurement Report and the actual position of the UE in the test case considered.

5 A-GPS minimum performance requirements

The A-GPS minimum performance requirements are defined by assuming that all relevant and valid assistance data is received by the UE in order to perform GPS measurements and/or position calculation. This clause does not include nor consider delays occurring in the various signalling interfaces of the network.

In the following subclauses the minimum performance requirements are based on availability of the assistance data information and messages defined in annexes D and E.

The requirements in CELL_PCH and URA_PCH states are for further study.

5.1 Sensitivity

A sensitivity requirement is essential for verifying the performance of A-GPS receiver in weak satellite signal conditions. In order to test the most stringent signal levels for the satellites the sensitivity test case is performed in AWGN channel. This test case verifies the performance of the first position estimate, when the UE is provided with coarse or fine time assistance.

5.1.1 Coarse time assistance

In this test case 8 satellites are generated for the terminal. AWGN channel model is used.

Table 1: Test parameters

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GPS Time assistance accuracy	seconds	±2
GPS Signal for one satellites	dBm	-142
GPS Signal for remaining satellites	dBm	-147

5.1.1.1 Minimum Requirements (Coarse time assistance)

The position estimates shall meet the accuracy and response time specified in table 2.

Table 2: Minimum requirements (coarse time assistance)

Success rate	2-D position error	Max response time
95 %	100 m	20 s

5.1.2 Fine time assistance

This requirement is only valid for fine time assistance capable UEs. In this requirement 8 satellites are generated for the terminal. AWGN channel model is used.

Table 3: Test parameters for fine time assistance capable terminals

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GPS Time assistance accuracy	μs	±10
GPS Signal for all satellites	dBm	-147

5.1.2.1 Minimum Requirements (Fine time assistance)

The position estimates shall meet the accuracy and response time requirements in table 4.

Table 4: Minimum requirements for fine time assistance capable terminals

Success rate	2-D position error	Max response time
95 %	100 m	20 s

5.2 Nominal Accuracy

Nominal accuracy requirement verifies the accuracy of A-GPS position estimate in ideal conditions. The primarily aim of the test is to ensure good accuracy for a position estimate when satellite signal conditions allow it. This test case verifies the performance of the first position estimate.

In this requirement 8 satellites are generated for the terminal. AWGN channel model is used.

Table 5: Test parameters

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GPS Time assistance accuracy	seconds	±2
GPS Signal for all satellites	dBm	-130

5.2.1 Minimum requirements (nominal accuracy)

The position estimates shall meet the accuracy and response time requirements in table 6.

Table 6: Minimum requirements

Success rate	2-D position error	Max response time
95 %	30 m	20 s

5.3 Dynamic Range

The aim of a dynamic range requirement is to ensure that a GPS receiver performs well when visible satellites have rather different signal levels. Strong satellites are likely to degrade the acquisition of weaker satellites due to their cross-correlation products. Hence, it is important in this test case to keep use AWGN in order to avoid loosening the requirements due to additional margin because of fading channels. This test case verifies the performance of the first position estimate.

In this requirement 6 satellites are generated for the terminal. AWGN channel model is used.

Table 7: Test parameters

Parameters	Unit	Value
Number of generated satellites	-	6
HDOP Range	-	1.4 to 2.1
GPS Time assistance accuracy	seconds	±2
Propagation conditions	-	AWGN
GPS Signal for 1st satellite	dBm	-129
GPS Signal for 2nd satellite	dBm	-135
GPS Signal for 3rd satellite	dBm	-141
GPS Signal for 4th satellite	dBm	-147
GPS Signal for 5th satellite	dBm	-147
GPS Signal for 6th satellite	dBm	-147

5.3.1 Minimum requirements (dynamic range)

The position estimates shall meet the accuracy and response time requirements in table 8.

Table 8: Minimum requirements

Success rate	2-D position error	Max response time
95 %	100 m	20 s

5.4 Multi-Path scenario

The purpose of the test case is to verify the receiver's tolerance to multipath while keeping the test setup simple. This test case verifies the performance of the first position estimate.

In this requirement 5 satellites are generated for the terminal. Two of the satellites have one tap channel representing Line-Of-Sight (LOS) signal. The three other satellites have two-tap channel, where the first tap represents LOS signal and the second reflected and attenuated signal as specified in Case G1 in subclause C.2.2.

Table 9: Test parameters

Parameters	Unit	Value
Number of generated satellites (Satellites 1, 2 unaffected by multipath) (Satellites 3, 4, 5 affected by multipath)	-	5
GPS Time assistance accuracy	seconds	±2
HDOP Range	-	1.8 to 2.5
Satellite 1, 2 signal	dBm	-130
Satellite 3, 4, 5 signal	dBm	LOS signal of -130 dBm, multipath signal of -136 dBm

5.4.1 Minimum Requirements (multi-path scenario)

The position estimates shall meet the accuracy and response time requirements in table 10.

Table 10: Minimum requirements

Success rate	2-D position error	Max response time
95 %	100 m	20 s

5.5 Moving scenario and periodic update

The purpose of the test case is to verify the receiver's capability to produce GPS measurements or location fixes on a regular basis, and to follow when it is located in a vehicle that slows down, turns or accelerates. A good tracking performance is essential for a certain location services. A moving scenario with periodic update is well suited for verifying the tracking capabilities of an A-GPS receiver in changing UE speed and direction. In the requirement the UE moves on a rectangular trajectory, which imitates urban streets. AWGN channel model is used. This test is not performed as a Time to First Fix (TTFF) test.

In this requirement 5 satellites are generated for the terminal. The UE is requested to use periodical reporting with a reporting interval of 2 seconds.

The UE moves on a rectangular trajectory of 940 m by 1 440 m with rounded corner defined in figure 1. The initial reference is first defined followed by acceleration to final speed of 100 km/h in 250 m. The UE then maintains the speed for 400 m. This is followed by deceleration to final speed of 25 km/h in 250 m. The UE then turn 90 degrees with turning radius of 20 m at 25 km/h. This is followed by acceleration to final speed of 100 km/h in 250 m. The sequence is repeated to complete the rectangle.

