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Technical Report

**Universal Mobile Telecommunications System (UMTS);
Evaluation of the inclusion of path loss based
location technology in the UTRAN
(3GPP TR 25.907 version 9.0.1 Release 9)**

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Contents

Foreword

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1 Scope

<Editor's note: Text in this section is cited from the original text in 'Annex A.1 Overview'>

Path-loss technologies cover a broad scope of specific location technologies, including: RSSI Trilateration technologies, certain Enhanced Cell-ID technologies, and RF pattern matching technologies. For the purposes of this Study Item, individual technology groups to be evaluated will be treated independently as Annexes to the TR.

In this TR, Annex.A should:

- Describe pattern matching and outline it's benefits and challenges.
- Illustrate the required messaging to support RF pattern matching technologies, as well as the projected performance improvements associated with additional messaging/measurement support.
- Confirm the performance capability of RF pattern matching Technology on the UMTS air-interface, over all environments. Both in terms of accuracy and location result latency:
  - Dense Urban
  - In-Building
  - Rural
- Illustrate the Standardized architecture for RF pattern matching technologies as related to the UMTS and future air interfaces.
- Provide an outline of anticipated standardization requirements for improved performance and interoperability of RF pattern matching technologies.
- Provide a conclusion based on the information contained herein and a recommendation to the 3GPP regarding standardization of RF pattern matching Technologies within the RAN.

2 References

[1] Weiss, A., "On The Accuracy of A Cellular Location System Based on RSS Measurements," *IEEE Transactions on Vehicular Technology*, vol. 52, pp. 1508 – 1518, Nov 2003.

[2] Catovic, A. and Sahinoglu, Z., "The Cramer–Rao Bounds of Hybrid TOA/RSS and TDOA/RSS Location Estimation Schemes," *IEEE Communications Letters*, vol. 8, pp. 626 – 8, Oct 2004.

[3] 3GPP TR 25.942: " Universal Mobile Telecommunications System (UMTS); Radio Frequency (RF) system scenarios

[4] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[5] 3GPP TS 25.331: "Radio Resource Control (RRC); Protocol specification".

[6] 3GPP TS 25.453: "UTRAN Iupc interface Positioning Calculation Application Part (PCAP) signalling".

[7] 3GPP TS 25.215: "Physical layer; Measurements (FDD)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [4] 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 [4].

3.2 Symbols

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

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].

4 Overview

<Editor's note: Text in this section is cited from the original text in 'Annex A.1>

Performance in field deployments and trials of Path-loss technologies indicates potential benefits, both in terms of location accuracy and latency, in including some of these technologies in the Standards. Individual Path-loss technologies will be evaluated thoroughly and objectively in this TR to assess which, if any, of these are sufficiently promising so as to justify further consideration by the 3GPP.

5 Feasibility of path-loss technologies for location on UMTS

5.1 RF pattern matching

<Editor's note: Text in this section is cited from the original text in 'Annex A.2.1 and A.2.1.1>

pattern matching technologies represent a family of Path Loss based technologies that rely on matching the RF environment (as experienced by the UE) to the known characteristics of the larger RF System in which the UE is operating. Information from the UE, including measurements of neighbour cell signal strengths, time delay and other network parameters form the basis of the RF environment to be compared to the established System RF Database. The intent of this approach is to mitigate the negative impacts of anomalies within the RF environment that challenge the accuracy of trilateration technologies (e.g. multipath and reflection).

The RF pattern matching positioning method is based on measurements made by the UE and Node B. The essential measurement set required for this method is currently defined in [25.215] and necessary for the basic mobility functionality and hence this method will work with existing mobiles without any modification.

6 Evaluated performance of path-loss technologies on UMTS

6.1 General

<Editor's note: Text in this section is cited from the original text in 'Annex A.8, detailed simulation methodology and results are presented in Annex A >

- RF pattern matching provides a significant improvement in performance to Cell-ID with RTT
  - Average simulated improvement was 47.3%
  - Highest simulated improvement was 259%

6.2 RF pattern matching technologies on UMTS

See Annex A.6.

