Project	**IEEE 802.16j Mobile Multihop Relay Task Group**
Title	**Definition of terminology used in Mobile Multihop Relay**
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Re:	IEEE P802.16j Task Group on Mobile Multihop Relay
Abstract	This contribution proposes definitions of terminologies to be used in the Mobile Multi-hop Relay Task Group.
Purpose	Discussion
Notice	
Release	
Patent Policy and Procedures	

Definition of terminology used in Mobile Multihop Relay

1 Introduction

This contribution proposes definitions of terminology to be used in the Mobile Multihop Relay amendment to IEEE Standard 802.16e-2005. Terminology proposed for the 802.16j amendment is defined in Section 2. This contribution also proposes definitions of performance metrics for use during the Task Group discussions. The proposed metrics are presented in Section 3. These definitions were originally proposed in IEEE 802.16mmr-06/007r1 which was presented at IEEE 802.16 Session 41 in January 2006 but have been extensively expanded by all authors of this contribution

2 Definitions for the amendment

Acronyms and terms used in these definitions and not defined herein are defined in paragraph 3 of IEEE Standard 802.16-2004 or IEEE Standard 802.16e-2005 or in the IEEE Dictionary of Standards Terms. These definitions are in alphabetical order and may depend upon later definitions.

2.1 access link: An 802.16 radio link between an MS and a serving station (i.e. a BS, MMR-BS or RS).

Informative Note: An unmodified IEEE 802.16e MS is always connected to a BS or an MMR-BS or an RS via an 802.16e compliant radio link referred to as an access link.

2.2 access traffic: Traffic traveling over an access link

2.3 active station: A station that is accessible to an MS via a one-hop radio link and informed of some/all of the MS's capabilities and MAC context information. An active station is a member of a diversity set. The station can be an RS, BS, or MMR-BS (i.e., active RS, active BS or active MMR-BS).

Informative note: Active BS was defined in 802.16e and the terminology is modified to include an active MMR-BS and active RS as well as an active BS.

2.4 anchor station: For Macro Diversity Handover (MDHO), cooperative relay, and Fast Serving Station Switching (FSSS), this is the station to which the MS is registered and synchronized. The station can be an RS, BS, or MMR-BS (i.e., anchor RS, anchor BS or anchor MMR-BS). The MS performs ranging with the station and monitors the downlink for control information from this station. For FSSS supporting an MS, this is the serving station that is designated to transmit/receive data to/from the MS at a given frame. For cooperative relay or MDHO supporting an MS, one of active stations in a diversity set is selected as an anchor station.

Informative note: Anchor BS was defined in 802.16e and the terminology is modified to include an anchor MMR-BS and anchor RS as well as an anchor BS.

2.5 base station (BS): An IEEE 802.16-2004 compliant station that provides connectivity, management, and control of nearby mobile stations utilizing only one-hop radio links.

Informative notes: MS being controlled must be close enough to the BS to reliably receive control and user data. In the context of this amendment, a BS is not 802.16j compliant and therefore does not control relay stations and is itself not a relay station.

2.6 candidate station: A potential serving station for a given MS during the next handover. A candidate can be an RS, BS, or MMR-BS (i.e., candidate RS, candidate BS or candidate MMR-BS). To qualify, the received signal level at the MS must be above some predefined threshold.

Informative note: This definition is different from that of a neighbor station in that the candidate must have the ability to serve subscribers. In other words, all candidates are neighbors, but not all neighbors are candidates.

2.7 cell: The geographic area containing all locations served by a particular station (e.g. RS, BS or MMR-BS) using a one-hop radio link with that RS, BS or MMR-BS.

Informative Notes: Communications resources within a cell are managed by the serving station (e.g. RS, BS or MMR-BS). This coverage area includes the coverage area of all sector antennas (if any) supported by the station. This coverage area does not include locations served by relay stations. This definition is different from the ITU-R M.1024 in that the ITU definition of cell is the coverage area determined by a single sector. By this

definition, a cell is the total direct-access area of a serving station. Thus, there are BS cells, MMR-BS cells, and RS cells. An MMR-BS cell does not include locations served by its RSs via multi-hop communication links. Instead, this total area composed of the MMR-BS cell plus its subordinate RS cells is defined in a separate term called the “MMR cell”.

2.8 centralized MMR control: MMR where all radio resource management and routing procedures within a cell are explicitly controlled by the MMR-BS for that cell.

Informative Note: No radio resource management or routing management authority is delegated to relay stations in a system using centralized MMR control. Network entry procedures are implemented in relay stations even when using centralized MMR control.

