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Re:	Call for comments	
Abstract	In this contribution, we propose to define some primitives for radio resource management process.	
Purpose	Adoption	
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Primitives for Radio Resource Management

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1 Introduction

WiMAX Forum Network Working Group (NWG) prepared a draft Stage-2 document on “WiMAX End-to-End Network Systems Architecture - Stage 2: Architecture Tenets, Reference Model and Reference Points” [1]. This also includes sections on Radio Resource Management (RRM): Functional Requirements, Functional Entities, Reference Model, Protocol and Procedures [2]. In particular, NWG proposed RRM primitives for information exchange between Base Stations (BS) or between a BS and a central component within a WiMAX network.

It is understood that the essential radio related parts of these RRM primitives shall be mapped into 802.16g [3]. So there is an overlap between the WMF NWG documents and 802.16g. This contribution aims at presenting the current status of the RRM protocol work in WiMAX Forum NWG to the IEEE 802.16g Working Group. Work on Stage-2 including RRM procedures is ongoing in WMF NWG, and feedback from 802.16g (NETMAN) is welcome. The authors are members of the RRM subteam in WMF NWG.

2 Current RRM concepts

RRM is defined as:
Measurement, *exchange*, and *control* of *radio resource-related indicators* (e.g. current subchannel allocations to service flows) in a wireless network.

> *Measurement* refers to determining values of standardized radio resource indicators that measure or assist in estimation of available radio resources.
> *Exchange* refers to procedures and primitives between functional entities used for requesting and reporting such measurements or estimations. The resulting information from exchange may be made available within the measuring station (using proprietary procedures and primitives), or, to a remote functional entity (using standardized procedures and primitives).
> *Control* refers to decisions made by the measuring station or remote entity to adjust (i.e. allocate, reallocate or deallocate) radio resources based on the reported measurements, other information, or using proprietary algorithms, and communicating such adjustments to network entities using standardized primitives. Such control may be local and remote from the measuring station

RRM procedures may provide *decision support* for one or more of the following WiMAX network functions. However, RRM specification shall not be tied to any one of these functions.

> **MS Admission Control** and **Connection Admission Control** – i.e. ascertaining a priori that required radio resources are available at a potential target BS before handover.
> **Service Flow Admission Control** – i.e. creation or modification of existing/additional service flows for an existing MS in the network.
> **Selection of values for Admitted and Active QoS parameter sets** for Service Flows.
> **Load Control** – manages situation where system load exceeds the threshold and some counter-measures have to be taken to get the system back to feasible load.

Handover preparation and Control – for improvement/maintenance of overall performance indicators (for example, RRM may assist in system load balancing by facilitating selection of the most suitable BS during a handover.)

According current NWG and 802.16g concepts, RRM is performed by help of two entities:
1) Radio Resource Agents (**RRA**), located in the BSs, and
2) One or more Radio Resource Controllers (**RRC**), located anywhere in the Network Control and Management System (**NCMS**).
RRM related communication can occur between
- RRA and RRC, and
- Among RRCs.

This communication is based on RRM primitives.

3 Primitives

Currently, the following RRM primitives have been specified

Name	Source	Destination	Purpose	Reporting or Decision support
RRM-PHY-parameters-request	RRC	RRA	Request for PHY-report, per MS.	Request reports from RRA
RRM-PHY-parameters-report	RRA	RRC	Assessment of link level quality per MS.	Reporting from RRA to RRC
RRM-Spare-capacity-report	RRA/RRC	RRC	Per-QoS profile capacity report per BS.	Request reports from RRA; Request reports from RRC
RRM-Spare-capacity-request	RRC	RRA/RRC	Request for spare capacity report per BS.	Reporting from RRA to RRC; Reporting between RRCs
RRM-Neighbor-BS radio resource status update	RRC	RRA	Update the broadcasted Neighbor BS list	Decision support

Table 1: Primitives for RRM

The first four are for measurement report from a BS to any other entity in the ASN; the fifth one is an example of “Decision Support”: The RRM entity updates the neighbor BS list to be used by a Serving BS in Handover procedures.

4 Proposed Text Changes

[*Modify section 14.5.12 as follow*]

14.5.12 Radio Resource Management

14.5.12.1 Radio Measurements and Reporting

The RRM Primitives are a set of primitives for supporting RRM procedures between BS and NCMS.

