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Title	**Recommendations for the Scope and Purpose of the Mobile Multihop Relay Task Group**	
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Re:	IEEE P802.16 MMR SG	
Abstract	This contribution proposes that the scope of the MMR Task Group include 1) multiple relays rather than only a two-hop single relay path to the base station, 2) the option to study subscriber station relays in the path to the base station, and 3) the option to study relay for wireless backhaul. This contribution also proposes definitions for performance metrics to be used in comparing mobile multihop relay strategies.	
Purpose	Discussion	
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Release		
Patent Policy and Procedures		

Recommendations for the Scope and Purpose of the Mobile Multihop Relay Task Group

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1 Introduction

The Study Group on Mobile Multihop Relay (MMR) for 802.16 was created on 22 July 2005 by the IEEE 802 Executive Committee. The charter of the MMR Study Group is defined in IEEE 802.16-05/51 [1] which cites IEEE C802.16-05/13 [2] and IEEE C802.16-05/15 [3] as a "reference presentations". These reference presentations serve as the starting point for this contribution. This contribution is in response to IEEE 802.16mmr-05/21 [4] which requests inputs regarding the creation of the Project Authorization Request (PAR) and "Five Criteria" for a Mobile Multihop Relay Task Group (TG).

Previous contributions created by or supported by Motorola [2][3][5] have also addressed the scope and purpose of the MMR Task Group. This document clarifies and extends these previous contributions. This contribution addresses sections 12 (scope) and 13 (purpose) of the Project Authorization Request that will be drafted during 802.16 Working Group Session 40 in November 2005.

The anticipated MMR Task Group will create an addendum to IEEE 802.16-2005. It is recognized that this base document does not yet exist, however, it is expected that the 802.16e addendum and the 802.16-2004 corrigendum will be combined to create 802.16-2005 before specific MMR text is created by the proposed TG.

In the following, specific recommendations are identified by indented bold text. This indented bold text will state the specific recommendations for which support of this Study Group is solicited.

> **This is an example of text for which explicit SG support is being solicited.**

The requirements and recommendations herein are not intended to define all of the requirements for 802.16 MMR. Rather, they are intended to clarify and augment a subset of these requirements.

2 Requirements for 802.16 MMR Task Group

The relay strategies and technologies that will be considered by the MMR Task Group are intended to enhance the performance of 802.16-2005-based products. Performance enhancement in the areas of coverage (both range extension and mitigation of severe shadowing including coverage hole), throughput, and system complexity (particularly for start-up systems) is expected. It is hoped that system capacity improvements will also be achieved. Since MMR is an addendum to an existing standard, most of the top-level requirements for 802.16-2005 are also applicable to MMR. These top-level requirements include metropolitan area coverage, broadband coverage, support for IP-based communications, support for fixed, nomadic and mobile subscriber stations, support for line-of-sight, near line-of-sight, and non-line-of-sight propagation, operation in both licensed or license-exempt spectrum, and many others. These high-level requirements are addressed via backwards compatibility requirements for MMR and not explicitly herein.

Many different relay architectures are possible for consideration by the SG. These architectures differ with respect to what types of terminals are capable of relaying, the possible end points of the relayed communication paths, whether or not communication paths are allowed that do not pass through the service provider infrastructure, and whether system control is centralized or distributed. The paragraphs below suggest constraints on the set of architectures that will be considered by the proposed MMR Task Group. These constraints are intended to focus the TG efforts and thus enable timely TG completion.

2.1 Backward Compatibility

> **The mobile multihop relay solutions proposed by the 802.16 MMR Task Group shall be backward compatible with IEEE 802.16-2004 paragraphs 1 through 5, 6.1, 6.3 (except 6.3.1.2, 6.3.6.6, 6.3.9.14, 6.3.16), 7 (except 7,2,2,2, 7.4.1.6, 7.4.2.4, 7.4.2.5), 8.3 (except 8.3.5.3), 8.4, and 9 through 12. The MMR solutions shall also be backward compatible with all paragraphs of IEEE 802.16e. "Backward compatible" means that a subscriber station or mobile subscriber station meeting the requirements in the paragraphs identified above shall function normally in the MMR enhanced infrastructure.**

2.2 Relay Path Architectures

All relayed communication paths considered by the 802.16 MMR Task Group shall terminate at a service provider base station. This base station may be directly connected to wired infrastructure or may be connected via wireless infrastructure to a gateway where the connection to the wired infrastructure is completed.