2.9 centralized MMR function: A system function that is controlled entirely by the MMR-BS.

2.10 cooperative relay: Transmitting information over multiple relayed paths and estimating the transmitted information at the receiver by combining or selecting the signals received from multiple paths where at least one path is relayed.

2.11 decentralized MMR control: MMR where some radio resource management and routing authority may be delegated to relay stations while overall management of these functions remains in the MMR-BS. Network entry procedures are implemented in relay stations and in MMR-BS.

Informative Notes: “Decentralized MMR control” is also referred to as “distributed MMR control”.

2.12 decentralized MMR function: A system function that is controlled cooperatively by the MMR-BS and by a participating RS.

Informative Notes: “Decentralized MMR control” is also referred to as “distributed MMR control”.

2.13 distributed MMR control: Same as decentralized MMR control.

2.14 distributed MMR function: Same as decentralized MMR function.

2.15 diversity set: List of active RSs, BSs, and/or MMR-BSs to an MS. The diversity set is applicable to macro diversity handover, cooperative relay, and fast serving station switching.

Informative note: Diversity Set was defined in 802.16e and the definition is extended to support cooperative relay as well as macro diversity handover and fast serving station switching.

2.16 downstream: In the direction of an MS following the MMR path originating at an MMR-BS

2.17 fast serving station switching (FSSS): Serving station switching with which an MS can change its serving station from frame to frame depending on the serving station selection mechanism. A serving station can be an RS, BS, or MMR-BS

Informative note: Fast BS switching (FBSS) was defined in 802.16e and the terminology is modified to allow switching between any types of serving stations (RS, BS, or MMR-BS). Switching can be either between same type of serving stations or between different types of serving stations.

2.18 fixed relay station (FRS): A relay station that is permanently installed at a fixed location.

Informative Notes: A connection to a power source is assumed. A backup power source may be provided.

2.19 hybrid MMR control: MMR where some relay stations are explicitly controlled by the MMR-BS for the cell and other relay stations may have limited control delegated to them by the MMR-BS.

2.20 inband relay: MMR using the same spectrum (i.e. the same time-frequency channels (i.e. slots) within the same overall band) for both the RS to MMR-BS radio links and the RS to MS radio links.

2.21 intermediate RS: Any *k*-hop RS along an *m*-hop MMR path where *k* is *less* than *m* and *m* is the number of hops between two end points of the MMR path (i.e., the MMR-BS and the RS that has direct access to the MS)

2.22 intra-MMR-BS handover: MS or RS handover between two RS or between an MMR-BS and an RS where all stations involved in the handover are controlled by the same MMR-BS.

Informative Notes: The MS or RS that is being handed over is in the same MMR-cell both before and after the handover.

2.23 inter-MMR-BS handover: MS or RS handover between two RS or between a BS and an RS where two different MMR-BS are involved in the handover.

Informative Notes: The MS or RS that is being handed over is in a different MMR-cell before and after the handover.

2.24 k-hop MS: An MS that is using a k-hop path (see Figure 1 at the end of this contribution) to communicate with an MMR-BS.

Informative Notes: For example, a one-hop MS communicates with an MMR-BS (or BS) directly and a two-hop MS communicates with an MMR-BS through one RS.

2.25 k-hop RS: An RS that is using a k-hop path (see Figure 1) to communicate with an MMR-BS.

Informative Notes: For example, a one-hop RS communicates directly with an MMR-BS and a two-hop RS communicates with an MMR-BS through one RS.

2.26 link metric: A criterion used to characterize the performance/quality/eligibility of an MMR link or access link as a member of a multihop path between an MMR-BS and an MS . A link metric may be used in a computation of a path metric.

2.27 MMR-base station (MMR-BS): A base station that is compliant with amendment IEEE 802.16j to IEEE Standard 802.16e-2005.

Informative Notes: An MMR-BS is fully compliant with IEEE Standard 802.16e-2005 and has been enhanced by amendment IEEE 802.16j to support mobile multihop relay. Mobile multihop relay is supported only for the OFDMA mode of IEEE Standard 802.16e-2005. Relay stations that support a particular MMR-BS are managed by that MMR-BS.

2.28 MMR broadcast tree: A tree network topology as a collection of MMR paths where the tree topology is designed to reach every station in a broadcast network.

2.29 MMR-cell: The geographic area covering all locations where an MS may communicate through a particular MMR-BS using either one-hop communications links with that MMR-BS or using relayed communications links.

