ETSI TS 103 655-1 V1.2.1 (2022-09)

TECHNICAL SPECIFICATION

Reconfigurable Radio Systems (RRS);
Radio Interface Engine (RIE);
Part 1: Technical requirements

Reference
RTS/RRS-0153

Keywords
mobile, radio, requirements, system

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Reconfigurable Radio Systems (RRS).

The present document is part 1 of a multi-part deliverable covering the Radio Interface Engine (RIE), as identified below:

Part 1: "Technical requirements";

Part 2: "Architecture".

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

The radio interface engine comprises context information and communication needs to improve both depending on the demands. In ETSI TR 103 587 [i.1], several use cases are identified and described that are used as base for the requirements of the radio interface engine. The concept demands requirements for a future architecture of the radio interface engine. The requirements are split into two categories: the functional and the performance requirements. The functional requirements consist of three groups. These are the radio and hardware processing resources, the functions that are supporting the reconfiguration and the mobile device mobility and connectivity management.

The performance requirements comprise communication as well as context information indicators. Context information includes positioning performance indicators and is proposed in 3GPP TR 22.872 [i.2] where positioning relevant KPIs are identified. The context information performance KPIs steer the potential of the radio interface engine to improve and reach the communication performance requirements of the network.

1 Scope

The present document specifies the system requirements for Reconfigurable Radio Systems operating in different environments and bands to apply the concept of the radio interface engine that is introduced in ETSI TR 103 587 [i.1] together with use cases comprising different key performance indicators in radio systems.

The documented key performance indicators are described and followed by the requirements on the wireless systems which are structured in the following requirement categories:

- Requirements for radio and hardware processing resources.
- Requirements for functions supporting the reconfiguration.
- Requirements for mobile device mobility and connectivity management.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 103 587: "Reconfigurable Radio Systems (RRS); Feasibility study of a Radio Interface Engine (RIE)".

[i.2] 3GPP TR 22.872 (V16.1.0): "Study on positioning use cases (Release 16)", SA WG1.

[i.3] ETSI TS 103 154 (V1.1.1): "Reconfigurable Radio Systems (RRS); System requirements for operation of Mobile Broadband Systems in the 2 300 MHz - 2 400 MHz band under Licensed Shared Access (LSA)".

[i.4] TEDDI database: TErms and Definitions Database Interactive (TEDDI).

NOTE: Available at https://webapp.etsi.org/Teddi/.

[i.5] Void.

[i.6] ETSI TS 103 652-1: "Reconfigurable Radio Systems (RRS); evolved Licensed Shared Access (eLSA); Part 1: System requirements".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

allowance zone: geographical area within which a radio equipment is allowed to operate radio transmitters on its assigned spectrum resource

NOTE 1: An allowance zone is defined using specific measurement quantities and thresholds, e.g. a maximum field strength level expressed in dBµ V/m/MHz, along the border of its geographical area.

NOTE 2: An allowance zone is normally applicable for a defined frequency range and time period.

NOTE 3: The term of "allowance zone" as used here is an extension of the term used in [i.6].

exclusion zone: geographical area within which only designated incumbent technologies are allowed to have active radio transmitters

NOTE 1: An exclusion zone is normally applicable for a defined frequency range and time period.

NOTE 2: The term of "exclusion zone" as used here is an extension of the term used in [i.6].

incumbent: current holder of spectrum rights of use

protection zone: geographical area within which incumbent receivers will not be subject to harmful interference caused by unauthorized radio equipment transmissions

NOTE 1: A protection zone is defined using specific measurement quantities and thresholds (e.g. a mean field strength that does not exceed a defined value in dBµ V/m/MHz at a defined receiver antenna height above ground level). A protection zone is normally applicable for a defined frequency range and time period.