> **Subscriber-station-to-subscriber-station communication paths that do not include a base station in the communication path shall not be considered by this Task Group.**

The Study Group reference contributions [2][3] have defined a Relay Station (RS) as a station that is owned by, installed by, and controlled by a service provider. An RS is not directly connected to wired infrastructure and has the minimum functionality necessary to support MMR. An RS is capable of acting as a base station from the subscriber station point of view. Simulation studies have shown that the placement and capability (transmit power, antenna characteristics, and so on) of the RS critically affects the overall benefits of MMR. We conclude, therefore, that MMR benefits might be enhanced by allowing the possibility of subscriber station relay. It is not expected that 802.16-2004- and 802.16e-compliant subscriber stations will function as relays. Rather, relay-capable subscriber stations could be defined within this Task Group. It is recommended that the issue of whether to define a relay-capable subscriber station be left as a study item for the TG.

Fixed Relay Stations (FRS) are owned, installed, and operated by an 802.16 service provider. FRS are at fixed geographic locations determined by the service provider's system design. Nomadic Relay Stations (NRS) are owned and operated by an 802.16 service provider but may be installed by either the service provider or the subscriber. NRS are not placed during initial system design. Rather, NRS are placed at locations as needed to mitigate coverage problems and may be moved from time to time as subscriber needs change. Mobile Relay Stations (MRS) are owned and operated by an 802.16 service provider and are installed in vehicles. Relay Stations do not create any bearer traffic of their own. However, Relay Stations may generate some MMR related signaling traffic. The 802.16 MMR Task Group shall consider FRS, NRS, and MRS-based MMR as its primary relay strategy. The 802.16 MMR Task Group may also consider enhanced Subscriber Stations, denoted MMR-SS, as potential relay stations. An MMR-SS may be a source or sink of its own traffic as well as serving as a relay station for other user's traffic.

The number of relay stations in a relayed communications path is constrained by maximum delay requirements. We do not believe that the number of relay stations should be limited *a priori* without careful study of the cost-benefit trade off studies involved. Therefore, it is recommended that the number of relay stations participating in a particular communication path be left as a study item for the TG.

> **Relayed communication paths may include one or more Relay Stations (RS) and/or one or more MMR-SS. The maximum number of RS in a path is constrained a Quality of Service (QoS) delay requirement. A maximum number of relay stations participating in a single communications path may be established by the 802.16 MMR Task Group based upon complexity-benefit trade off studies done as part of the TG effort.**

2.3 Cooperative Relay and Path Diversity

Cooperative Relay technology [10][11][12][16] is alleged to improve system performance by sending information simultaneously via more than one path, receiving this information at a single receiver, and combining the received information using advanced signal processing techniques to create an estimate of the transmitted information. There are many options of performing Cooperative Relay. One possibility is to transmit the same information over several different paths and to use selection diversity to choose the information estimated to be most reliable. Another possibility is to encode the information using standard error correction techniques and to send different coded information over multiple paths. The coded information is combined and decoded at a single common receiver. Many other options are possible; the details of these options are not important at this time. However, it is important that the capability of exploiting multiple paths for relay communication be available to the MMR Task Group. We therefore make the following recommendation.

> **The 802.16 MMR Task Group may consider cooperative relay techniques wherein reliable communications is achieved by combining information sent via multiple paths between the source and destination.**

2.4 Spectrum

The MMR Task Group shall consider relay strategies that utilize licensed spectrum only and/or license exempt spectrum only and/or strategies that utilize a combination of licensed and license exempt spectrum.

2.5 Relay Station Control

The MMR Task Group shall consider only relay strategies that are centrally controlled. That is, all transmissions within the relay-extended range of a base station shall be explicitly controlled by that base station possibly using connectivity and traffic information obtained from RS and MMR-RS.

2.6 Relay Traffic Forwarding

The MMR TG shall implement traffic forwarding through a RS in Layer 2 (link layer + MAC) only, and shall not rely on Layer 3 IP packet forwarding mechanisms.