14.5.12.1.1 RRM Primitives

14.5.12.1.1.1 RRM Spare Capacity Request Primitive

The Radio Resource Controller (RRC) may use this primitive to request a BS to provide spare capacity information to the RRC. Note that the RRC may be located in another BS, or in a central entity in the NCMS.

RRM Type
Indication of RRM type: Spare Capacity Request
Sender NCMS Node ID
NCMS Node or BS unique identifier
Target NCMS Node ID
NCMS Node or BS unique identifier
Spare Capacity Report Type
Type of requested report profile. 1 for spare capacity report type 1. (Types > 1 reserved for future types)
Report Characteristics
Indicates whether report should be sent periodically, or event driven. Following events are possible:

Completion of Network Entry
Deregistration of MS
Adding / changing / deleting connections
MOB_MSHO-REQ received from MS
MOB_SCAN-REPORT received from MS
Association performed by MS
MOB_HO-IND received by Serving BS
Completion of network re-entry at Target BS after HO
Report solicitation from RRC

14.5.12.1.1.2 Spare capacity report primitive

The BS may use this primitive to provide spare capacity information to the RRC, as requested by the RRC within the Spare Capacity Request Primitive. This Spare Capacity Report Primitive exists in two types: Type 1 for reporting a range of Spare Capacity Indicators (SCI) for a range of Physical Service Level (PSL) values, and Type 2 for reporting a single SCI associated to a single pair of UL PSL and DL PSL.
Type 1 is for reporting a range of Spare Capacity Indicators (SCI) for a range of Physical Service Level (PSL) values.

RRM Type
Indication of RRM type: Spare Capacity Report
Sender NCMS Node ID
NCMS Node or BS unique identifier
Target NCMS Node ID
NCMS Node or BS unique identifier
Spare Capacity Report Type

Type of report profile = 1

Available Radio Resource

Percentage of reported average available subchannels and symbols resources per frame, in steps of 20%: (0%, 20%, 40%, 60%, 80%, 100%, as defined in [802.16e/D9], section 6.3.2.3.47)

DCD Configuration Change Count

This represents the Neighbor BS current Downlink Channel Descriptor (DCD) configuration change count

UCD Configuration Change Count

This represents the Neighbor BS current Uplink Channel Descriptor (UCD) configuration change count

14.5.12.1.1.3 PHY report request primitive

The Radio Resource Controller (RRC) may use this primitive to request a BS to provide a report of the link level quality for a specific MS.

RRM Type

Indication of RRM type: Physical Parameters Request

Sender NCMS Node ID

NCMS Node or BS unique identifier

Target NCMS Node ID

BS unique identifier

MS ID

48-bit unique identifier of the MS

14.5.12.1.1.4 RRM PHY report primitive

The BS may use this primitive to provide a report of the link level quality for a specific MS to the Radio Resource Controller (RRC).

RRM Type

Indication of RRM type: : Physical Parameters Report

Sender NCMS Node ID

BS unique identifier

Target NCMS Node ID

NCMS Node or BS unique identifier

MS ID

48-bit unique identifier used by MS

Downlink Physical Service Level

Channel rate available for the MS calculated as a multiple of 1/32 of nominal bandwidth in the correspondent direction assuming 1 bit/Hz. For example, if DL channel bandwidth is 10 MHz, value PSL=4 means 4*1/32*10 Mbps = 1.25 Mbps. 1 PSL 96 (Number of sub channels in different OFDMA modes is multiple of 16 or 32; highest modulation (QAM64) provides 3 bits/Hz)

Downlink RSSI mean

As specified in 8.1.9 Channel quality measurements [802.16-2004].

Downlink RSSI standard deviation

As specified in 8.1.9 Channel quality measurements [802.16-2004].

Downlink CINR mean

As specified in 8.1.9 Channel quality measurements [802.16-2004].

Downlink CINR standard deviation

As specified in 8.1.9 Channel quality measurements [802.16-2004].

Uplink Physical Service Level

Channel rate available for the MS calculated as a multiple of 1/32 of nominal bandwidth in the correspondent direction assuming 1 bit/Hz. (see definition of Downlink Physical Service Level)

Uplink RSSI mean

As specified in 8.1.9 Channel quality measurements [802.16-2004].

Uplink RSSI standard deviation

As specified in 8.1.9 Channel quality measurements [802.16-2004].