Table 11: Trajectory Parameters

Parameter	Distance (m)	Speed (km/h)
l_{11}, l_{15}, l_{21}, l_{25}	20	25
l_{12}, l_{14}, l_{22}, l_{24}	250	25 to 100 and 100 to 25
l_{13}	400	100
l_{23}	900	100

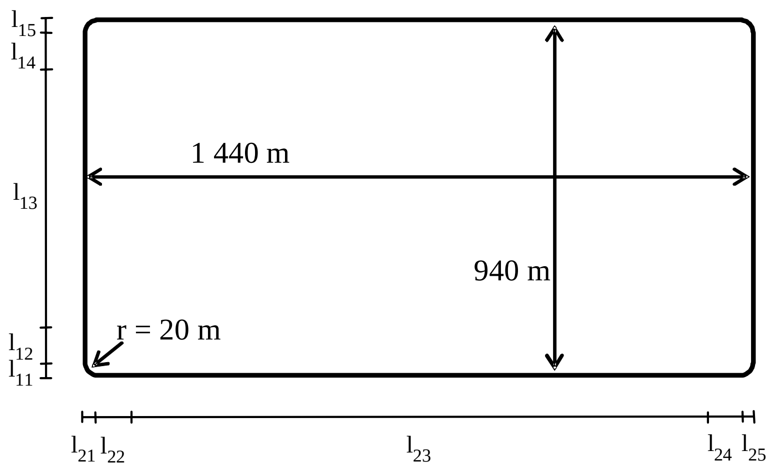

Figure 1: Rectangular trajectory of the moving scenario and periodic update test case

Table 12: Test Parameters

Parameters	Unit	Value
Number of generated satellites	-	5
HDOP Range	-	1.8 to 2.5
Propagation condition	-	AWGN
GPS signal for all satellites	dBm	-130

5.5.1 Minimum Requirements (moving scenario and periodic update)

The position estimates shall meet the accuracy requirement of table 13 with the periodical reporting interval defined in table 13 after the first reported position estimates.

NOTE: In the actual testing the UE may report error messages until it has been able to acquire GPS measured results or a position estimate. The test equipment shall only consider the first measurement report different from an error message as the first position estimate in the requirement in table 13.

Table 13: Minimum requirements

Success Rate	2-D position error	Periodical reporting interval
95 %	100 m	2 s

Annex A (normative): Test cases

A.1 Purpose of annex

This annex specifies test specific parameters for some of the functional requirements in clauses 4 to 8. The tests provide additional information to how the requirements should be interpreted for the purpose of conformance testing. The tests in this Annex are described such that one functional requirement may be tested in one or several test and one test may verify several requirements. Some requirements may lack a test.

The conformance tests are specified in 3GPP TS 34.121 [3]. Statistical interpretation of the requirements is described in clause A.2.

A.2 Requirement classification for statistical testing

Requirements in the present document are either expressed as absolute requirements with a single value stating the requirement, or expressed as a success rate. There are no provisions for the statistical variations that will occur when the parameter is tested.

Annex A outlines the test in more detail and lists the test parameters needed. The test will result in an outcome of a test variable value for the DUT inside or outside the test limit. Overall, the probability of a "good" DUT being inside the test limit(s) and the probability of a "bad" DUT being outside the test limit(s) should be as high as possible. For this reason, when selecting the test variable and the test limit(s), the statistical nature of the test is accounted for.

When testing a parameter with a statistical nature, a confidence level has to be set. The confidence level establishes the probability that a DUT passing the test actually meets the requirement and determines how many times a test has to be repeated. The confidence levels are defined for the final tests in 3GPP TS 34.121 [3].

Annex B (normative): Test conditions

B.1 General

This annex specifies the additional parameters that are needed for the test cases specified in clauses 4 and 5 and applies to all tests unless otherwise stated.

B.1.1 Parameter values

Additionally, amongst all the listed parameters (see annex E), the following values for some important parameters are to be used in the measurement control message.

Table B.1: Parameter values

Information element	Value - TTFF tests	Value - Periodic tests
Measurement Reporting Mode	Periodical reporting	Periodical reporting
Amount of reporting	1	Infinite (see note)
Reporting interval	20 000 ms	2 000 ms
Horizontal accuracy	50 m	50 m
Vertical accuracy	100 m	100 m
NOTE: Infinite means during the complete test time.		

In the Sensitivity test case with Fine Time Assistance, the following parameter values are used.

Table B.2: Parameters for Fine Time Assistance test

Information element	Value
TUTRAN-GPS drift rate	0
SFN-TOW Uncertainty	lessThan10

B.1.2 Time assistance

For every Test Instance in each TTFF test case, the IE GPS TOW ms shall have a random offset, relative to GPS system time, within the allowed uncertainty of Coarse Time Assistance defined in subclause 4.4. This offset value shall have a uniform random distribution.

In addition, for every Fine Time Assistance Test Instance the IE UTRAN GPS timing of cell frames shall have a random offset, relative to the true value of the relationship between the two time references, within the allowed uncertainty of Fine Time Assistance defined in subclause 4.4. This offset value shall have a uniform random distribution.

For the Moving Scenario and Periodic Update Test Case the IE values shall be set to the nominal values.

B.1.3 GPS Reference Time

For every Test Instance in each TTFF test case, the GPS reference time shall be advanced so that, at the time the fix is made, it is at least 2 minutes later than the previous fix.

B.1.4 Reference and UE locations

There is no limitation on the selection of the reference location, consistent with achieving the required HDOP for the Test Case. For each test instance the reference location shall change sufficiently such that the UE shall have to use the new assistance data. The uncertainty of the semi-major axis is 3 km. The uncertainty of the semi-minor axis is 3 km. The orientation of major axis is 0 degrees. The uncertainty of the altitude information is 500 m. The confidence factor is 68 %.

For every Test Instance in each TTFF test case, the UE location shall be randomly selected to be within 3 km of the Reference Location. The Altitude of the UE shall be randomly selected between 0 m to 1 000 m above WGS-84 reference ellipsoid. These values shall have uniform random distributions.