3 Goals for the 802.16 MMR Task Group

3.1 Coverage

Relay technology is expected to improve coverage reliability in geographic areas that are severely shadowed from the base station and/or to extend the range of a base station. Both of these benefits are included in the concept of "coverage enhancement". In both cases the relay station enhances coverage by transmitting from an advantaged location closer to a disadvantaged SS than the base station.

Coverage enhancement is a primary goal of MMR. The metric used to compare coverage enhancement concepts shall be total system cost (both capital and operation) to achieve a certain coverage reliability for a TG-specified subscriber environment. Coverage reliability shall be a measure of the probability that a randomly placed subscriber is able to reliably communicate at a particular data rate.

3.2 Throughput

Relay technology is expected to improve the throughput for users at the fringes of an 802.16 cell. It has been recognized in previous 802.16 contributions that subscribers at the fringes of a cell may be required to communicate at reduced information rates because received signal strength is lower at the cell fringe. Enhanced throughput is a primary goal of MMR but is included in the scope of the coverage enhancement goal above. Therefore an independent throughput enhancement goal is not required for the MMR Task Group.

3.3 System Capacity

Academic research [8] has shown that the capacity of an ad hoc wireless network may be increased using relay technology. The relay architecture considered in [8] is <u>not</u> the same as the architecture considered in this MMR Task Group. This academic research has shown that, while relay increases total system capacity, the capacity for individual users slowly approaches zero as the user density increases. The capacity increase in this seminal academic study is due partially to spectrum reuse enabled by controlling subscriber transmit power to the minimum possible to achieve connectivity with nearest neighbor stations. As the density of stations increases, transmit power decreases and increased geographic spectrum reuse is possible. It is hoped that relay can also enable increased geographic spectrum reuse in 802.16 systems.

System capacity enhancement due to MMR is a secondary goal of the Task Group. System capacity is a measure of the maximum total information rate supported by a base station per unit bandwidth per unit geographic area.

3.4 Battery Life

Fixed, Nomadic, and Mobile Relay Stations will, in most implementations, be powered either by a power utility or a vehicle's power source. Therefore, battery life is not a major issue for these stations. However, the relay strategy can affect the battery life of a Subscriber Station or an MMR-enhanced Subscriber Station. This may occur if, for example, the requirements for paging channel monitoring are not carefully considered. Since battery life is key to the desirability of a mobile device, we recommend that battery life be a primary goal of the MMR Task Group.

> **Battery life of subscriber stations operating within a relay-enhanced 802.16 system shall be a primary consideration of the MMR Task Group. Battery life of an SS shall not be degraded when that SS is functioning within a relay enhanced infrastructure relative to the battery life of that same SS operating in a conventional infrastructure.**

3.5 System Start-Up Complexity

A potential advantage of Mobile Multihop Relay is that fewer base stations may be required at system start-up. The required number of base stations is a function of the achievable coverage range of a single base station which is addressed by the coverage goal of Paragraph 3.1 above. Therefore, system start-up complexity is an indirect goal of the MMR Task Group.

3.6 Relay Station Complexity

Relay technology will reduce total system complexity only if the complexity of a relay station is significantly less than the complexity of a base station. Thus, achieving minimum relay station complexity must be a primary goal of the MMR Task Group.

> **Relay station complexity minimization shall be a primary goal of the MMR Task Group.**

4 Definitions

The following definitions are suggested for use in all 802.16 MMR Task Group discussions. Because the TG output will be an addendum to the IEEE 802.16-2005 standard, all definitions of the baseline document are unchanged.

> **Fixed Relay Station (FRS):** A permanently installed station whose function is to relay information between a subscriber station and a base station. An FRS is owned and maintained by a service provider and is most often installed by that service provider. An FRS may, however, be installed by a subscriber within that subscriber's place of business or home. A connection to a wired power source is assumed. The FRS antennas may be directional or omnidirectional and may be mounted on a rooftop or an antenna tower. An FRS and all other relay stations are controlled by a centralized MMR controller. An FRS does not generate information of its own except for control information associated with the relay function.

