Recommendations and Requirements for Device Reported Metrics and Diagnostics on WiMAX Forum Certified™ Products - Phase 1

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1 Introduction

IEEE Std 802.16™ is an emerging suite of standards for Broadband Wireless Access (BWA). IEEE Std 802.16e™ amendment to the IEEE 802.16 base specification enables combined, fixed, and mobile operation in licensed and license-exempt frequency bands under 11 GHz. IEEE Std 802.16 defines a high-throughput packet data network radio interface capable of supporting several classes of Internet Protocol (IP) applications and services including isochronous applications such as Voice Over IP (VoIP) and applications with bursty data access profiles such as TCP applications.

This is the first of a three-stage, end-to-end network system architecture specification for broadband wireless networks based on WiMAX Forum Certified™ products. This document specifies recommendations and requirements for such networks from the perspective of network operators intending to deploy WiMAX networks. It describes business and use cases, deployment models, functional requirements, and performance guidelines for the end-to-end system. Architecture details shall be specified in stage-2 and stage-3 specifications based on requirements outlined in this document.

During the course of the development of this document, a progressive phased approach to the development of the WiMAX network capability was identified to be able to build networks and network components on a timely basis, yet ultimately produce a full-featured network.

This work will be governed by the objectives of the WiMAX Forum™. While this work is aligned with the IEEE 802.16 suite of standards, there is a need and opportunity to address issues that go beyond the IEEE 802.16 standards. These issues could be in areas that are covered by other standards, or not covered by any other standards. Throughout the rest of this document, the terms *WiMAX networks* and *WiMAX technology* will be used to loosely refer to the networks and technology that are the focus of this specification. The term *WiMAX Forum Certified* will be used formally to refer to certified products.

2 Scope

2.1 Overall Scope

The present document defines the use cases and the requirements for the Device Reported Metrics & Diagnostics (DRMD) feature.

The overall scope of this DRMD feature applies to both devices and network and includes the following:

1. To ensure backward compatibility is maintained for features or functions already in Rel 1.0 and Rel 1.5,
2. Description of use cases for Device Reported Metrics and Diagnostics,
3. To define requirements for the metrics to be reported by the User Devices to the DRMD Server (e.g., frequency, initiation criteria),
4. To identify WiMAX device metrics (e.g., radio condition, KPI measurement). For metrics related to air interface (e.g. RSSI, CINR, HARQ.ARQ re-transmission), it is necessary to look at them from both BS and the device perspectives,
5. To investigate the complementary roles of BS & User Device metrics,
6. To investigate the WiMAX device metrics required to support Self Organizing Network (SON) as defined in e.g., IEEE, 3GPP, NGMN, etc.,

7. To minimize development time & cost/complexity of implementation by leveraging existing WiMAX protocols such as WiMAX OTA activation and provisioning. Protocols for metrics collection,
8. Identification of potential impacts and requirements (e.g., user privacy, security, charging, roaming, increased signaling load),
9. Identifying type(s) of device or class(es) of device to which the feature will apply, e.g., to determine whether or not this feature should be optional or mandatory to some or all type(s) or class(es) of devices.

2.2 Phase 1 and Phase 2 Scope

To meet the industry trend and the service providers' business requirements, the specification and development of the DRMD feature is divided into two phases - Phase 1 and Phase 2.

In general the overall scope as described above applies to both Phase 1 and Phase 2, however with the phase specifics noted below:

- **Phase 1**: Phase 1 will concentrate on developing the DRMD functionality based on a simplified and limited set of high priority metrics with a limited set of reporting and diagnostics options to reduce the complexity of implementation. Specifically, Phase 1 focuses on the following:
    1. Define only a simplified and limited set of use cases,
    2. Define only *basic* requirements for metrics collection from *User Devices*,
    3. Identify only *a limited set* of high priority metrics,
    4. Provide for extensions to ensure backward compatibility for the subsequent Phase 2 functionality,
    5. Identify device type(s) upon which the DRMD functionality will be applicable.

NOTE: The italicization is to emphasize the differences between the phase 1 scope and the overall scope.

The working principles used in defining Phase 1 requirements include the following:

- Metrics are reported by the device at the request of the network rather than reported automatically by the device to the server,
- There is no specific consideration of issues associated with roaming,
- Only TDD systems are supported (FDD is not in the Phase 1 scope),
- Metrics are assumed to be collected by an integrated service provider, where the Network Access Provider (NAP) and Network Service Provider (NSP) are operated by the same service provider,
- There are no additional requirements placed on the 802.16 air interface (MAC/PHY), instead the focus is on collection of data that is already available,
- The collection of metrics does not imply significant additional hardware and software complexity on the device,
- There are no requirements on diagnostic self test by the User device.

- **Phase** 2: Phase 2 will focus on developing a more comprehensive capability of the DRMD feature.

3 Abbreviations, Definitions, and Conventions *(Informative)*

3.1 Conventions *(Informative)*

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in RFC 2119 Ref [3].