NOTE 2: The term of "protection zone" as used here is an extension of the term used in [i.6].

radio equipment: product or relevant component thereof capable of communication by means of the emission and/or reception of radio waves utilizing the spectrum allocated to terrestrial/space radio communication

NOTE: This definition is taken from the TEDDI database [i.4].

restriction zone: geographical area within an allowance zone where a radio equipment has to operate under certain additional restrictive conditions (e.g. maximum EIRP limits and/or constraints on antenna parameters)

NOTE 1: A restriction zone is normally applicable for a defined frequency range and time period.

NOTE 2: The term of "restriction zone" as used here is an extension of the term used in [i.3].

spectrum resource: resource or set of resources defined in time, space and frequency domains

3.2 Symbols

Void.

3.3 Abbreviations

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

3GPP	3G (mobile) Partnership Project
COM	Communications
CON	Context
dBµ	deciBel relative to one microvolt
EIRP	Effective Isotropic Radiated Power
EU	European Union
FPGA	Field Programmable Gate Array
FUNC	Functional aspects
GNSS	Global Navigation Satellite System
GPP	General Purpose Processor
HPR	Hardware Processing Resources
ID	IDentifier
KPI	Key Performance Indicator
LB	Location-Based
LTE-U	Long Term Evolution-Unlicensed
MAC	Message Authentication Code
MOB	Mobility aspects
PERF	Performance aspects
PHY	PHYsical layer
QoS	Quality of Service
RBS	Random Binary Sequence
RE	Radio Equipment
REC	Reconfiguration aspects
R-FUNC	Requirements Function
RHR	Radio and Hardware Resources
RIE	Radio Interface Engine
R-PERF	Performance Requirements
RR	Radio Resources
RRS	Reconfigurable Radio Systems
TEDDI	TErms and Definitions Database Interactive
TR	Technical Report
TS	Technical Specification
WD	Wireless Device
Wi-Fi	Wireless Fidelity

4 Requirement Organization and Methodology

4.1 Requirement Organization

The requirements are organized into two categories. Category one defines the function requirements and category two the performance requirements. Both categories are further split up into different groups. Figure 1 visualizes the categories and its enclosed groups.