B.1.5 Satellite constellation

The satellite constellation shall consist of 24 satellites. Almanac assistance data shall be available for all these 24 satellites. At least 9 of the satellites shall be visible to the UE (that is above 15 degrees elevation with respect to the UE). Other assistance data shall be available for 9 of these visible satellites. In each test, signals are generated for only a sub-set of these satellites for which other assistance data is available. The number of satellites in this sub-set is specified in the test. The HDOP for the test shall be calculated using this sub-set of satellites. The selection of satellites for this sub-set shall be random and consistent with achieving the required HDOP for the test.

B.1.6 Atmospheric delays

Typical Ionospheric and Tropospheric delays shall be simulated and the corresponding values inserted into the Ionospheric Model IEs.

B.1.7 UTRA Frequency and frequency error

In all test cases the UTRA frequency used shall be the mid range for the UTRA operating band. The UTRA frequency with respect to the GPS carrier frequency shall be offset by +0.025 PPM.

B.1.8 Information elements

The information elements that are available to the UE in all the test cases are listed in annex E.

B.1.9 GPS signals

The GPS signal is defined at the A-GPS antenna connector of the UE. For UE with integral antenna only, a reference antenna with a gain of 0 dBi is assumed.

B.1.10 RESET UE POSITIONING STORED INFORMATION Message

In order to ensure each Test Instance in each TTFF test is performed under Time to First Fix (TTFF) conditions, a dedicated test signal (*RESET UE POSITIONING STORED INFORMATION*) shall be used.

When the UE receives the '*RESET UE POSITIONING STORED INFORMATION*' signal, with the IE *UE POSITIONING TECHNOLOGY* set to *AGPS* it shall:

- discard any internally stored GPS reference time, reference location, and any other aiding data obtained or derived during the previous test instance (e.g. expected ranges and Doppler);

- accept or request a new set of reference time or reference location or other required information, as in a TTFF condition;

- calculate the position or perform GPS measurements using the 'new' reference time or reference location or other information.

B.2 Test conditions for CELL_DCH

For further study.

B.3 Test conditions for CELL_FACH

For further study.

B.4 Test conditions for CELL_PCH

For further study.

B.5 Test conditions for URA_PCH

For further study.

Annex C (normative): Propagation conditions

C.1 General

Void

C.2 Propagation Conditions

C.2.1 Static propagation conditions

The propagation for the static performance measurement is an Additive White Gaussian Noise (AWGN) environment. No fading and multi-paths exist for this propagation model.

C.2.2 Multi-path Case G1

Doppler frequency difference between direct and reflected signal paths is applied to the carrier and code frequencies. The Carrier and Code Doppler frequencies of LOS and multipath for GPS L1 signal are defined in table C.1.

Table C.1: Case G1

Initial relative Delay [GPS chip]	Carrier Doppler frequency of tap [Hz]	Code Doppler frequency of tap [Hz]	Relative mean Power [dB]
0	Fd	Fd / N	0
0.5	Fd - 0.1	(Fd-0.1) /N	-6
NOTE: Discrete Doppler frequency is used for each tap.			

$N = f_{GPSL1}/f_{chip}$, where f_{GPSL1} is the nominal carrier frequency of the GPS L1 signal and f_{chip} is the GPS L1 C/A code chip rate.

The initial carrier phase difference between taps shall be randomly selected between [0, 2 π]. The initial value shall have uniform random distribution.

C.2.3 Additional propagation conditions

TBD

Annex D (normative): Measurement sequence chart

D.1 General

The measurement Sequence Charts that are required in all the proposed test cases, are defined in this clause.