3.2 Abbreviations and Acronyms (*Informative)*

3GPP	Third Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
BS	Base Station
BSID	Base Station Identifier
CID	Cell Identifier
CINR	Carrier Interference Noise Ratio
DM	Device Management
DRMD	Device Reported Metrics and Diagnostics
FDD	Frequency Division Duplex
GPS	Global Positioning System
HARQ	Hybrid Automatic Repeat Request
ICMP	Internet Control Message Protocol
KPI	Key Performance Indicator
MCS	Modulation Coding Scheme
MIMO	Multiple Input and Multiple Output
NAP	Network Access Provider
NAT	Network Address Translation
NGMN	Next Generation Mobile Network
NSP	Network Service Provider
OMA	Open Mobile Alliance
OTA	Over the Air
RSSI	Radio Signal Strength Indication
RTT	Round Trip Time
SDU	Service Data Unit
SON	Self Organizing Networks
TDD	Time Division Duplex

3.3 Definitions (*Informative)*

3.3.1 DRMD Client

The application in the User Device which receives the requests from the DRMD server; retrieves the requested metric data from various interfaces within the device; formats & returns the results to the DRMD server.

3.3.2 DRMD Server

The network entity that on behalf of a requesting entity in the netowrk, requests device metrics from the DRMD Client and prepares the collected device metrics for analysis.

4 References

[1] Recommendations and Requirements for Networks based on WiMAX Forum Certified Products, Release 1.5.

[2] WiMAX Device Reported Metrics and Diagnostic Work Item Description, WiMAX SPWG 2008 contribution number 347.

[3] RFC 2119 “Key words for use in RFCs to Indicate Requirement Levels”, S. Bradner, March 1997, URL:http://www.ietf.org/rfc/rfc2119.txt.

[4] IEEE P802.16-2004/Cor2/D3 “Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Corrigendum 2”.

[5] IEEE P802.16Rev2/D6 “Part 16: Air Interface for Broadband Wireless Access Systems.

[6] IETF RFC 1213 “Management Information Base for Network Management of TCP/IP-based internets: MIB-II.

[7] IETF RFC 4008 “Definitions of Managed Objects for Network Address Translators (NAT)”.

[8] IETF RFC 4293 “Management Information Base for the Internet Protocol (IP)”.

[9] WiMAX Over-The-Air General Provisioning System Specification," NWG Release 1.5.

5 Use Cases (*Informative)*

This section presents various use cases for Device Metrics. The scenarios in this section are not meant to be exhaustive and will be expanded as needed. The scenarios might use entities that are out-of-scope of Device Metrics for purposes of clarity.

In this decription we have split the use cases into “supporting” & “application” cases; where the supporting cases describe the underlying processes for metrics collection, & the application cases describe the various uses of these underlying cases to provide the diagnostics services to the end users. This is illustrated in Figure 1.