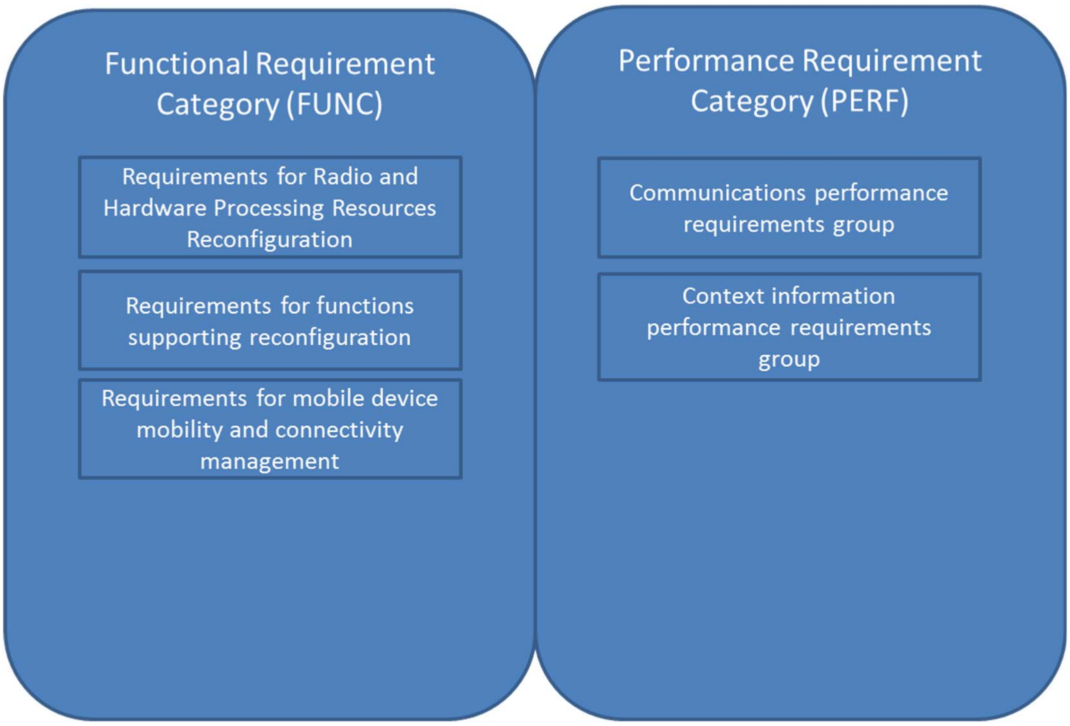

Figure 1: Requirements Operations

4.2 Requirement Format

A letter code is defined to uniquely identify each requirement R<CAT><GROUP><XX>. It is constructed as follows:

- R-:standard requirement prefix.
- <CAT>:

Code	Category
FUNC	Functional aspects
PERF	Performance aspects

- <GROUP>: Requirement group identifier. A three letter code will be used for this identifier.
- <XX>: Requirement identifier within requirement group; range 01 → 99.

EXAMPLE: R-FUNC-RHR-01: Requirements-Function-Radio_and_Hardware_Resources_01.

4.3 Requirement Formulation

A requirement is formulated in such a way that it is uniquely defined. It is built as follows:

- Title: <Title Description>

5 Working Assumptions

The working assumptions described below are based on ETSI TR 103 587 [i.1]. There a radio interface engine is defined to comprise the following use cases which all rely on context information, such as current and predictive location information of the wireless device:

- Decision making based on context information of either the mobile device or the base station identifying if a single or multiple links are best.

- User circumstance trigger context information management that adapts the communication KPIs.
- Considering context information to download and install a different PHY/MAC protocol of wireless devices.
- Tracking context information to decide where the processing unit shall be executed.
- Considering context information to adapt PHY and MAC to improve the location estimation of the WD iteratively further.

Relevant performance indicators are categorized in two groups:

- Communications performance indicators, such as data rate, latency, spectrum and power efficiency.
- Context information performance indicators, such as waveform, location accuracy, integrity of sensor data, and used spectrum for ranging and outdated sensor data.

6 Functional System Requirements

6.1 Requirements for radio and hardware processing resources

6.1.1 R-FUNC-RHR-01: Reconfiguration for each WD

The system shall support the reconfiguration of both the Hardware Processing Resources (HPR) and the Radio Resources (RR) for each supported Wireless Device (WD).

Explanation: The system should be able to perform resource reconfiguration of both the hardware processing resources and the radio resources for each supported WD. The radio resources assigned to each supported WD can be dynamically modified, which includes bandwidth, frequencies, power levels, spectrum masks, etc. Meanwhile, the percentage of hardware processing resources devoted to each supported WD should be dynamically modified. For example, sufficient HPR should be configured to a WD when a new channel is assigned to it.

6.1.2 R-FUNC-RHR-02: Reconfiguration between WDs

The system shall support reconfiguration of both HPR and RR between different WDs.

Explanation: The system can reconfigure multiple WDs with flexibility in terms of the percentage of HPR and RR between different WDs according to the status of the network.

6.2 Requirements for functions supporting the reconfiguration

6.2.1 R-FUNC-REC-01: Gathering and processing function

The system shall support a gathering and processing function to gather and process radio related metrics and parameters.

Explanation: After having gathered radio related metrics and parameters, the gathering and processing function may process them to make decisions on reconfiguration in order to optimize radio performance. The identification of the radio related metrics and parameters which can be used for reconfiguration purposes may vary according the specific use case. These are expected to include traffic variations, channel bandwidth, interference, transmit power and QoS.

6.2.2 R-FUNC-REC-02: Support of trigger events for reconfiguration

The system shall support trigger events for reconfiguration.

