Requirements for WiMAX Forum® Release 2.2

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1. Introduction (*Informative*)

This document specifies the stage-1 requirements to support WiMAX Release 2.2 features. Release 2.2 includes key features of co-existence between R1/R2 mode and Additional Element within WiMAX Release 2.1. These requirements are specified for WiMAX Systems from the perspective of network operators. This document on requirements specifies usage scenarios, functional requirements, and performance guidelines for WiMAX Release 2.2. Architecture details for this feature shall be specified in WiMAX stage-2 and stage-3 specifications based on the requirements specified in this document.

2. References

Other specifications, articles, books, or technical references are referenced through the specification.

[1] Internet Engineering Task Force - RFC: 2119.

3. Objective and Scope

The objective of this specification is to specify requirements for WiMAX Systems to support release 2.2. Release 2.2 includes features of co-existence between R1/R2 mode and Additional Element. Typical key features are load balancing and interworking between R1/R2 mode and AE, and carrier aggregation among release 2.1. This specification will define network and air interface requirements for WiMAX Systems

An objective of this specification is to ensure the solution shall be backward compatible with these previous WiMAX releases:

1) Network: Releases 1.5, 1.6, 2.0, and 2.1.
2) Air Interface: Release 2.1 (including coexistence in IEEE802.16e-IEEE802.16m mixed mode) and Release 1.0 (as specified in T24-002-R010_TPA).

The scope of this specification is to define requirements for WiMAX Systems in supporting WiMAX Release 2.2 and includes, but is not limited to, the following aspects:

1) Requirements related to synchronization of WiMAX and LTE TDD networks to mitigate interference.
2) Requirements related to the radio for the purpose of interference mitigation when WiMAX and LTE networks are simultaneously operating in the same band.
3) Requirements relevant to in-band carrier separation of the two networks.
4) Requirements related to co-existence support by WiMAX ASN & CSN and LTE RAN and core-network.
5) Requirements related to performance impacts to WiMAX Systems.

4. Background (*Informative*)

Air-Interface Coexistence Scenarios

There are several deployment scenarios for R1/R2 mode and AE in WiMAX Release 2.1 coexistence:

- R1/R2 mode and AE in WiMAX Release 2.1 coexisting in the same band.
- R1/R2 mode and AE in WiMAX Release 2.1 coexisting in the different band.

Core Deployment Scenarios

Two core deployment scenarios are possible when R1/R2 mode and AE in WiMAX Release 2.1 coexist and are operated by the same provider:

- R1/R2 mode and AE in WiMAX Release 2.1 connected to their respected cores but share some common core resources (e.g. HA, AAA, billing).

Deployment Challenges

Service providers may face deployment challenges that may result in performance degradation of one or both networks. In the following sections, we will explain some of the deployment challenges.

5. Abbreviations, Definitions, and Conventions (*Informative*)

5.1 Conventions (*Informative*)

The keywords “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in Ref [1] RFC 2119.

5.2 Abbreviations and Acronyms (*Informative)*

3GPP	3rd Generation Partnership Project
AAA	Authentication, Authorization, and Accounting
AE	Additional Element
BS	Base Station
BSID	Base Station Identifier
CMIP	Client Mobile IP
eNB	evolved Node-B
FA	Foreign Agent
HA	Home Agent
HDTV	High Definition Television
IMS	IP Multimedia Subsystem
LTE	Long Term Evolution
NIC	Network Interface Controller
PMIP	Proxy Mobile IP
R1	Release 1
R2	Release 2
RAN	Radio Access Network
SIM	Subscriber Identity Module

5.3 Definitions (*Informative*)

5.3.1 WiMAX Network

For the purpose of this specification, WiMAX Network refers to the concatenation of the ASN and the CSN network nodes and services.

5.3.2 WiMAX System

For the purpose of this specification, WiMAX System refers to the concatenation of the WiMAX Network & the User Device.

5.3.3 LTE Network

For the purpose of this specification, LTE Network refers to the concatenation of LTE RAN and core network nodes and services.

5.3.4 LTE System

For the purpose of this specification, LTE System refers to the concatenation of the LTE Network & the User Device.

6. Use Cases (*Informative*)

6.1 Use Case 1 – WiMAX Release 2.2 Network, WiMAX Release 2.2 Device

6.1.1 Short Description

An operator with WiMAX Release 2.1 System operates R1 mode and AE. The use case discusses the scenario that the MS capable of Release 2.2 AE selects an appropriate system between Release 2 and Release 2.1 AE based on the radio load of BSs and hands off between Release 2 BS and Release 2.1 AE BS.

6.1.2 Actors

John is a user of a WiMAX Release 2.1 Additional Element MS covering the full 2.5 GHz band.

Ned who works for the carrier is in charge of managing/configuring the Release 2.2 network.

6.1.3 Pre-Conditions

The 2.5 GHz band is fully deployed using the M2500T-01 profile, with Release 2 10MHz, 2 FA. An operator is going to deploy WiMAX Release 2.2 AE 20MHz, 1FA. WiMAX Release 2 and Release 2.1 system are connected to each core network respectively. Home AAA and Home Agent are shared between those core networks. Each BS in each Release 2 and Release 2.1 AE is interconnected, and radio resource information is shared.

6.1.4 Post-Conditions

After deploying Release 2.1 AE 20MHz, 1FA, a user is connected to WiMAX Release 2 BS 10MHz, 2 FA in a case that WiMAX Release 2.1 AE BS does not have enough radio resource for that user, and still enjoy broadband communication. Also, when a user is going to WiMAX Release 2 area out from Release 2.1 AE coverage, interwork between WiMAX Release 2.1 AE and Release 2 system keeps the session, and a user can enjoy seamless communication.