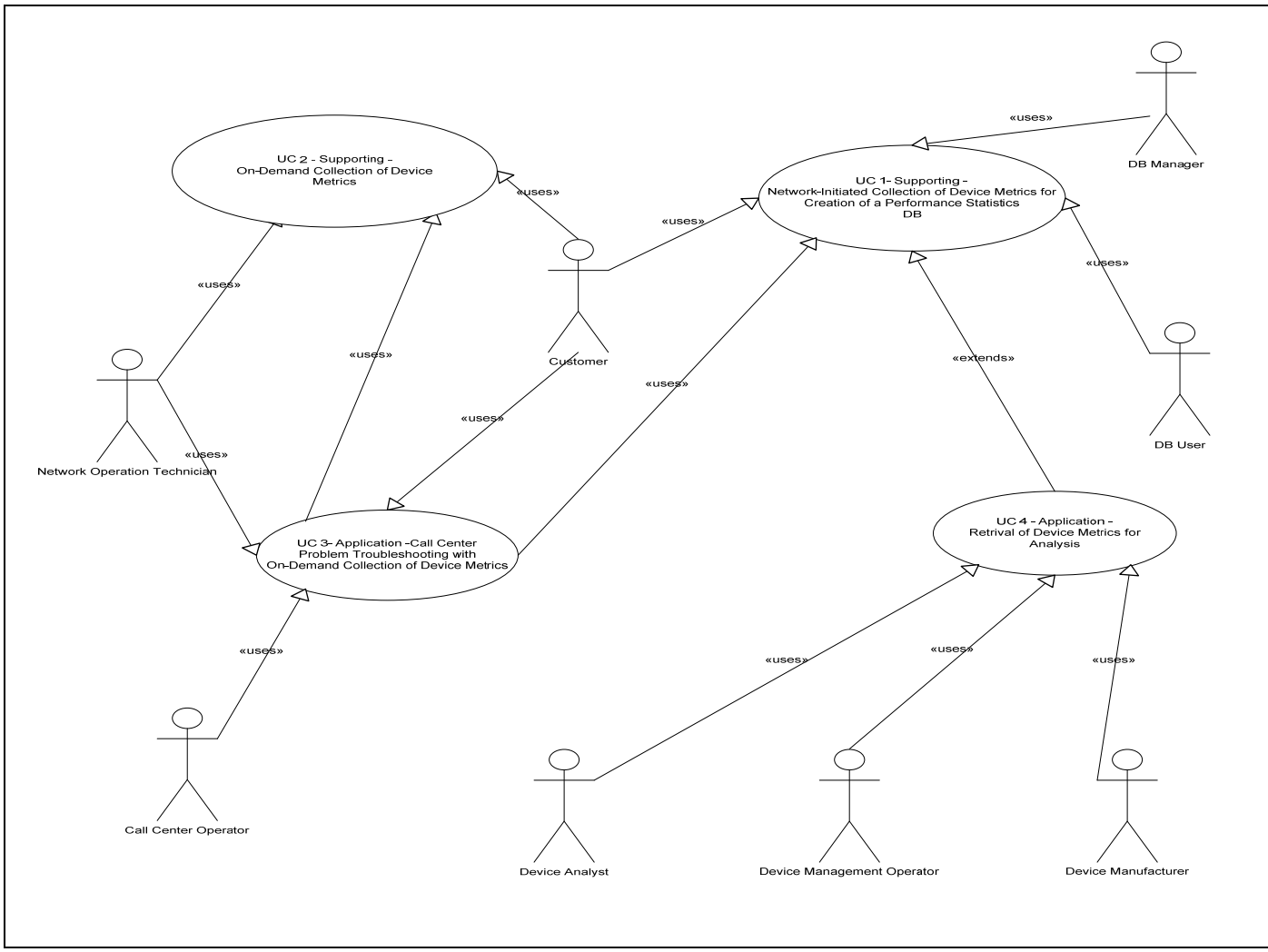

Figure 1: Usage models

5.1 Use case 1 – Supporting - Network-Initiated Collection of Device Metrics for Creation of a Performance Statistics Database (*Informative)*

5.1.1 Short Description

The purpose of this Use Case is to create a historic database of performance statistic metrics by retrieving them from User Devices active in the network. This database can then be used by various parties including customer service representatives (as described in use case 2), device performance analysts (as described in use case 3), network performance analysts; and by other parties whose use is beyond the scope of consideration by the WiMAX Forum. Contents of this database will typically include the device details (MAC address, make, model, version number), generic access information (serving BSID, frequency, etc.),

RF performance data (RSSI, CINR, etc); link activity (ping time, up/down data rates, uptime, etc) & device activity (e.g., time in active mode, time in idle mode) & environmental info (last reboot cause, device uptime, temperature, etc.) The database may be searched by many different dimensions to retrieve data for analysis.

5.1.2 Actors

Database Manager – The service provider's Database Manager controls the gathering of data from User Devices.
Database User – The Database User can be any authorized individual or functional entity that needs to use the data and/or, who may request that specific statistics be gathered.
Customer – Subscriber to the WiMAX service & user of the User Device.

5.1.3 Pre-conditions

User Devices are connected to the network which are capable of gathering & sending device metrics. Necessary Customers' permissions to gather the data (due to privacy concerns etc.) have been obtained; e.g., as part of a service contract.

5.1.4 Post-conditions

A database of performance statistics garnered from devices active on the network is available to Database Users.

5.1.5 Normal Flow

1. The Database Manager gathers from multiple Database Users their requirements for the statistic metrics to be gathered etc.
2. The Database Manager compounds these into a compound set of requirements that will meet all Database Users' requirements.
3. The Database Manager issues commands to the appropriate set of devices to start gathering metric statistics. These commands will be sent individually to each device defined by MAC address (note: additional options such as a broadcast request may be described in Phase 2 of this WI), and may include specific requirements as to the time period over which to gather cumulative statistics.
4. The Database Manager sets up a polling system to retrieve the statistics from each device, according to some schedule that is determined by network or server load or other factors specific to that operator.
5. The devices are polled by the database server according to the schedule & the retrieved data inserted into the database. Any errors in gathering the statistics (e.g., retrieval failure, function not supported by specific device type) are noted in the database also.
6. When the process of retrieval is complete according to the requirements from the user, the Database Manager informs the Database Users that the data is available on the database.

5.1.6 Alternative Flow

1. A Database User requests the Database Manager to gather specific metrics from a group of User Devices. The user may specify the metrics to be gathered & the time period(s) over which these metrics should be measured & the periodicity of their gathering.

2. The Database Manager compares the list of requirements from the user against the current list of statistics being gathered.
3. The Database Manager issues commands to the appropriate set of devices to start gathering metric statistics. These commands will be sent individually to each device defined by MAC address (NOTE: additional options such as a broadcast request may be described in Phase 2 of this WI), and may include specific requirements as to the time period over which to gather cumulative statistics (other trigger options may be included in Phase 2).
4. The Database Manager sets up a polling system to retrieve the statistics from each device, according to some schedule that is determined by network or server load or other factors specific to that operator.
5. The devices are polled by the database server according to the schedule & the retrieved data inserted into the database. Any errors in gathering the statistics (e.g., retrieval failure, function not supported by specific device type) are noted in the database also.
6. When the process of retrieval is complete according to the requirements from the user, the Database Manager informs the Database User that the requested data is available on the database.

5.2 Use case 2 – Supporting – On-Demand Collection of Device Metrics (*Informative)*

5.2.1 Short Description

A network operation technician requests the DRMD Client to send a current set of devicemetrics in real-time.

5.2.2 Actors

Customer – User of the operator's network whose device is under performing.
Network Operation Technician – person acting on behalf of the operator who has access to the DRMD server system.

5.2.3 Pre-conditions

The User Device is accessing the operator's network. The user has given permission for the diagnostic metric data to be retrieved. Some condition causes a Network Operator Technician to require retrieval of diagnostic metrics from the device in real time; e.g., the customer has called in with a complaint of poor service.