Explanation: Trigger events are described by certain parameters (e.g. thresholds, hysteresis) in order to define the condition under which an event is happening. When one or more events occur, the system starts to evaluate the need for a possible reconfiguration.

6.2.3 R-FUNC-REC-03: Support for reconfiguration function

The system shall support a reconfiguration function to make decisions for radio resource reconfiguration and inform RBSs to perform the reconfiguration e.g. triggered by events in clause 6.2.2.

Explanation: The reconfiguration function shall make radio resource reconfiguration decisions such as, reconfiguration time, reconfigured RATs, frequency bands allocation and adding/dropping carrier frequencies at RBSs.

6.2.4 R-FUNC-REC-04: Support for execution function

The system shall support the execution function in order to perform the reconfiguration.

Explanation: The system WDs should support mechanisms in order to be reconfigured according to the reconfiguration decision of the reconfiguration function.

EXAMPLE: An example is to exchange location estimates between WDs to improve the estimation process on the receiver itself.

6.2.5 R-FUNC-REC-05: Support of learning function

The system shall support a learning function to improve and optimize the reconfiguration decisions.

Explanation: For example, the learning capability may consist in monitoring the performance of the system after each reconfiguration and verifying whether the decisions meet or not the reconfiguration target. Another possibility is to learn about the causes that trigger a particular reconfiguration by memorizing the situation; if such causes happen again, the reconfiguration that should be performed is already known.

6.2.6 R-FUNC-REC-06: Support of information provisioning function

The system shall support an information provisioning function to provide updated network configuration information to the appropriate system devices.

Explanation: After a reconfiguration, the information related to the new network configuration and policies are expected to be efficiently provided to the system devices (only the ones affected by the reconfiguration) in order to minimize the control plane overhead due to the reconfiguration.

6.3 Requirements for mobile device mobility and connectivity management

6.3.1 R-FUNC-MOB-01: Mobility management of the WDs

The system shall guarantee the mobility management of the WDs.

Explanation: Network reconfiguration (e.g. change of WD in currently used band or starting operations in a new band using a WD already deployed or a new WD) may imply the change of radio parameters, such as neighbour cells relation information (e.g. the neighbour cells IDs, the neighbour cells operating frequency, etc.) affecting the cell selection/reselection of WDs in idle mode. The mobility management is guaranteed by providing such updated information to the WDs.

6.3.2 R-FUNC-MOB-02: Connectivity management of the WDs

The system shall manage the connectivity of the WDs during the reconfiguration.

Explanation: When a WD is in connected mode and operating on radio resources that may be reconfigured, an appropriate decision has to be evaluated by the system in order to maintain the connectivity of the involved WDs. In the following, different examples of approaches are depicted according to the WDs capabilities:

In order to support connectivity of WDs that are only able to operate on WD "a" in band "x", sufficient radio resource in band "x" may be maintained for WD "a" in band "x". In order to support WDs capable of operating on WD "a" or WD "b" in band "x" and which are in connected mode on WD "a" in band "x", it may be evaluated if the connectivity currently provided to the WDs on WD "a" could be provided also on WD "b" performing handover from WD "a" to WD "b" before the reconfiguration from WD "a" to WD "b" on band "x".

In order to support WDs capable of operating only on WD "a" in band "x" and band "y" and which are in connected mode on WD "a" in band "x", the WDs may be handed over to band "y" before the reconfiguration of the radio resources that refer to band "x".

6.3.3 R-FUNC-MOB-03: Scalability of connections of the WDs

The system shall consider scalability of the potentially active mobile WDs that are either managed by the network or a central unit.

EXAMPLE: Mobile WDs may operate in a peer-to-peer mode and demand resources (spectrum, power) in a predictive manner. Therefore, scalability is supported by the predictive demand of the mobile WD.

6.3.4 R-FUNC-MOB-04: Support of authentication

The system shall support authentication methods to provide traceable and trustable data sources from WDs.