Uplink CINR mean

As specified in 8.1.9 Channel quality measurements [802.16-2004].

Uplink CINR standard deviation

As specified in 8.1.9 Channel quality measurements [802.16-2004].

14.5.12.1.1.5 RRM Neighbor-BS Radio Resource Status Update primitive

This primitive can be used by RRC to inform a Serving BS about the list of Neighbor BS's which are potential HO Target Base Stations for any MS's being served by the SBS, including an information about their radio resource status

RRM Type

Indication of RRM type: Neighbor-BS Radio Resource Status Update

Sender NCMS Node ID

NCMS Node or BS unique identifier

Target NCMS Node ID

BS unique identifier

N NEIGHBORS

Number of neighbor BS's

For (j=0; j<N NEIGHBORS; j++) {

BS Identity

Unique identifier of BS

Available Radio Resource

Percentage of reported average available subchannels and symbols resources per frame, in steps of 20%: 0%, 20%, 40%, 60%, 80%, 100%, as defined in [802.16e/D9], section 6.3.2.3.47:

DCD Configuration Change Count

This represents the Neighbor BS current Downlink Channel Descriptor (DCD) configuration change count

UCD Configuration Change Count

This represents the Neighbor BS current Uplink Channel Descriptor (UCD) configuration change count

}

14.5.12.1.2 RRM Procedures

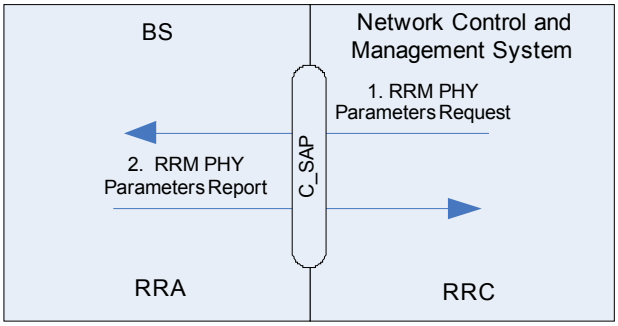

Figure 1: Example Primitive Flow of Physical Parameter Report

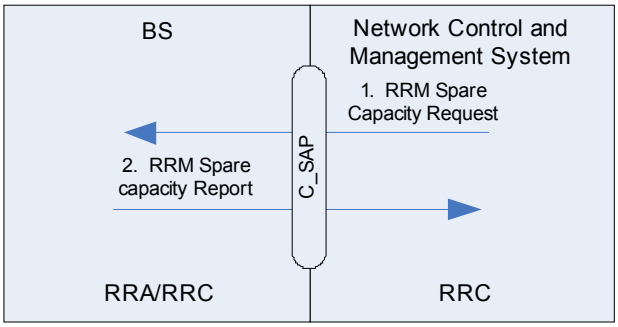

Figure 2: Example Primitive Flow of Spare capacity Report

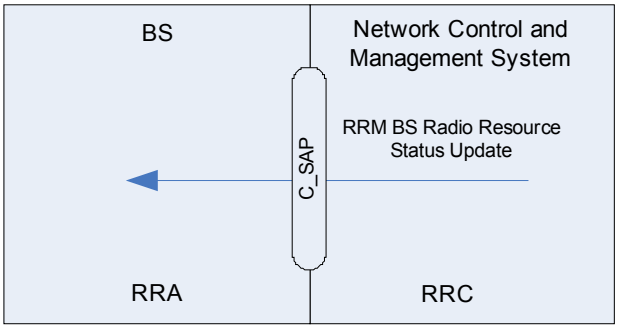

Figure 3: Example Primitive Flow of Radio Resource Status Update

5 References

[1] WiMAX NWG Stage-2 specification, at WiMAX NWG Server under http://www.wimaxforum.org/apps/org/workgroup/nwg/document.php?document_id=1678

[2] Radio Resource Management (RRM) text for WiMAX NWG Stage 2 specification; http://www.wimaxforum.org/apps/org/workgroup/nwg/document.php?document_id=1572

[3] IEEE 802.16g baseline document 802.16g-04/03r2, http://ieee802.org/16/netman/docs/80216g-04_03r2.pdf

[4] IEEE 802.16g Protocol Architecture Model. http://www.wirelessman.org/netman/contrib/C80216g-05_010r1.pdf