5.2.4 Post-conditions

The Network Operator Technician is presented with a set of diagnostics metrics that have been freshly retrieved from the device.

5.2.5 Normal Flow

1. Network Operator Technician obtains device identifying information from the user and/or subscription records.
2. Network Operator Technician sends a request to the diagnostic metrics server to retrieve the metrics from the device. This request may comprise a preset menu of metrics or may consist of a list of individual items (e.g. RSSI, CINR, Serving BSID, received data rate) , depending upon the nature of the problem being analyzed.
3. A request is sent out by the diagnostic metrics server to the DRMD Client.
4. The DRMD Client returns the requested metrics & they are presented to the agent.
5. Returned metrics may also be stored in the customer record (i.e. as part of the record of the current workflow) or a performance database.

5.2.6 Alternative Flow

- Device has become detached from network and an error message is returned to the Network Operator Technician or
- Device does not support diagnostic metrics and an error message is returned to the agent or
- Device does not support the full list of requested metrics & both the successfully-retrieved metrics & appropriate error messages ("function not supported") are returned to the agent & potentially stored in the customer record

5.3 Use case 3 – Application - Call Center Problem Troubleshooting with On-Demand Collection of Device Metrics (*Informative)*

5.3.1 Short Description

A Subscriber calls a Customer Care Call Center to report performance problems with his/her User Device. In order to troubleshoot the service, a Call Center Operator will collect customer information. If the Call Center Operator concluded the issues require more technical support, this call will be transferred to the Network Operation team. A Network Operation Technician collects performance data from various sources in the network, including performance event logs and/or by "on demand" metrics collection from the customer's User Device. Using the collected performance data, the Network Operation Technician will diagnose the cause of the problem and implement a solution, potentially with the assistance of the customer.

5.3.2 Actors

Customer – User of the operator's network whose device is under performing.
Call Center Operator – Service Provider tasked with addressing Subscriber concerns as they contact the Customer Call Center.
Network Operation Technician - This representative has the technical training on analyzing the performance data and on demand metrics to determine the root cause of customer reported problem.

5.3.3 Pre-conditions

The User Device is accessing the operator's network. The user experiences performance problems.

5.3.4 Post-conditions

Device is performing properly, a potential network problem has been reported/corrected; or the user is required to replace or update the device in order to clear the problem.

5.3.5 Normal Flow

1. The Subscriber calls the Service Provider Call Center to report an under performing service (e.g., low data rate).
2. The Call Center Operator queries the Subscriber for account identifying information, validates the customer and obtains relevant privacy permission.
3. The Call Center Operator asks the Subscriber to identify the affected device (assuming more than one device on the customer's account).
4. If the user is currently experiencing difficulty with their service and the User Device is attached to the network, the Call Center Operator transfers this call to the Network Operation Center.
5. The Network Operation Technician retrieves on-demand metrics data as described in use case 2 above, & retrieves historic data from the metrics database described in use case 1 above.
6. The Network Operation Technician analyzes the collected information and performs troubleshooting procedures on the network and/or User Device as appropriate. This may include:
    1. Updating of the user records & network provisioning,
    2. Updating of the User Device provisioned data or software/firmware,
    3. User action; e.g. to re-position the User Device for better signal, or to return a device for repair or replacement,
    4. Reporting network issues to the service provider network operation.

5.4 Use case 4 - Application - Retrieval of Device Metrics from Database for Analysis (*Informative)*

5.4.1 Short Description

The purpose of this Use Case is to identify and correct problematic devices by retrieving and analyzing device metrics from the metrics Database (e.g. on a periodic basis). For each device, the associated device model and firmware is identified which should facilitate to evaluate the overall performance of the device. Example metrics to be retrieved include CPU utilization, Memory utilization, etc., in addition to various performance metrics. The use case will end with a flow to verify that any detected problems are corrected.

5.4.2 Actors

Device Analyst– A Service Provider's Network Analyst that specializes in optimizing the device performance. This Device Analyst will determine that devices are using the network resources properly and

will report potentially faulty device firmware to the device manufacturer and verify its performance once it is installed.

Device Management Operator – A Services Provider's Operations Staff whose responsibility is to implement device metrics collection strategies, report device metrics and deploy device firmware.

Device Manufacturer – The manufacturer of the problematic device.

5.4.3 Pre-conditions

The User Devices have been in use for some time. The Device Management Operator has colleted historical metrics from the devices.

5.4.4 Post-conditions

The problematic devices' firmware has been updated and the new firmware is working at acceptable levels of performance and quality.

5.4.5 Normal Flow

1. The Device Analyst requests the retrieval of the targeted device metrics, which have been collected in the metrics Database as described in Use Case 1 above, from the Device Management operator and mines it for potential problematic devices. The analysis reveals potential firmware issues.
2. The Device Analyst requests new firmware from the Device Manufacturer based on the collected metrics.
3. The Device Manufacturer delivers the new firmware to the Device Management Operator.
4. The Device Management Operator informs the Device Analyst that a new firmware version will be installed.
5. The Device Management Operator collects metrics on the devices that just received the new firmware.
6. The Device Management Operator sends the collected metrics to the Device Analyst.
7. The Device Analyst verifies that the firmware is performing properly.