Explanation: If data is exchanged between WDs that is used for determining the context information it is relevant that an authenticated source that can be trusted provides the information. Therefore, the risk of changing context information by spoofing location relevant data is reduced.

7 Key Performance Requirements

7.1 Key Performance Indicators for Communications

7.1.1 R-PERF-KPI-COM-01: Selecting the best PHY/MAC of the communication system

The system shall select the best PHY/MAC protocol depending on context information such as network and user requirements.

EXAMPLE: A given WD, e.g. a Wi-Fi® node, is using a certain MAC protocol, which provides a certain QoS under the current environment conditions. However, at a certain point in time, an external structured quasi-periodic and impulsive interference appears, e.g. due to an LTE-U transmission in the same band, which decreases the achievable QoS. Since the interference is impulsive and quasi-periodic, it can be easily predicted and, if known, it would be trivially avoided by MAC protocol operation. Rather than a priori designing a MAC protocol so as to integrate support for avoidance of such structured interference, which would create a significant overhead in situations where there is no interference, the WiFi node can use the context information to detect if, in the current environment, there is an active interference and which is its pattern, and then download and switch to a MAC protocol specifically designed for avoiding that specific pattern.

7.1.2 R-PERF-KPI-COM-02: Reliability of the communication link

The system shall perform predictive handover to keep the transmission reliable.

EXAMPLE: The acquired context information is exploited in order to identify the best possible working point for a concerned Wireless Equipment. For this purpose a combination of instantaneous observations together with historical (averaged) data is used in order to enable predictive decision making. Depending on the choice of the decision making entity (e.g. Network centric decision making, Wireless Equipment centric decision making, hybrid decision making split between Network and Wireless Equipment), the context information needs to be transported (and accumulated from various sources) to the decision making entity.

7.1.3 R-PERF-KPI-COM-03: Selection of power compliant processing units

The system shall switch to a low power consuming unit if the context information identifies relevant changes.

EXAMPLE: The WD is serving an outdoor park; the cell load will be directly related to the weather conditions. For situations where the load is high (good weather conditions) and many users need to be served, the most time consuming operations of the protocol stack (e.g. PHY processing) are executed in high performance devices (like FPGAs). In the situation where the weather is likely to change, as predicted by humidity, temperature, and pressure sensors, which provide the context information, the cell load will tend to decrease rapidly. Thus, under the new circumstance of low cell load, the decision making entity selects a less performant less energy consuming processing device (e.g. GPP) to perform the PHY processing, with the purpose of serving the reduced number of users at lower energy consumption and power radiation with a QoS target.

7.1.4 R-PERF-KPI-COM-04: Preselecting relevant sensor data

The system shall preselect data that is maybe no longer relevant because it is outdated to improve the net-throughput. The decision can be done at the WD.

EXAMPLE: The WD is sharing relevant correction data for ionospheric effects to improve GNSS based location estimation. If this data is outdated but will be used it could lead to a higher location error.

7.2 Key Performance Indicators for Context Information

7.2.1 R-PERF-KPI-CON-01: Accuracy of the localization estimation

The system shall assess the accuracy. Such an assessment may be performed by known ground truth points, or estimating the noise level, or the bias due to non-line-of-sight conditions.

EXAMPLE: A set of known fixed ground truth points act as a reference points. Distance measurements depending on the reference points together with the geometrical distribution and knowledge about past measurements allow assessing the accuracy of the estimate of the location.

7.2.2 R-PERF-KPI-CON-02: Integrity of the localization performance

The system shall assess the integrity of the estimated localization performance.

EXAMPLE: Known reference points allow to establish an integrity level to derive a confidence level of exploitable context information. Other methods could be location measurement units share their integrity measurements to be prepared to detect either spoofing or jamming.

7.2.3 R-PERF-KPI-CON-03: Geometric constellation of WD

The system shall assess the geometrical constellation of all active and passive WDs to decide how the location estimation process is affected, and therefore the resources are reasonably invested.