D.2 UE Based A-GPS Measurement Sequence Chart

D.2.1 UE Based GPS Message Sequence Normal

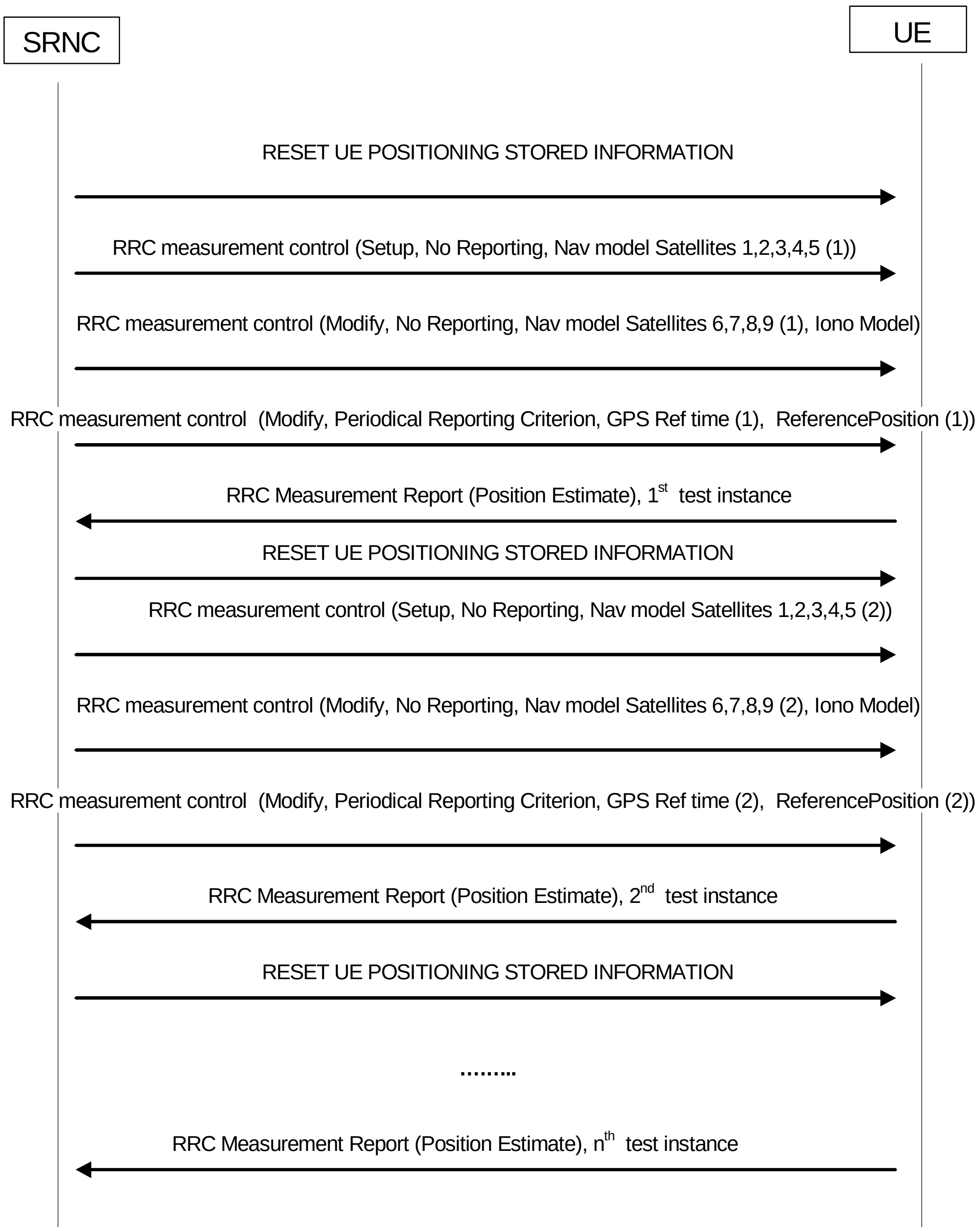

Figure D.1: UE-Based GPS Message Sequence Normal

D.2.2 UE Based GPS Message Sequence Normal for moving scenario and periodic update test case

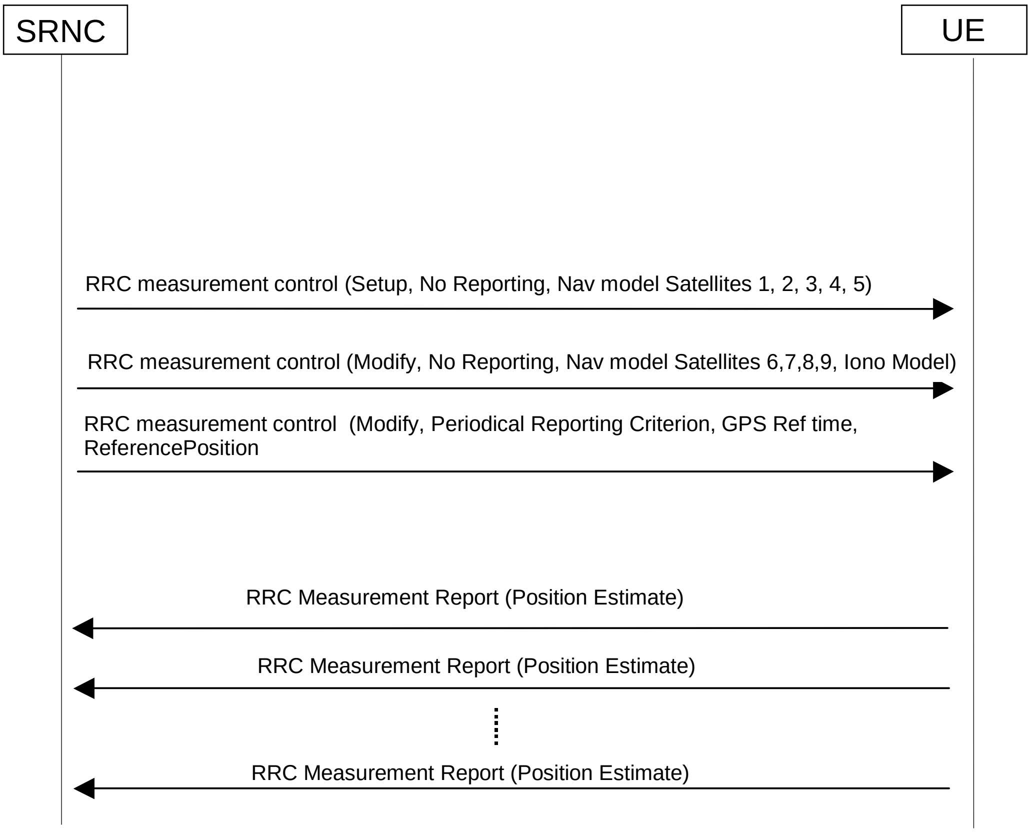

Figure D.2: UE-Based GPS Message Sequence Normal for moving scenario test case

NOTE: In the actual testing the UE may report error messages until it has been able to acquire a position estimate.