6 Requirements

The following sections describe a list of requirements needed in WiMAX Release 2.0 to support the Device Reported Metrics & Diagnostics (DRMD) feature and its associated services and capabilities. It should be noted that DRMD in general is an optional feature for both the device and the network, but if supported these requirements define the expected behavior, thus "Conditional Normative".

6.1 Operator Overview (Informative)

In the above use cases, as with other network management functions, the "users" of the gathered data are agents of the WiMAX network operator, so that the requirements listed here reflect the needs of network operators to analyze performance of their network & attached devices. Therefore this requirement is very specific in stating the metrics to be supported by the implementation, based on carrier experience, and on metrics known to be provided internally in WiMAX devices.

Duplication of functions within the network will be avoided by the use of the same mechanisms as other device management functions in release 1.5; there is no point in developing two separate functions to securely request & retrieve data from the device.

To further expedite implementation, although it would be preferable for all networks & User Devices to support all the metrics described in these requirements, it is recognized that this may not be possible; so that each metric parameter may be individually requested, & a separate response to each, including "not supported" be sent from the User Device. This will eliminate the need to keep & reference records of the diagnostic capabilities of the User Devices on a model by model or even revision-by-revision basis; & should be the basis for backwards compatibility with R1.5 devices that support the underlying device management protocols but do not support this additional feature. Similarly, the representation of a specific metric value should be common to all devices, to prevent the need for device-specific translation by the diagnostics server.

Estimates of the network traffic that may be generated by DRMD show that it may be a large multiple of that produced by other device management capabilities such as provisioning; for example, a device may only require provisioning once or twice per year, but diagnostic traffic will probably occur on a near-daily basis. The protocol & transmission formats used for DRMD therefore need to be very efficient in their use both of transmission & server capacity. To further optimize network use while keeping the DRMD client functions simplified in Phase 1, metric measurement messages should only be sent by the device upon request from the server, rather then being sent by the device unsolicited, so that the timing of retrieval from a large number of devices may be staggered by the server; & according to the priorities of the operator.

DRMD must not compromise user privacy; the prime issue here may be retrieval of user location; however, the solution to this issue may not require a real-time permission to be granted by the user, but may just need some form of "informed consent" to be granted by the subscriber in the service agreement which will allow the subscriber an opt-out option.

Network security must not be compromised by the deployment of DRMD; for example, it must not be possible to use DRMD to generate Denial of Service attacks on the network.

6.2 Functional Requirements (Conditional Normative)

6.2.1 System Requirements

R-[F001] The WiMAX Network Architecture SHALL be able to support the Device Reported Metrics and Diagnostic (DRMD) feature.

R-[F002] DRMD SHALL be supported by the same device management protocols used for OTA provisioning specification in NWG Rel 1.5 [9]. Support by other protocols is not required but MAY be provided.

R-[F003] DRMD SHALL enable the request and the retrieval of individual or a set of metric parameters as defined in Table 1 and Table 2.

R-[F004] DRMD SHALL allow concatenation of lists of metric requests into a single message.

R-[F005] DRMD SHALL be backwards compatible with Rel 1.5 devices and DM Server supporting the underlying device management protocols that do not support the DRMD feature.

R-[F006] The representation of specific metrics between the User Device and the DRMD server SHALL be identical across different device types using the same protocol, uless otherwise noted.

R-[F007] DRMD SHALL be able to support that the User Device reports metrics results only per request from the DRMD Server.

R-[F008] DRMD SHALL provide user privacy by supporting user permission for data retrieval.

R-[F009] DRMD SHALL support mutual authentication between the client and the server to allow only authorized request and retrieval of metrics by the service provider.

R-[F010] The response to a DRMD metric request SHALL be returned as soon as practical after the request is received by the User Device.

R-[F011] DRMD SHALL allow concatenation of list of metric responses into a single message.

R-[F012] The DRMD Client MAY perform other reporting/monitoring/diagnostic functions only if supported and permitted by the network operator.

6.2.1.1 Phase 1 Metrics Set

Tables 1 & 2 contain the limited set of high priority metrics.

Legend:

- **Metric #:** A number assigned to the said metric for easy identification purpose.
- **Name:** An abbreviated name assigned to the said metric for easy identification purpose.
- **Definition:** A text that outlines the nature of the said metric.
- **Reference:** The source standards where the said metric is defined or other source(s) of the said metric, e.g., IEEE 802.16, vendor(s), Service Provider(s). The reference identified for a given metric should only guide but not dictate the actual data format definition to be specified at Stage-2/3. If a source standard cannot be identified for a given metric then it will be noted as "Not Available" (which implies that they are to be identified and/or specified at Stage-2/3). **Note**: IEEE 802.16 Rev 2 information is included to ensure the design of phase 1 metrics are scalable, flexible to be evolved to the phase 2.

The metrics defined for the DRMD feature can either be WiMAX-specifc or non-WiMAX-specific (generic) as described in Table 1 and Table 2 respectively. WiMAX-specifc metrics refer to metrics that are intrinsic to MAC and PHY layers of the WiMAX air interface (e.g., IEEE 802.16). Non-WiMAX-specific metrics refer to metrics that are not relevant to the WiMAX MAC and PHY layers.