Informative Notes: All communications resources within an MMR-cell are managed by the MMR-BS either through centralized or decentralized control. The MMR-cell contains all MS connected to the MMR-BS using one-hop links and all MS connected to any of the RS managed by the MMR-RS. Resource management and control of MS within an MMR-cell may be via direct radio link (i.e. not relayed) or via relayed messages.

2.30 MMR frame: An MMR frame is a structured data sequence of fixed duration used by some PHY specifications to support multihop relay.

Informative Note: There are many options for partitioning time-frequency resources to support MMR. One means in to partition the legacy 802.16e frame into subframes. In that case, an MMR frame may contain multiple pairs of uplink and downlink subframes for multihop relay. The duration of the subframes can be different to achieve efficient usage of resource. Other options may include partitioning in the frequency dimension. In both cases, the frame is partitioned differently from a legacy 802.16e frame and is called an MMR frame.

2.31 MMR link: An 802.16j radio link between an MMR-BS and an RS or between a pair of RSs.

2.32 MMR multicast tree: A tree network topology as a collection of MMR paths where the tree topology is designed to reach a plurality of stations in a multi-cast group

2.33 MMR path: A concatenated set of MMR links between the MMR-BS and the MS or vice versa (depending on direction of traffic flow).

2.34 MMR traffic: Traffic traveling over an MMR link

2.35 mobile multihop relay (MMR): The concept of relaying user data and possibly control information between an MMR base station and an IEEE Standard 802.16 compliant mobile station through one or more relay stations.

Informative Notes: Licensed spectrum is used for relay. The purpose of enabling relay is to enhance coverage, range, and throughput and possibly capacity of an MMR base station and to enable very low power

devices to participate in the network. The adjective “mobile” used here refers to the fact that both mobile subscriber stations and mobile relay stations are supported. A “one-hop connection” has a single radio link between a BS or MMR-BS and MS. A “two-hop connection” has two radio links and a single relay station between an MMR-BS and MS. A “three-hop connection” has three radio links and two relay stations between an MMR-BS and MS. See Figure 1 for further clarification. It is possible to establish multiple communications paths between the MMR-BS and an MS and to communicate the same user data and/or control/management information through both paths to improve communications reliability.

2.36 mobile station (MS): Refer to 802.16e-2005 section 3.83 for the definition.

Informative Notes: An MS may be fixed, nomadic, or mobile.

2.37 mobile relay station (MRS): A relay station that is intended to function while in motion.

Informative Notes: MRS mobility is constrained by the same limits as an MS in IEEE Standard 802.16e-2005. An MRS may be installed, for example, in a bus or train for use by subscribers using IEEE Standard 802.16e-2005 SS or MS.

2.38 neighbor station (NS): A station that is within one-hop communication range of the station of interest

Informative Notes; A neighbor is any 802.16j station (i.e., BS, MMR-BS, RS, and/or MS) whose signal (as received at the station of interest) is above a pre-defined threshold.

2.39 neighborhood: A set of stations consisting of a station and all of its neighbor stations.

Informative Note: The term “neighborhood” is always used with reference to a particular station of interest. That is, each station has a neighborhood consisting of all of the stations within one-hop communications range.

2.40 nomadic relay station (NRS): A relay station that is intended to function from a location that is fixed during periods of time comparable to a user session.

Informative Notes: An NRS is not permanently installed. An NRS may rely solely on battery power in some instances.

2.41 OFDMA channel: A contiguous frequency band over which the 802.16 OFDMA waveform is transmitted.

Informative Notes: The frequency in an OFDMA channel is partitioned into sub-carriers (one for each FFT point) and the subcarriers are grouped into subchannels according to one or more of the subchannelization schemes specified in 802.16.

2.42 out-of-band relay: MMR using the different licensed spectrum for the RS to MMR-BS radio links and the RS to MS radio links.

Informative Note: Licensed spectrum is used for both the RS to MMR-BS and the RS to MS links.

2.43 path metric: A criterion used for path selection. The path metric is computed based on one or more link metrics.

2.44 predecessor: The previous station along an MMR path. A station is said to be a predecessor of another station if the latter is the successor of the former.

2.45 relay station (RS): A station that has been enhanced to be conformant with IEEE 802.16j and whose functions are 1) to relay either user data or user data and control information between other stations, and 2) to execute processes that indirectly support mobile multihop relay.