EXAMPLE: Two WDs that support the localization process are placed in line behind each other. Using both devices in such a constellation will bring no benefit, but requires resources such as spectrum and power.

7.2.4 R-PERF-KPI-CON-04: Sensor reliability

The system shall assess the reliability of sensors that assess data to be integrated as context information (such as pressure and humidity) and provide the measurement data.

EXAMPLE: Sensor information such as humidity or pressure could predict a change of the weather. Therefore rain could harm the transmission at certain carrier frequencies, such as mmWave. Additional sensors could foresee such a weather change to adapt the wireless link to a more robust carrier frequency.

7.2.5 R-PERF-KPI-CON-05: Spectrum requirements

The system shall adapt the spectrum depending on the current accuracy requirements, especially in the context of a second WD.

EXAMPLE: Broader spectrum allows estimate the ranging performance more accurately. However, depending on the requirements this is not necessary and could allow a second WD to estimate with its own spectrum the range.

7.2.6 R-PERF-KPI-CON-06: Waveform adaptations

The system shall adapt the applied waveform to optimally choose the current waveform on scenarios with line-of-sight or non-line-of-sight conditions.

EXAMPLE: The waveform determines the performance with a given spectrum. This is of interest in simultaneously ranging between WDs that are collocated.

7.2.7 R-PERF-KPI-CON-07: Location methods

The system shall adapt its location methods depending on the performance requirements, available sensor data, update rate and potential power consumption.

EXAMPLE: Different location methods exist with constraints in respect to complexity, latency and used sensor data. The key constraints limit the power consumption and therefore, only a simple location method is applied with a low update rate and using only limited sensor data.

7.2.8 R-PERF-KPI-CON-08: Horizontal and vertical accuracy performance

The system shall differentiate between the horizontal and vertical accuracy performance.

EXAMPLE: Human addressed use cases exploit location information only on a single floor (in the horizontal dimension). Therefore, the performance requirements shall be different between the horizontal and vertical dimension.

Annex A (informative): RIE Instantiation of Location-Based Spectrum Sharing

In this annex the concept of Location-Based Spectrum Sharing is explained with an instantiation of the RIE. This is one example of how to design a solution in accordance with requirements specified in the present document. Other solutions may exist.

The term Radio Equipment (RE) is used in this annex to indicate the concepts for Wireless Devices can be applied for radio equipment in general and to use terminology that is in use in legal texts across the EU.

The concept of location-based spectrum sharing may be described as follows.

A Radio Equipment (RE) operating in a given location (L1) when changing its location (to location L2), may need to comply to a different set of legal constraints which it interprets as a set of requirements R for its spectrum usage. Thereby, RIE requirements are associated with locations and RE is designed to comply with the legal constraints in its current location.

Figure A.1 illustrates this concept. As the RE moves from location L1 to location L2, the requirements for its spectrum usage change from R1 to R2. This change is effected as the location of the RE relative to the border lines changes. The role of the border lines is to help clarify the transition from R1 to R2 while the RE is moving.