Table 1: WiMAX-specific Metrics Table

Metric #	Name	Definition	Reference
W-1	Serving BSID	The Base Station Identifier of the serving	• wmanIf2BsCmnPhyBsId in wmanIf2BsCmnPhyDownlinkChannelTa

		base station at the time of reporting.	ble [5]
W-2	Downlink Frequency	The central frequency as seen by the User Device of the serving base station at the time of reporting.	• wmanIf2BsCmnPhyDownlinkCenterFreq in wmanIf2BsCmnPhyDownlinkChannelTable [5]
W-3	Downlink Bandwidth	The channel bandwidth as seen by the User Device of the serving base station at the time of reporting.	• 11.18.2 PHY mode ID, Table 605 [5]
W-4	Downlink Mean RSSI	Implementation-specific downlink RSSI measurements performed against the preamble must be used to maintain a mean using the method outlined in WiMAX Rel 1.0 Mobility Profile. DL Mean RSSI is measured in the interval from device network entry / re-entry (i.e., active state) to the tme of reporting.	• 8.4.11.2 RSSI mean and standard deviation [5] • wmanIf2BsStdDeviationRssiReport in wmanIf2BsRssiCinrMetricsTable [5]
W-5	Downlink Std Dev RSSI	Implementation-specific RSSI measurements performed against the preamble must be used to maintain a expectation-squared statistic from which the standard deviation can be determined using the method outlined in WiMAX Rel 1.0 Mobility Profile. DL standard deviation RSSI is measured in the interval from device network entry / re-entry (i.e., active state) to the tme of reporting.	• 8.4.11.2 RSSI mean and standard deviation [5] • wmanIf2BsStdDeviationRssiReport in wmanIf2BsRssiCinrMetricsTable [5]
W-6	Downlink Mean	Implementation-	• 8.4.11.3 CINR mean and standard

	CINR	specific physical CINR measurements performed against the preamble must be used to maintain a mean using the method outlined in WiMAX Rel 1.0 Mobility Profile. DL Mean CINR is measured in the interval from device network entry / re-entry (i.e., active state) to the tme of reporting.	deviation [5] • wmanIf2BsMeanCinrReport in wmanIf2BsRssiCinrMetricsTable [5]
W-7	Downlink Std Dev CINR	The standard deviation of the downlink CINR to be measured for frequency reuse configuration 1 and 3. Implementation-specific CINR measurements performed against the preamble must be used to maintain a expectation-squared statistic from which the standard deviation can be determined using the method outlined in WiMAX Rel 1.0 Mobility Profile. DL standard deviation CINR is measured in the interval from device network entry / re-entry (i.e., active state) to the tme of reporting.	• 8.4.11.3 CINR mean and standard deviation [5] • wmanIf2BsStdDeviationCinrReport in wmanIf2BsRssiCinrMetricsTable [5]
W-8	Tx Power	The total uplink transmission power of the User Device across all active subcarriers during the most recent frame in which it transmitted uplink burst(s) at the time of reporting.	• 8.4.10.3.2.1 UL Tx power and Headroom transmission condition [5]

W-9	Tx Headroom Power	The difference between the maximum total uplink transmission power the User Device was capable of transmitting and the current total uplink transmission power of the User Device across all active subcarriers during the most recent frame in which it transmitted uplink burst(s) at the time of reporting.	• 8.4.10.3.2.1 UL Tx power and Headroom transmission condition [5]
W-10	HARQ Retries TX	The number of HARQ bursts transmitted by the User Device that represented a retransmission of HARQ bursts that had been sent since device network entry / re-entry (i.e., active state). Where multiple retransmissions of a burst are attempted, then this metric will be incremented for every retransmission attempt.	• 6.3.27.3 HARQ retransmission [5] • wmanIf2BsUlHarqBlocks wmanIf2BsUlHarqBlockDropped • wmanIf2BsUlHarqBlockErrorRate in wmanIf2BsArqHarqMetricsTable [5]
W-11	HARQ Retries RX	The number of HARQ bursts the User Device attempted to decode that represented a retransmission of HARQ bursts that had been received since device network entry / re-entry (i.e., active state). This metric must be incremented on every retransmission attempt of a burst.	• 6.3.27.3 HARQ retransmission [5] • wmanIf2BsDlHarqBlocks wmanIf2BsDlHarqBlockDropped • wmanIf2BsDlHarqBlockErrorRate in wmanIf2BsArqHarqMetricsTable [5]
W-12	Initial Range with Response	The total number of initial ranging codes transmitted by the User Device since the device power-up or reset which resulted in a	• 6.3.10 Ranging [5] • wmanIf2BsRangingSuccess in wmanIf2BsStartupMetricsTable [5]

		RNG-RSP message with any status being received by that User Device.	
W-13	Initial Range with No Response	The total number of initial ranging codes transmitted by the User Device since the device power-up or reset which did not result in any RNG-RSP message being received by that User Device.	• 6.3.10 Ranging [5] • wmanIf2BsRangingAttempt • wmanIf2BsRangingSuccess in wmanIf2BsStartupMetricsTable [5]
W-14	Periodic Range with Response	The total number of periodic ranging codes transmitted by the User Device since the device power-up or reset which resulted in a RNG-RSP message with any status being received by that User Device.	• 6.3.10 Ranging [5]
W-15	Periodic Range with No Response	The total number of periodic ranging codes transmitted by the User Device since the device power-up or reset which did not result in any RNG-RSP message being received by that User Device.	• 6.3.10 Ranging [5]
W-16	HO success	The total number of successful handovers performed by the User Device to the first target BS attempted in the handover list since the device power-up or reset. A handover attempt should be defined by the transmission by the User Device of a MOB_HO-IND message with HO IND type of Serving BS release.	• 6.3.22 MAC HO procedures [5] • wmanIf2BsHandoverAttempt wmanIf2BsHandoverSuccess in wmanIf2BsHandoverMetricsTable [5]
W-17	HO fail	The total number of	• 6.3.22 MAC HO procedures [5]