Informative Notes: Relayed paths terminate at an MS at one end and an MMR-BS at the other. Multiple relays may participate in a single relay path. Participating relays may include FRS, MRS, and NRS in any combination and sequence. A relay station may generate control information associated with the relay function. All relay stations are managed by a MMR-BS but may have limited control of relay functions within their neighborhood. For in-band relay, the spectrum used for relay communications is the same licensed spectrum used for communications with the mobile stations.

2.46 route set: A set of available routes between a specific MS and an MMR-BS

2.47 RS cell mobility: Mobility of an entire RS cell where an RS and its subordinate RSs and/or MSs located within the RS cell move together as a group.

2.48 serving station: A station that provides access to MSs via a single radio links or hops.

Informative Note: An MS may have more than one serving station when cooperative relay is implemented. A serving station may be an RS, BS, or MMR-BS.

2.49 station: Any device that contains an IEEE 802.16e conformant medium access and physical layer interface to the wireless medium.

Informative Note: A station is a transceiver that is compliant with IEEE Standard 802.16e-2005 and also compliant with the mobile multihop relay amendment to that standard. The term "station" includes Base Stations, MMR-Base Stations, Relay Stations, Mobile Stations, and Subscriber Stations.

2.50 successor: The next station along the MMR path. A station is said to be a successor of another station if it is one hop closer to the destination and thus directly receives traffic forwarded by the latter.

Informative Note: Referring to the three-hop path of Figure 1 at the end of this contribution and considering the downlink path from the MMR-BS to the MS, the intermediate RS is a successor of the MMR-BS and the serving RS is a successor of the intermediate RS.

2.51 target station: A station to which an MS intends to connect at the completion of a handover procedure. The station can be an RS, BS, or MMR-BS (i.e., target RS, target BS, or target MMR-BS).

Informative note: Target BS was defined in 802.16e and the terminology is modified to include a target MMR-BS and target RS as well as a target BS

2.52 upstream: In the direction of an MMR-BS following the MMR path originating at an MS

3 Abbreviations and Acronyms for the amendment

FRS	Fixed Relay Station
MMR-BS	Mobile Multihop Relay Base Station
MMR	Mobile Multihop Relay
MRS	Mobile Relay Station
NRS	Nomadic Relay Station
NS	Neighbor Station
RS	Relay Station

4 Definitions for performance evaluation

The following definitions are intended to support the comparison of the mobile multihop relay concepts by the task group.

4.1 coverage reliability: Coverage reliability for an 802.16 system is the probability that a randomly located mobile station is able to achieve a specified grade of service (delay and throughput) when the system load is at a specified level. Coverage Reliability may be used as a metric for the comparison of different relay strategies.

4.2 throughput: The rate at which user application information is transferred from source to destination. For the purpose of the MMR Task Group, throughput is the ratio of the total number of information bits in the payload portions of a sequence of Medium Access Control Packet Data Units (MAC-PDU) to the total average time required to transfer these bits successfully. Throughput accounts for the resources required to transmit all control, preamble, and other overhead data but does not count this information in the number of information bits transferred. Throughput may be calculated for a single link (i.e. one hop) or may be calculated for a relayed path between a mobile station and an MMR-BS. Throughput is measured or calculated with adaptive modulation and coding functions (if any) operational, with adaptive multiple antenna functions (if any) operational, and with power control (if any) operational. Throughput accounts for resources used for hybrid ARQ retransmissions.

4.3 system data capacity: The system data capacity is the total system information transfer rate that a base station can support while providing a specified throughput and Quality of Service to specified fraction of randomly placed users. Users that cannot be served with the specified throughput and QoS are not counted at all. Counted information includes only the payload portions of MAC-PDUs. Capacity accounts for the

resources required to transmit all control, preamble, and other overhead data but does not count this information in the number of subscriber information bits transferred. Capacity is measured or calculated with adaptive modulation and coding functions (if any) operational, with adaptive multiple antenna functions (if any) operational, and with power control (if any) operational. Transmissions from (or to) all user stations directly or indirectly via relay stations are counted. Capacity is dependent upon the specific physical environment (e.g. buildings, foliage, terrain, and so on). The measure of capacity is bits per second per Hz per cell or per MMR cell.

4.4 MMR delay: Delay is the average time between the events of receiving one MAC-SDU at layer 2 of an originating station and successfully receiving that MAC-SDU at a destination station. The time required to communicate ARQ acknowledgment to the originating station is not counted. MMR delay includes all relay transmission and processing delays (if any) between the originating and destination stations. This definition includes the waiting times in the per-flow queues encountered by data prior to MAC-SDU transmission and takes into account delays associated with the ARQ process and scheduling.