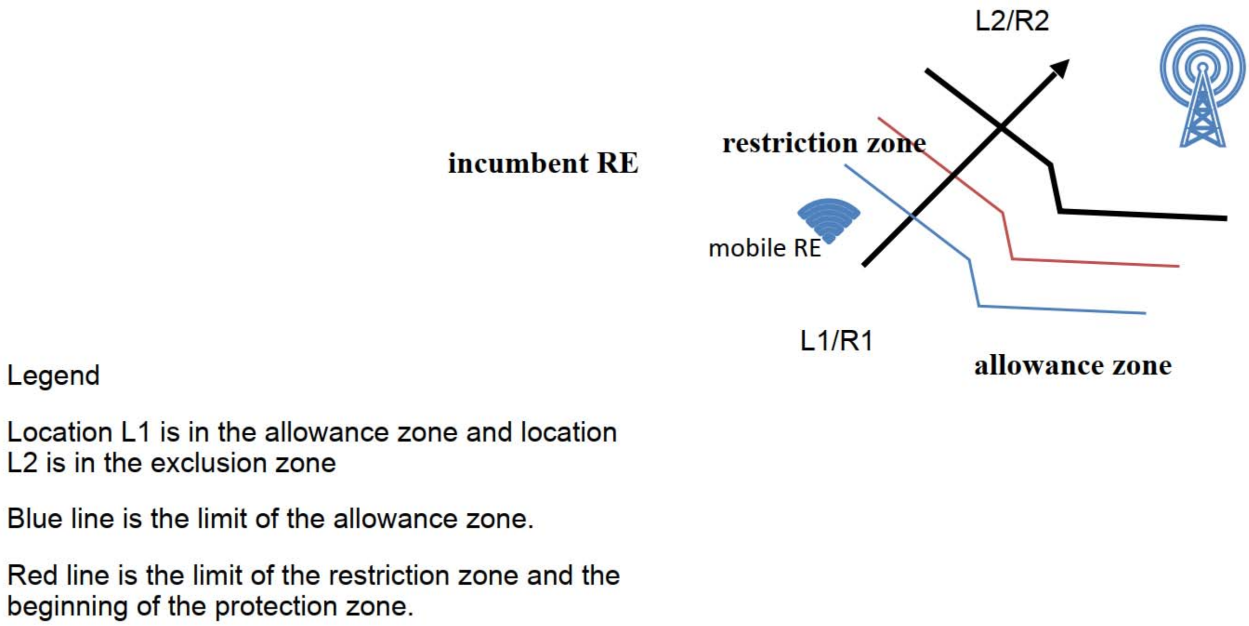

Figure A.1: Requirements for the mobile RE Change with Location

The set of requirements R proposed for examination is as follows.

1) The Location-Based compliant (LB) RE is designed so that the RE is by default be placed in receive only mode for a fixed period of time:

   a) upon power-up; or

   b) after commissioning; or

   c) after reconfiguration; or

   d) if the policy requires it, at fixed time intervals.

2) This fixed period is greater than the time normally necessary for determining its location, i.e. the determination period.

3) The LB RE does not enable transmission mode if the location of the RE cannot be determined.

4) The LB RE does not determine its location if two geographically relevant coordinates cannot be determined within its determination period.

5) The LB RE does not determine its location if the determination period cannot be determined using reliable and accurate time-stamps.

6) The LB RE does not determine its location if the accuracy of the determination is not reliably verified and is not compliant with the policy rules.

7) The LB RE does not determine its location if it cannot verify that its policy rules are updated and valid.

These requirements are examined for implementation in several steps. The steps may be described as follows:

STEP 0: The RE is in standby mode while it acquires information regarding its requirements status. Depending on its capabilities, the RE might perform a self-check in order to confirm its standby status by verifying that it complies with its own set of standby requirements.

In this step, a standby requirement set is complied with by running a standby setup reconfiguration that would be *R-FUNC-RHR-01: Reconfiguration for each WD*. The standby requirements set are always present in the firmware of the RE. Depending on the technology used, a self-check should enable the RE to confirm its own requirements.

Also in this step, the system might be using its *R-FUNC-REC-01: Gathering and processing function* in order to prepare to update its location and gather any relevant information regarding its spectrum usage allowance.

For Reconfigurable Radio Systems, STEP 0 is the default status where the system wakes up from power off and reboot in general, and where an important requirement is to control the spectrum usage, meaning in particular for the RIE, that it is not allowed to transmit.

The RRS subject to software and firmware updates should by default go to standby mode with transmission off, thus being in STEP 0 for the purpose of this process.