6.1.5 Normal Flow

1. One day, Ned stops 2 FAs of WiMAX Release 2 BS and launches WiMAX Release 2.1 AE BSs in a specific area, interconnecting these with neighbor WiMAX Release 2 BSs respectively.

   John has WiMAX Release 2.1 capable MS. After WiMAX Release 2.1 AE BS launched, John's MS selects WiMAX Release 2.1 AE system. If it is out of range from WiMAX Release 2.1 AE, then John's terminal selects WiMAX Release 2 BS.

2. In a case that WiMAX Release 2.1 AE BS does not have enough radio resource, then John's terminal is connected to WiMAX Release 2 BS by direction from BS.

3. When John moves to out of range from WiMAX Release 2.1 AE area, John hands off to WiMAX Release 2 system. The session is kept between core networks and communication continues seamlessly.

6.2 Use Case 2 – Handover between WiMAX and LTE

6.2.1 Short Description

This use case describes the scenarios of network selection for handing over application connection between LTE and WiMAX RANs and vice versa.

6.2.2 Actors

Mark is a WiMAX R2.2 user who has a subscription to both WiMAX and LTE TDD with a dual-mode device.

6.2.3 Pre-Conditions

Mark is a heavy data user who often watches HDTV programs on his smart phone on the move (walking, on public transportation systems, or in a car). The HDTV program requests at least 2Mbps transmission speed, 500ms packet delay bound and less than a 2% packet error rate on the downlink. The WiMAX MS can report the link quality, loading, and QoS requirements of the application connection(s) to Network Selection Entity (NSE).

Network selection decision is negotiated between LTE and WiMAX networks.

6.2.4 Post-Conditions

NSE can be co-located with WiMAX BS/LTE eNB or put into WiMAX and/or LTE core network.

6.2.5 Normal Flow

Handover from LTE to WiMAX

Step 1: Mark is watching a HDTV program via an LTE network while waiting at a bus stop.

Step 2: After Mark gets on the bus and finds that the surrounding LTE RANs to be too busy to support viewing an HDTV program.

Step 3: Mark's MS turns on the WiMAX NIC, starts measuring the link quality and loading of surrounding WiMAX RANs, and reports the measurement results to the NSE.

Step 4: The NSE selects target WiMAX BSs and sends the BSID list to the MS.

Step 5: The MS selects one BSID from the BSID list and starts the attach procedure as well as PMIP/CMIP handover procedure for the application connection(s).

Step 6: The MS releases LTE RAN resource and turns off the LTE NIC.

6.2.6 Alternative Flow

Handover from WiMAX to LTE

Step 1: Mark is watching a HDTV program via a WiMAX network while waiting at a bus stop.

Step 2: After Mark gets on the bus and finds that the surrounding WiMAX RANs to be too busy to support viewing an HDTV program.

Step 3: Mark's MS turns on the LTE NIC, starts measuring the link quality and loading of surrounding LTE RANs, and reports the measurement results to the NSE.

Step 4: The NSE selects target LTE eNBs and sends the CellID list to the MS.

Step 5: The MS selects one CellID from the CellID list and starts the attach procedure as well as PMIP/CMIP handover procedure for the application connection(s).

Step 6: The MS releases WiMAX RAN resource and turns off the WiMAX NIC.

7. Requirements (*Conditional Normative*)

7.1 Service Requirements

R-[1] WiMAX Release 2.2 SHALL support load-balancing between LTE TDD and WiMAX RAN.

R-[2] WiMAX Release 2.2 SHALL support load-balancing within a base station or between a pico and macro.

7.2 Functional Requirements

R-[3] WiMAX Release 2.2 SHOULD support LTE TDD and WiMAX on same frequency band.

R-[4] WiMAX Release 2.2 SHOULD support self-organized and self-healing networks.

R-[5] WiMAX Release 2.2 SHALL provide specification to support S2a (trusted non-3GPP WiMAX) interface. 3GPP specifications are still under study.

R-[6] Handover between Release 2.1 AE and Release 2.1 R1/R2 mode SHALL be supported.

7.3 System Requirements

R-[7] A WiMAX Network supporting LTE TDD co-existence SHALL be backward compatible with a WiMAX network, which doesn't support LTE TDD co-existence.

R-[8] A WiMAX BS supporting LTE TDD co-existence SHALL be able to interwork with a WiMAX BS that does not support LTE TDD coexistence.

R-[9] When a WiMAX Network is reconfigured to support WiMAX and LTE TDD co-existence in the same band, the WiMAX System MAY use over-the-air device configuration procedures to perform channel plan reconfiguration.

7.4 Roaming Requirements

R-[10] WiMAX Release 2.2 AE MS SHALL be able to roam with LTE TDD only network.

R-[11] LTE TDD only UE SHALL be able to roam with WiMAX Release 2.2 BS supporting AE.

7.5 Accounting and Management Requirements

R-[12] WiMAX Release 2.2 SHOULD provide a model for WiMAX AAA (non-physical SIM or SIM) and LTE/IMS HSS (SIM) to be able to interwork.

7.6 Performance Requirements

R-[13] WiMAX Release 2.2 SHOULD minimize any reduction in spectrum efficiency of the WiMAX network.

R-[14] WiMAX Release 2.2 SHOULD minimize any reduction in spectrum efficiency of WiMAX or LTE when using adjacent frequencies.