7 Network Architecture for Path-loss technologies on UMTS

7.1 RF pattern matching technologies on UMTS

<Editor's note: Diagram in this section is cited from the original text in 'Annex A.5.1>

- Architecture shown is the currently approved 3GPP LCS architecture (no architecture changes are needed for RF pattern matching)>

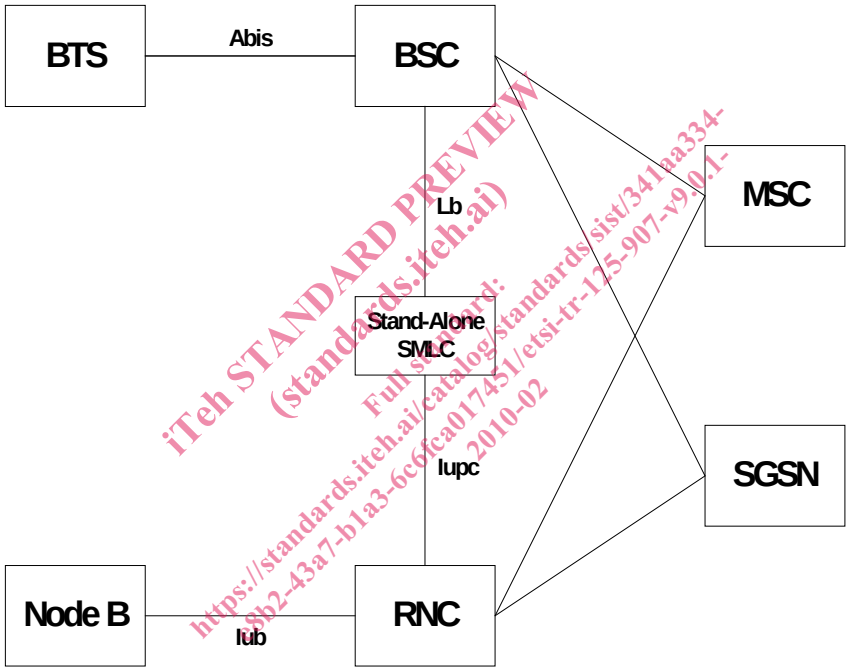

Figure A.5.1: Overlay Architecture for RF pattern matching

8 Summary comparison of path-loss technologies with currently standardized location technologies on UMTS

Refer to Clauses A.3 and 10.1.

9 Anticipated requirements for the standardization of path-loss technologies in 3GPP

9.1 RF pattern matching technologies on UMTS

<Editor's note: Diagram in this section is cited from the original text in 'Annex A.7>

9.1.1 Modifications to TS 25.331 [5] (RRC Protocol Specification) and TS 25.453 [6] include:

The changes anticipated for this specification include the definition/addition of RF pattern matching to the UE Positioning description section (8.6.7.19) and the inclusion of RF pattern matching in the defined UE positioning procedures. Additionally, a PCAP group for "RF pattern matching" will be required in TS 25.453.

9.1.2 Anticipated Change Requests

- Inter-RAT

The ability to leverage Inter-RAT measurements in an overlay network will provide significant potential improvements in location accuracy for RF pattern matching. It is anticipated that these measurements will be requested as an optional parameter (at least for use in emergency service locations).

- IPDL

IPDL offers similar advantages to RF pattern matching to those that it gives to other location technologies (e.g. OTDOA). To the extent that this capability is pursued for those technologies, it is intended that it will be used to benefit RF pattern matching as well.

- Absolute Ec (Sector TX Power)

As RF pattern matching is a path-loss, based location technology, absolute Ec will allow for better definition of the local UE environment and improved location accuracy. It is assumed that this measurement will be requested in the UE positioning report for RF pattern matching.

- Round Trip Time (RTT)

Given the dynamic power management scenarios that are being used in the UTRAN, The measure of RTT has good potential to improve the accuracy of any path-loss based location technology. Access to RTT as an optional parameter has great benefit to RF pattern matching, as well as ECID and should be and it is anticipated that this measure will be requested as an optional parameter.

10 Conclusions

<Editor's note: Text in this section is cited from the original text in 'A.8'>

10.1 RF pattern matching technologies

This section is reiterated in Annex A.8 and provides detailed information on the potential benefits, as well as the implications, of the inclusion of RF pattern matching in the UTRAN. As a result of the evaluation contained herein, it can be shown that:

- RF pattern matching provides a significant improvement in performance to Cell-ID with RTT
  - o Average simulated improvement was 47.3%
  - o Highest simulated improvement was 259%
- RF pattern matching operates with limited impact on the network or UE
  - o No network hardware requirements
  - o No UE modifications
- Anticipated Changes have benefit for other location methods
  - o IPDL – Also needed for OTDOA

- RTT – Also benefits Cell-ID, OTDOA and UTDOA

There are growing market segments for location services that require both location accuracy and user transparency (Government Surveillance and Lawful Intercept); these services cannot be addressed with location technologies which require UE support or modification (A-GPS, GNSS, OTDOA). Additionally, Emergency Service applications require a level of location accuracy which has not been met with Cell-ID and RTT. The potential benefits of RF pattern matching and and the relative ease with which this location method can be adopted in the UTRAN would indicate that it is appropriate that the technology be included in the UTRAN in support of the services noted above, as well as for cooperatve deployment with satellite-based systems (A-GPS, GNSS, etc.) in support of "Hybrid" location technology for Location Based Services (LBS).