STEP 1: The RE verifies the location information and authenticates it. After confirming its current location, the system may reconfigure the RIE for active transmission mode if the requirements associated to its current location allow it. Also STEP 1 may bring the RRS from the STEP 0 - standby mode in an active mode based on the actual location where the RE finds itself.

The RE gets the location related information and it verifies its authenticity using *R-FUNC-MOB-04: Support of authentication.* Depending on the capabilities of the RRS, the location information is checked for accuracy with *R-PERF-KPI-CON-01: Accuracy of the localization estimation* and integrity *R-PERF-KPI-CON-02: Integrity of the localization performance.*

In order to optimize radio spectrum utilization, and depending on its technological capabilities, the system performs an assessment of the geometrical constellation of all active and passive WDs, using *R-PERF-KPI-CON-03: Geometric constellation of WD*.

Having decided on the requirements associated to its current location, the RE may reconfigure to an active RIE in radio spectrum use with compliance of local requirements for transmission. This reconfiguration is performed by *R-FUNC-RHR-01: Reconfiguration for each WD.*

STEP 2: While in STEP 2, the RE acquires location information signaling a change from current requirements to a different set of requirements. STEP 2 is the step where the RE triggers the reconfiguration based on the change of requirements related to the change of location.

Using its *R-FUNC-REC-02: Support of trigger events for reconfiguration*, the moving RE determines the change in requirements, due to its location being changed by crossing the blue line.

If necessary, when location related information is unavailable, the RE adapts its location determination methods for a clear location determination, using *R-PERF-KPI-CON-07: Location methods*.

If the location determination fails or location information is unavailable for whatever reason the RE is returned to standby mode in STEP 0. Otherwise the RE progresses to STEP 3.

STEP 3: The RE changes the Radio Interface in order to adjust it for compliance with the local requirements.

NOTE: This step is different from STEP 1 due to the fact that the RE started from an authenticated location and it changed due to a trigger event.

The reconfiguration is performed using the functionality covered by the *R-FUNC-RHR-01: Reconfiguration for each WD* and *R-FUNC-REC-03: Support for reconfiguration function.*

STEP 4: The RE is ready to acquire new information regarding the local requirements for its radio interface. In this step, the mobile RE performs an update of the requirements that are updatable using the *R-FUNC-REC-06: Support of information provisioning function* and *R-PERF-KPI-COM-02: Reliability of the communication link* in order to ensure that the requirements are updated and aligned with the local regulatory demands.

In this process the time factor is important for allowing the RE to correctly implement the RIE for this concept.

Furthermore, here is an examination of the change of location in Figure A.1.

As the mobile RE moves from location L1 to location L2, the requirements change with location reflecting the transition from an allowance zone to the exclusion zone.

In L1 the mobile RE is allowed to transmit on its assigned spectrum resource.

Upon moving across the border line into the restriction zone, the RE determines this change in location and reconfigures as per STEP 2 *R-FUNC-REC-02: Support of trigger events for reconfiguration*, and the reconfiguration of STEP 3. In the restriction zone some of the requirements and parameters are different from those in the allowance zone, and the requirements in the restriction zone setup the transition of the mobile RE in order to prepare its transition into the protection zone.

When the mobile RE moves from the restriction zone to the protection zone, the requirements change to those that ensure that incumbent receivers are not be subject to harmful interference caused by unauthorized radio equipment transmissions. All along this transition from restriction zone to protection zone STEP 4 is active and is cycled through. In STEP 4 the requirements and more specifically, regulatory restrictions are updated in a way that corresponds to the speed of the change in location, and that does not create a risk of interference to the incumbent in the exclusion zone.

Finally the transition across the black line and into the exclusion is prepared by the STEP 2 and STEP 3, thus putting the mobile RE in state of compliance with the L2 local requirements for the exclusion zone, where the mobile device cannot transmit because it does not have assigned spectrum resource to use.

History

Document history		
V1.1.1	March 2019	Publication
V1.2.1	September 2022	Publication