5 References

[1] R. Peterson, K. Baum, E. Visotsky, M. Asa, A. Sharon, S. Ramachandran, D. T. Chen, N. Natarajan, “Definition of terminology used in Mobile Multihop Relay”, IEEE 802.16mmr – 06/007r1, January 2006.

[2] M. Asa, R. Peterson, S. Ramanchandran, D. T. Chen, N. Natarajan, ”Recommendations for the Scope and Purpose of the Mobile Multihop Relay Study Group”, document IEEE C802.16mmr-05/032, 11 November 2005.

[3] *The Authoritative Dictionary of IEEE Standards Terms,* Seventh Edition, New York, 2006.

[4] J. P. K. Gilb, *Wireless Dictionary,* IEEE Press, 2005.

6 Revision History

Version No.	Date	Remarks		Author
1.0	1 May 2006	Initial submission for MMR Task Group at Session 43 of IEEE 802.16		all authors

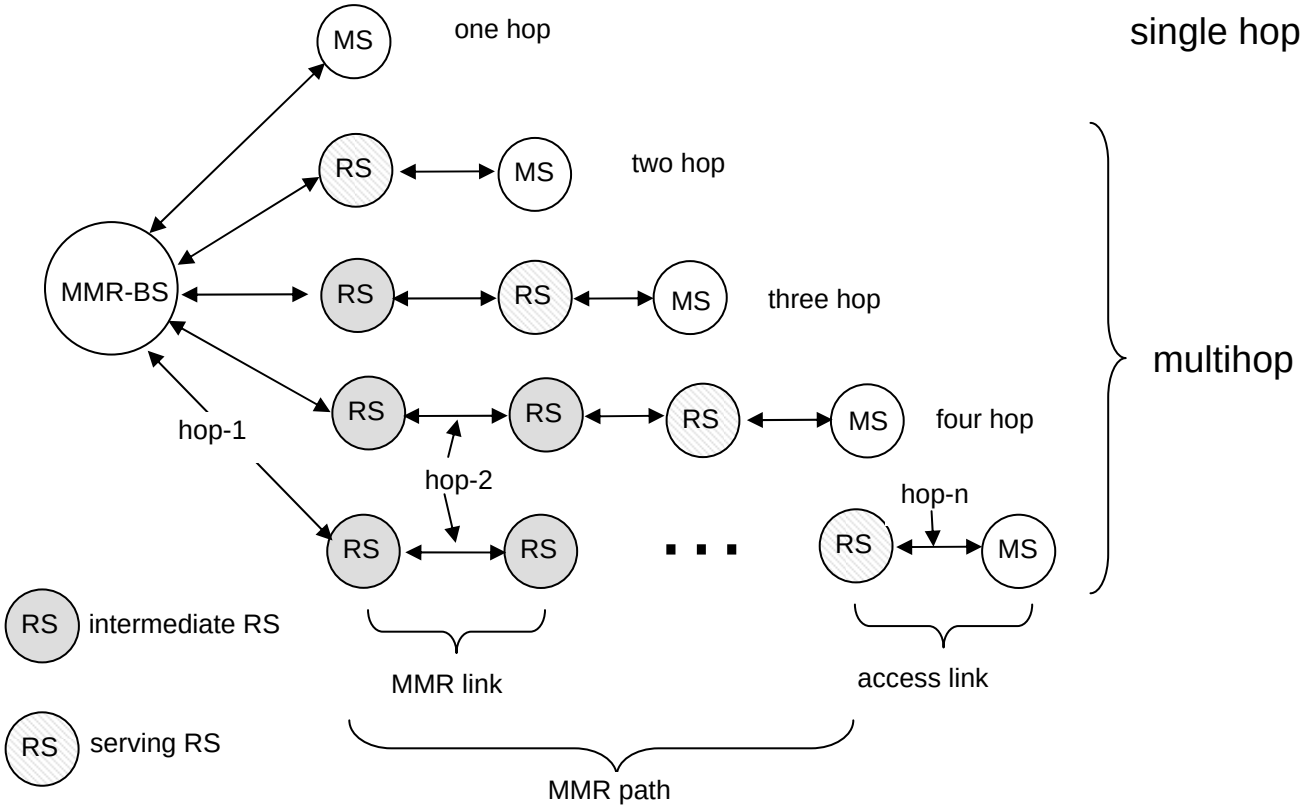

Figure 1. Clarification of hop count