D.2.3 UE Based GPS Message Sequence Failure

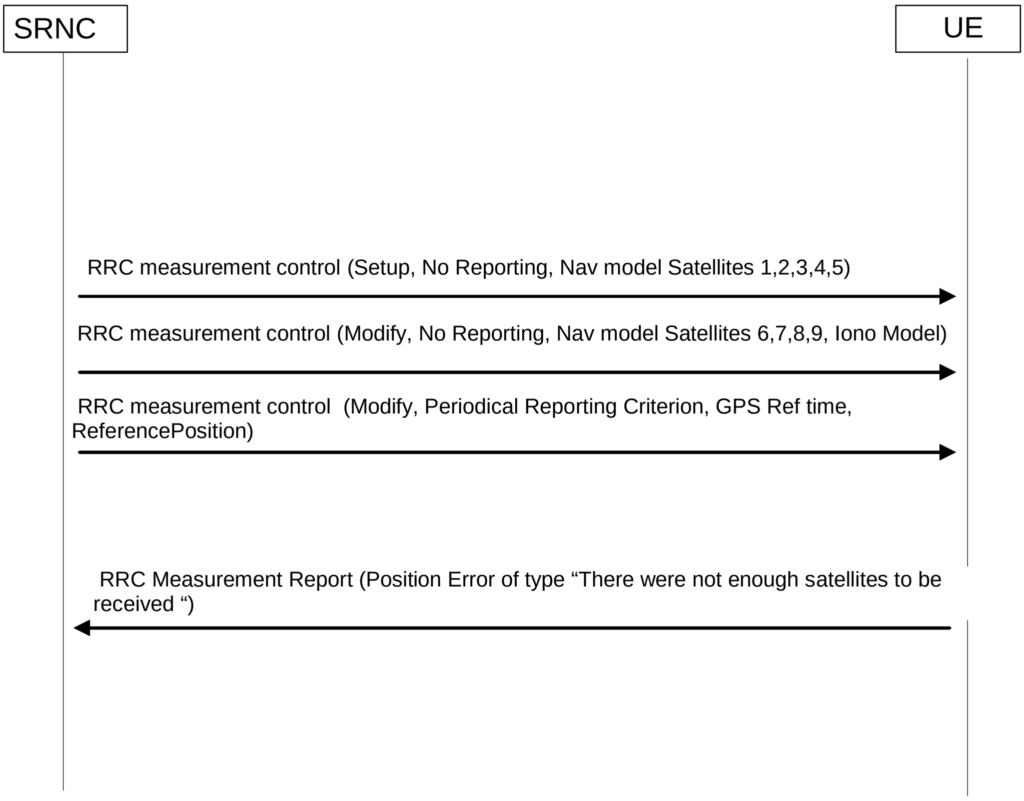

Figure D.3: UE-Based GPS Message Sequence Failure

D.3 UE Assisted A-GPS Measurement Sequence Chart

D.3.1 UE Assisted A-GPS Measurement Sequence Chart Normal

The assistance data requested by the UE and provided by the SRNC in this sequence of messages shall be selected from among those information elements described as available in clause E.3.

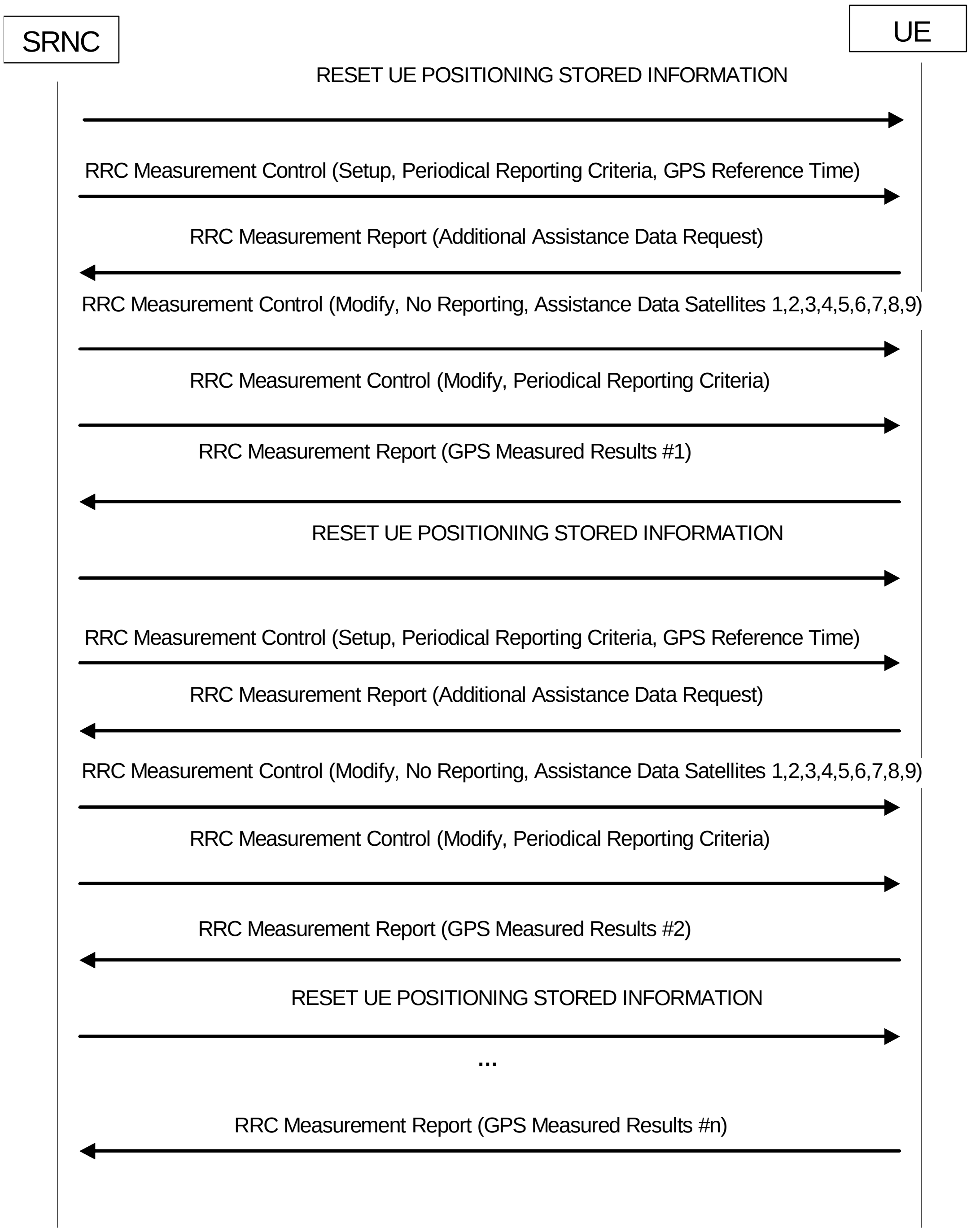

Figure D.4: UE-Assisted GPS Message Sequence

D.3.2 UE assisted A-GPS Measurement Sequence for moving scenario and periodic update test case

The assistance data requested by the UE and provided by the SRNC in this sequence of messages shall be selected from among those information elements described as available in clause E.3.