		unsuccessful handovers attempted by the User Device to the first targeted BS attempted in the handover list since the device power-up or reset. Unsuccessful handovers should therefore include cases where having transmitted a MOB_HO-IND message with HO_IND_type of Serving BS release, the User Device returns to the original sector and transmits a MOB_HO-IND message with HO_IND_type of cancel.	• wmanIf2BsHandoverSuccessRate • wmanIf2BsHandoverCancel • wmanIf2BsHandoverReject • wmanIf2BsHandoverCancelRate • wmanIf2BsHandoverRejectRate • wmanIf2BsUnexpectedHandover • wmanIf2BsAvgHandoverTime • wmanIf2BsMaxHandoverTime in wmanIf2BsHandoverMetricsTable [5]
W-18	MAP receive success	The total number of frames which the MAP (both uplink and downlink) was successfully decoded without error since the device power-up or reset.	• 8.4.4.2 TDD frame structure [5]
W-19	MAP receive fail	The total number of frames which the MAP (either uplink or downlink) was not successfully decoded since the device power up or reset.	• 8.4.4.2 TDD frame structure [5]
W-20	MCS stats	For each unique combination of modulation and coding scheme and MIMO type, a separate count of the number of bursts sent/received since the device power-up or reset.	• 8.4.9.4 modulation [5]
W-21	Rate limiter stats	The total number of SDUs dropped due to rate limiting mechanism; i.e., the	• 11.13.6 Maximum Sustained Traffic Rate parameter [5]

		total number of uplink SDUs that are discarded for reason other than queue overflow or SDUs exceeding their latency constraint, since the device network entry /re-entry (active state).	
W-22	Link uptime	The time elapsed since the device established a basic CID as part of the most recent initial system access in seconds.	• 6.2.9.5.1 Contention-based initial ranging and automatic adjustments, Table 177 [5]
W-23	Time in active mode	Count the number of frame when the User Device is in active mode. **Note**: it is assumed that frame period is consistent and is known by the network operator.	• wmanIf2BsActiveUsers [5] • wmanIf2BsMaxNormalModeUsers wmanIf2BsAvgNormalModeUsers in wmanIf2BsUserMetricsTable [5]
W-24	Time in idle mode	Count the number of frame when the User Device is in idle mode. **Note**: it is assumed that frame period is consistent and is known by the network operator.	• wmanIf2BsMaxIdleModeUsers in wmanIf2BsUserMetricsTable [5]
W-25	Time in sleep mode	Count the number of frame when the User Device is in sleep mode. **Note**: it is assumed that frame period is consistent and is known by the network operator.	• wmanIf2BsMaxSleepModeUsers in wmanIf2BsUserMetricsTable [5]
W-26	Scanned Base Station List	A report of the signal quality metrics received during the last scan of the base stations, e.g., as described on the neighbor list. The base stations are identified by the BSID (where available), the preamble, the center	• the list to be scanned is in the 6.3.2.3.47 Neighbor Advertisement (MOB_NBR-ADV) [4] • 13.1.3.4.2 wmanIf2BsRssiCinrMetricsTable [5]

		frequency and bandwidth. The full BSID should be reported, unless it is not known, in which case the truncated BSID should be reported if known. The signal quality metrics strengths will be RSSI and CINR; only those base stations where the RSSI exceeds -110dBm (TBD) or where the CINR exceeds -4dB (TBD) need be reported.	

Table 2: Non-WiMAX-Specific (Generic) Metrics Table

Metric #	Name	Definition	Reference
G-1	Last reboot cause	A unique cause value assigned, e.g., ”unknown”, “power on”, “external command (from host)”, “device fault (unspecified)”, “device temp”, “OMA-DM command”, “firmware update”.	Not Available
G-2	Device Log	This metric will comprise the combination of the device's event and error log where available. Where the device maintains an event log, the metric report will contain the last 100 records of that log, or less if fewer than 100 records are available in the log. Where the device maintains an error log, the metric report will contain the	Not Available

		last 100 records of that log, or less if fewer than 100 records are available in the log. The last reboot cause can be included in the device log. It is not expected that the format of the device log will be uniform across all devices. The use proprietary format is acceptable. Requirement R-[F-006] does not apply to this metric	
G-3	Device uptime	When the device boots, it will start a timer as part of its startup procedures. This metric will be the elapsed time in seconds of this timer.	• sysUpTime as defined in [6]
G-4	Device temp	Where the User Device includes a temperature measuring capability, this metric will be the output of the User Device in degrees Celsius.	Not Available
G-5	Round Trip Time (RTT)	The User Device sends an ICMP "echo request" packet to the primary DNS server and listens for an ICMP "echo response" reply. The round-trip time will be calculated from the time when the DRMD client sends the echo request SDU to the time when the DRMD client receives the echo reply SDU. Where the round-trip time exceeds 5000ms, the packet will be considered lost. This ping process is repeated four times in sequence. The average	Not Available