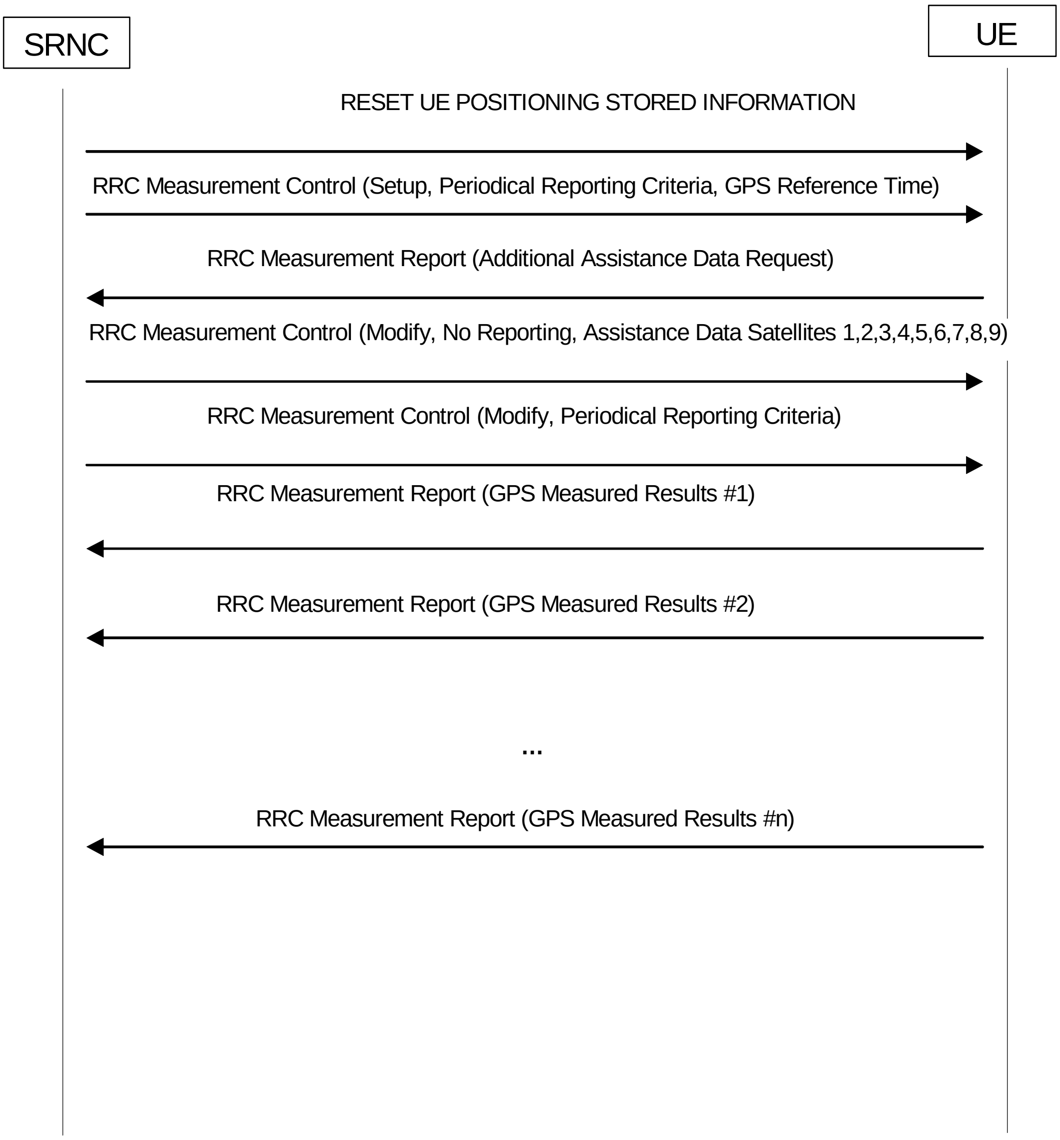

Figure D.5: UE assisted GPS Message Sequence for moving scenario and periodic update

NOTE: In the actual testing the UE may report error messages until it has been able to acquire GPS measured results.

Annex E (normative): Assistance data required for testing

E.1 Introduction

This annex defines the assistance data IE's available in all test cases. The assistance data shall be given for all satellites visible in the tests.

The information elements are given with reference to 3GPP TS 25.331 [4], where the details are defined.

Clause E.2 lists the assistance data IE's required for testing of UE-based mode, and clause E.3 lists the assistance data available for testing of UE-assisted mode.

E.2 Information elements required for UE-based

The following GPS assistance data IE's shall be present for each test:

a) UE positioning GPS reference time IE. This information element is defined in subclause 10.3.7.96 of 3GPP TS 25.331 [4].

Table E.1: UE positioning GPS reference time IE

Name of the IE	Fields of the IE	UE Based Coarse time	UE Based Fine Time
UE positioning GPS reference time subclause 10.3.7.96 of 3GPP TS 25.331 [4]			
	GPS Week	Yes	Yes
	GPS TOW msec	Yes	Yes
	UTRAN GPS reference time		Yes
	>UTRAN GPS timing of cell frames		Yes
	>CHOICE mode		Yes
	>>FDD		Yes
	>>>Primary CPICH Info		Yes
	>>TDD		
	>>>cell parameters id		
	>SFN		Yes
	SFN-TOW Uncertainty		Yes
	TUTRAN-GPS drift rate		Yes
	GPS TOW Assist	Yes	Yes
	SatID	Yes	Yes
	TLM Message	Yes	Yes
	TLM Reserved	Yes	Yes
	Alert	Yes	Yes
	Anti-Spoof	Yes	Yes

b) UE positioning GPS reference UE position IE. This information element is defined in subclause 10.3.8.4c of 3GPP TS 25.331 [4].

Table E.2: UE positioning GPS reference UE position IE

Name of the IE	Fields of the IE	UE Based Coarse time	UE Based Fine Time
Reference Location subclause 10.3.8.4c of 3GPP TS 25.331 [4]	Ellipsoid point with Altitude and uncertainty ellipsoid	Yes	Yes

c) UE positioning GPS navigation model IE. This information element is defined in subclause 10.3.7.94 of 3GPP TS 25.331 [4]. The Navigation model will be chosen for the reference time and reference position.

Table E.3: UE positioning GPS navigation model IE

Name of the IE	Fields of the IE	UE Based Coarse time	UE Based Fine Time
Navigation Model subclause 10.3.7.94 of 3GPP TS 25.331 [4]		Yes	Yes

d) UE positioning GPS ionospheric model IE. This information element is defined in subclause 10.3.7.92 of 3GPP TS 25.331 [4].