		round-trip time in milliseconds for those packets which have not been lost will be used as this metric. In the case that all packets are lost, the value reported will be such that it is indicated that the average is not available. **Note**: This may not be applicable for WiMAX module embeded in a notebook.	
G-6	LAN Ethernet MAC address	The local LAN MAC address of the User Device.	• ipNetToPhysicalTable as defined in [8]
G-7	NAT address table	List of the local IP address, MAC address, device name, and up/down packet counts for devices subtended. Only applicable to WiMAX User Device incorporating a NAT function.	• natAddrMapTable • natAddrBindTable • natAddrPortBindTable as defined in [7]
G-8	Current power supply voltage	For devices that are capable of measuring their power supply voltage as reported by the User Device in millivolts.	Not Available
G-9	Battery Capacity	For devices with an internal battery and the fule-gauging capability, the battery capacity (total charge retention capability) in mAh determined over the last charge cycles.	Not Available
G-10	GPS Location Data	For User Devices that are capable of providing GPS position, the latitude, longitude and Z-height (in meters) returned by the GPS chipset.	Not Available

6.3 Network Requirements (Conditional Normative)

R-[N001] The DRMD server SHALL support at least one of the metrics listed inTable 1 and/or Table 2.

R-[N002] The DRMD server SHALL support the server-initiated (network-initiated) statistics gathering; specifically the ability to retrieve both cumulative metrics (since each metric was last reset) and instantaneous metrics (at the time of reporting).

R-[N003] The DRMD server SHALL support on-demand metrics retrieval from the User Device.

R-[N-004] DRMD server SHALL be able to understand a "metric not supported" message from the device.

6.4 User Device Requirements (Conditional Normative)

R-[U001] The User Device SHALL support at least one of the metrics listed in Table 1 and/or Table 2.

R-[U002] The DRMD client in the User Device SHALL send a “metric not supported” response to any requests for individual metrics that it does not support or understand.

6.5 Charging and Network Management Requirements (Conditional Normative)

There are no specific charging and network management requirements defined for this feature.

6.6 Security Requirements (Conditional Normative)

There are no additional security requirements that are not already covered by implementation of OTA Activation and Provisioning in NWG Rel 1.5 [9].

Annex A Document History (*Informative)*

Date	Subject History	Version
2008-07-02	Initial template	0.1.0
2008-07-03	Editorial correctio to the initial template	0.1.1
2008-07-03	Including agreed contribution #378R1	0.2.0
2008-07-11	Including agreed contribution #391, #393R1, #394, #395	0.3.0
2008-07-17	Including agreed contributions #408R1, #409, #410R1	0.4.0
2008-07-24	Including agreed contribution #421R1, #424, #425R2	0.5.0
2008-08-06	Including approved contribution #430, #431R1, #432R4, #433R1	0.6.0
2008-08-18	Including agreed contributions #452R2, #453R1, #454R2, #460R1	0.7.0
2008-08-21	Including agreed contributions #467R2, #472R2	0.8.0
2008-09-03	Including agreed contribution #501R1	0.9.0
2008-09-03	Editorial clean up based on 0.9.0, new version	Ballot version
2008-09-24	Included accepted ballot comments: Intel #9, Intel #5, Intel #14, Intel #6, Intel #7, Nokia #2, , Intel #11, Nokia #3, Samsung #1, Nokia #4, Clearwire #2, Samsung #2, Intel #10, Samsung #15, Nokia #8, ALU #3, Intel #18, Intel #19, Intel #16, Intel #44, Intel #45, Intel #46, Intel #20, Intel #21, Intel #22, Intel #23, Intel #24, Intel #25, Intel #26, Intel #27, Intel #28, Intel #29, Intel #30, Intel #31, Intel 32, Intel #33, Intel #34, Intel #35, Intel #36, Intel #1, Intel 8, Samsung #5, ALU #1.	0.9.3
2008-09-25	Included accepted ballot comments: Nokia #5, Nokia #6, ALU #2, Intel #37, Intel #38, Intel #39, Intel #43, Nokia #7, Nokia #1, Fujitsu #1, Samsung #6, Samsung #7, Samsung #8, Fujitsu #3, Intel #12, Intel #13	0.9.4
2008-09-25	Approved version	1.0.0

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Annex B Metrics (Informative)

Metric #	Name	Definition	Reference
M-1	Downlink data rate	The total cumulative size in bytes of SDUs received from the service access point of the packet common part sublayer divided by the number of seconds in the collection period.	• wmanIf2BsAvgDlUserThroughput • wmanIf2BsAvgDlMacThroughput wmanIf2BsAvgDlPhyThroughp • wmanIf2BsPeakDlUserThroughput • wmanIf2BsPeakDlMacThroughput • wmanIf2BsPeakDlPhyThroughput wmanIf2BsAvgDlCellEdgeThroughput in wmanIf2BsThroughputMetricsTable [5]
M-2	Uplink data rate	The total cumulative size in bytes of SDUs presented to the service access point of the packet common part sublayer divided by the number of seconds in the collection period.	• wmanIf2BsUlPacketsReceived • wmanIf2BsUlPacketsErrored wmanIf2BsUlPacketErrorRate in wmanIf2BsPacketErrorRateTable [5]