Table E.4: UE positioning GPS ionospheric model IE

Name of the IE	Fields of the IE	UE Based Coarse time	UE Based Fine Time
Ionospheric Model subclause 10.3.7.92 of 3GPP TS 25.331 [4]		Yes	Yes

E.3 Information elements available for UE-assisted

The following GPS assistance data IE's shall be available for each test:

a) UE positioning GPS reference time IE. This information element is defined in subclause 10.3.7.96 of 3GPP TS 25.331 [4].

Table E.5: UE positioning GPS reference time IE

Name of the IE	Fields of the IE	UE Assisted Coarse time	UE Assisted Fine Time
UE positioning GPS reference time subclause 10.3.7.96 of 3GPP TS 25.331 [4]			
	GPS Week	Yes	Yes
	GPS TOW msec	Yes	Yes
	UTRAN GPS reference time		Yes
	>UTRAN GPS timing of cell frames		Yes
	>CHOICE mode		Yes
	>>FDD		Yes
	>>>Primary CPICH Info		Yes
	>>TDD		
	>>>cell parameters id		
	>SFN		Yes
	SFN-TOW Uncertainty		Yes
	TUTRAN-GPS drift rate		Yes
	GPS TOW Assist	Yes	Yes
	SatID	Yes	Yes
	TLM Message	Yes	Yes
	TLM Reserved	Yes	Yes
	Alert	Yes	Yes
	Anti-Spoof	Yes	Yes

b) **UE positioning GPS reference UE position IE.** This information element is defined in subclause 10.3.8.4c of 3GPP TS 25.331 [4].

Table E.6: UE positioning GPS reference UE position IE

Name of the IE	Fields of the IE	UE Assisted Coarse Time	UE Assisted Fine Time
Reference Location subclause 10.3.8.4c of 3GPP TS 25.331 [4]	Ellipsoid point with Altitude and uncertainty ellipsoid	Yes	Yes

c) **UE positioning GPS almanac** This information element is defined in subclause 10.3.7.89 of 3GPP TS 25.331 [4]. The Almanac shall be chosen for the reference time.

Table E.7: UE positioning GPS almanac IE

Name of the IE	Fields of the IE	UE Assisted Coarse Time	UE Assisted Fine Time
UE positioning GPS almanac subclause 10.3.7.89 of 3GPP TS 25.331 [4]			
	Almanac Reference Week	Yes	Yes
	Satellite information	Yes	Yes

d) **UE positioning GPS navigation model IE.** This information element is defined in subclause 10.3.7.94 of 3GPP TS 25.331 [4]. The Navigation model will be chosen for the reference time and reference position.

Table E.8: UE positioning GPS navigation model IE

Name of the IE	Fields of the IE	UE Assisted Coarse Time	UE Assisted Fine Time
Navigation Model subclause 10.3.7.94 of 3GPP TS 25.331 [4]		Yes	Yes

e) **UE positioning GPS acquisition assistance IE.** This information element is defined in subclause 10.3.7.88 of 3GPP TS 25.331 [4].

Table E.9: UE positioning GPS acquisition assistance IE

Name of the IE	Fields of the IE	UE Assisted Coarse time	UE Assisted Fine Time
Acquisition Assistance subclause 10.3.7.88 of 3GPP TS 25.331 [4]			
-	GPS TOW msec	Yes	Yes
-	UTRAN GPS reference time		Yes
-	>UTRAN GPS timing of cell frames		Yes
-	>CHOICE *mode*		Yes
-	>>FDD		Yes
-	>>>Primary CPICH Info		Yes
-	>SFN		Yes
-	Satellite information	Yes	Yes
-	>SatID	Yes	Yes
	>Doppler (0th order term)	Yes	Yes
	>Extra Doppler	Yes	Yes
	>>Doppler (1st order term)	Yes	Yes
	>>Doppler Uncertainty	Yes	Yes
	>Code Phase	Yes	Yes
	>Integer Code Phase	Yes	Yes
	>GPS Bit number	Yes	Yes
	>Code Phase Search Window	Yes	Yes
	>Azimuth and Elevation	Yes	Yes
	>> Azimuth	Yes	Yes
	>> Elevation	Yes	Yes

Annex F (normative): Converting UE-assisted measurement reports into position estimates

F.1 Introduction

To convert the UE measurement reports in case of UE-assisted mode of A-GPS into position errors, a transformation between the "measurement domain" (code-phases, etc.) into the "state" domain (position estimate) would first be necessary. Such a transformation procedure is outlined in the following clauses. The details can be found in [8], [9] and [10].

F.2 UE measurement reports

In case of UE-assisted A-GPS, the measurement parameters are contained in the RRC UE POSITIONING GPS MEASURED RESULTS IE (subclause 10.3.7.93 in 3GPP TS 25.331 [4]). The measurement parameters required for calculating the UE position are:

1) Reference Time: The UE has two choices for the Reference Time:

   a) "UE GPS timing of cell frames";

   b) "GPS TOW msec".

2) Measurement Parameters: 1 to <maxSat>:

   a) "Satellite ID (SV PRN)";

   b) "Whole GPS chips";

   c) "Fractional GPS Chips";

   d) "Pseudorange RMS Error".

Additional information required at the system simulator:

1) "UE positioning GPS reference UE position" (subclause 10.3.8.4c in 3GPP TS 25.331 [4]):
   Used for initial approximate receiver coordinates.

2) "UE positioning GPS navigation model" (subclause 10.3.7.94 in 3GPP TS 25.331 [4]):
   Contains the GPS ephemeris and clock correction parameters as specified in [8]; used for calculating the satellite positions and clock corrections.

3) "UE positioning GPS ionospheric model" (subclause 10.3.7.92 in 3GPP TS 25.331 [4]):
   Contains the ionospheric parameters which allow the single frequency user to utilize the ionospheric model as specified in [8] for computation of the ionospheric delay.

F.3 WLS position solution

The WLS position solution problem is concerned with the task of solving for four unknowns; x_u, y_u, z_u the receiver coordinates in a suitable frame of reference (usually ECEF) and b_u the receiver clock bias. It typically requires the following steps:

Step 1: Formation of pseudo-ranges

The observation of code phase reported by the UE for each satellite SV_i is related to the pseudo-range/c modulo 1 ms (the length of the C/A code period). For the formation of pseudo-ranges, the integer number of milliseconds to be added to each code-phase measurement has to be determined first. Since 1 ms corresponds to a travelled distance of 300 km, the number of integer ms can be found with the help of reference location and satellite ephemeris. The distance between the reference location and each satellite SV_i is calculated and the integer number of milli-seconds to be added to the UE code phase measurements is obtained.

Step 2: Formation of weighting matrix

The UE reported "Pseudorange RMS Error" values are used to calculate the weighting matrix for the WLS algorithm [9]. According to 3GPP TS 25.331 [4], the encoding for this field is a 6 bit value that consists of a 3 bit mantissa, X_i and a 3 bit exponent, Y_i for each SV_i:

$$w_i = RMSError = 0.5 \times \left(1 + \frac{X_i}{8}\right) \times 2^{Y_i}$$

The weighting Matrix **W** is defined as a diagonal matrix containing the estimated variances calculated from the "Pseudorange RMS Error" values:

$$\mathbf{W} = \mathrm{diag}\left\{1/w_1^2, 1/w_2^2, \cdots, 1/w_n^2\right\}$$

Step 3: WLS position solution

The WLS position solution is described in reference [9] and usually requires the following steps:

1) Computation of satellite locations at time of transmission using the ephemeris parameters and user algorithms defined in [8] section 20.3.3.4.3.

2) Computation of clock correction parameters using the parameters and algorithms as defined in [8] section 20.3.3.3.3.1.

3) Computation of atmospheric delay corrections using the parameters and algorithms defined in [8] section 20.3.3.5.2.5 for the ionospheric delay, and using the Gupta model in reference [10] p. 121 equation (2) for the tropospheric delay.

4) The WLS position solution starts with an initial estimate of the user state (position and clock offset). The Reference Location is used as initial position estimate. The following steps are required:

   a) Calculate geometric range (corrected for Earth rotation) between initial location estimate and each satellite included in the UE measurement report.

   b) Predict pseudo-ranges for each measurement including clock and atmospheric biases as calculated in 1) to 3) above and defined in [8,9].

   c) Calculate difference between predicted and measured pseudo-ranges $\Delta\boldsymbol{\rho}$

   d) Calculate the "Geometry Matrix" **G** as defined in [9]:

$$\mathbf{G} \equiv \begin{bmatrix} -\hat{\mathbf{1}}_1^T & 1 \\ -\hat{\mathbf{1}}_2^T & 1 \\ \vdots & \vdots \\ -\hat{\mathbf{1}}_n^T & 1 \end{bmatrix}$$ with $\hat{\mathbf{1}}_i \equiv \frac{\mathbf{r}_{si} - \hat{\mathbf{r}}_u}{|\mathbf{r}_{si} - \hat{\mathbf{r}}_u|}$ where $\mathbf{r}_{si}$ is the Satellite position vector for SV_i (calculated in 1) above), and $\hat{\mathbf{r}}_u$ is the estimate of the user location.

e) Calculate the WLS solution according to [9]:

$$\Delta\hat{\mathbf{x}} = \left(\mathbf{G}^T \mathbf{W} \mathbf{G}\right)^{-1} \mathbf{G}^T \mathbf{W} \Delta\boldsymbol{\rho}$$

f) Adding the $\Delta\hat{\mathbf{x}}$ to the initial state estimate gives an improved estimate of the state vector:

$$\hat{\mathbf{x}} \rightarrow \hat{\mathbf{x}} + \Delta\hat{\mathbf{x}}.$$

5) This new state vector $\hat{\mathbf{x}}$ can be used as new initial estimate and the procedure is repeated until the change in $\hat{\mathbf{x}}$ is sufficiently small.

Step 4: Transformation from Cartesian coordinate system to Geodetic coordinate system

The state vector $\hat{\mathbf{x}}$ calculated in Step 3 contains the UE position in ECEF Cartesian coordinates together with the UE receiver clock bias. Only the user position is of further interest. It is usually desirable to convert from ECEF coordinates x_u, y_u, z_u to geodetic latitude φ, longitude λ and altitude h on the WGS84 reference ellipsoid.

Step 5: Calculation of "2-D Position Errors"

The latitude φ / longitude λ obtained after Step 4 is used to calculate the 2-D position error.

Annex G (informative): Change History

Date	Meeting	Document	Comment	Version old	Version New
	RAN WG4 #29	R4-031082	Document proposed at RAN#29		
	RAN WG4 #29	R4-031156	Comments added inline with discussion at RAN#29		
Dec 2003			Comment on R4-031156		
Jan 2004	RAN WG4 #30	R4-040104	Comments added after Ad-hoc 29/1/04		
Jan 2004	RAN WG4 #29	R4-040169	Revised version of R4-040104 to allow printing		
May 2004	RAN WG4 #31	R4-040362	Revised version of R4-040233		
May 2004	RAN WG4 #31	R4-040387	Approved version at RAN#31		
May 2004	RAN WG4 #31		V0.0.0 produced based on R4-040387		0.0.0
May 2004			V0.1.0 with input from R4-040364	0.0.0	0.1.0
Aug 2004	Conference call on Aug 5, 2004		V0.1.0 with approved CRs: R4-04043, R4-04048, R4AH-04049, R4AH-04050 and R4AH-04052	0.1.0	0.2.0
Aug 2004	RAN WG4 #32	R4-040465	V0.2.0 for approval at RAN WG4 #32		
Aug 2004	RAN WG4 #32	R4-040564	V0.3.0 for approval at RAN WG4 #32, inclusion of changes in R4-040535	0.2.0	0.3.0
Sep 2004	RAN #25	RP-040341	Submit for approval	0.3.0	1.0.0
Sep 2004	RAN #25		Approved at RAN#24	1.0.0	6.0.0

History

Document history		
V6.0.0	September 2004	Publication