> **Nomadic Relay Station (NRS):** A relay station that is not permanently installed whose function is to relay information between a subscriber station and a base station. Since the NRS is not permanently installed, it may be relocated from time to time. An NRS is assumed to be at a single location for periods of time at least as long as typical subscriber session. An NRS may be owned and maintained with by a service provider or by a subscriber. An NRS is typically installed by a subscriber in the subscriber's place of business or home. NRS antennas are assumed to be omnidirectional and are mounted with the NRS itself (i.e. not on a separate structure). Nomadic relay stations may or may not rely on batteries for primary power but should have battery backup power sources. An NRS does not generate information of its own except for control information associated with the relay function. An NRS is controlled by a centralized MMR controller.

> **Mobile Relay Station (MRS):** A fully mobile station whose function is to relay information between a subscriber station and a base station. An MRS is typically owned and maintained by a service provider. An MRS may be installed, for example, in a bus or train for use by subscribers in these vehicles. MRS antennas are assumed to be omnidirectional and are mounted on the vehicle rooftop. An MRS does not generate information of its own except for control information associated with the relay function. An

MRS is controlled by a centralized MMR controller. An MRS is powered by the vehicle in which it is installed. The concept of MRS can be found in MMR contribution IEEE C802.16mmr-05/001 [9].

Relay Station (RS): An FRS or NRS or MRS.

MMR-Subscriber Station (MMR-SS): A subscriber station that has been enhanced to enable it to function as a relay. The MMR-SS may be one element in a relay path between another subscriber station and a base station. The entire relay path may include other MMR-SS and/or RS. The MMR-SS is owned by the subscriber and is controlled cooperatively by the subscriber and the service provider. The MMR-SS is a source and sink of information in addition to functioning as a relay for other subscriber's information.

MMR-Base Station (MMR-BS): An 802.16 base station that has been enhanced to support Mobile Multihop Relay. An MMR-base station shall be fully compliant with all paragraphs on IEEE 802.16-2005 except that the relay function itself need only be compliant with the paragraphs listed in Paragraph 2.1 above.

Coverage Hole: A geographic area in which a subscriber station does not have total functionality due to excessive path loss between that subscriber station and the best possible serving base station or between that subscriber station and the best possible relay station.. Partial functionality at possibly reduced data rates may or may not be possible within a coverage hole. Control information may, in some cases, be reliably communicated to a SS that is within a coverage hole. While relay technology reduces the occurrence of coverage holes, these holes may still occur in relay-enhanced systems.

Coverage Reliability: Coverage reliability for a system design is the probability that a randomly located subscriber station is able to provide a user a specified level of service (QoS and data rate) when the system load is at a specified level. Comparison of the coverage reliability for differing relay strategies is best done using a static physical environment (buildings, trees, terrain, etc).

Throughput: The rate at which subscriber 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 time required to transfer these bits. Throughput accounts for time required to transmit all control, preamble, and other overhead data but does not count this information in the number of subscriber 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 subscriber station and a base station. Throughput does not account for time in transmission queues; however ARQ and HARQ retransmission time is included. Therefore, throughput should be measured or calculated for a lightly loaded system. For a TDD relay system, throughput is dependent upon the ratio of forward link to reverse link time allocations. [Note that alternate definitions of throughput are possible that could take queuing delays and total latency into account.]

System Data Capacity: The system data capacity is the maximum total system information transfer rate that a base station can support with a specified Quality of Service for delay. Counted information includes only the payload portions of MAC-PDUs. Transmissions from (or to) all subscriber stations, directly or indirectly via RS are counted. For this calculation, subscribers are assumed to be uniformly distributed within the base station service area. Capacity is dependent upon the traffic type offered by the subscribers and is therefore measured or calculated for a single traffic type. Capacity is dependent upon the specific environment (e.g. buildings, foliage, terrain, and so on) and is therefore measured or calculated for a single physical environment specified along with the capacity estimate. The measure of capacity is bits per second per unit bandwidth per base station. That is, capacity is normalized by bandwidth and is the rate of information transfer for a single base station.

5 Mobile Multihop Relay Strategies

5.1 Relay Station Based MMR

Relay station based multihop is the primary focus of the MMR Task Group. As illustrated in Figure 1, numerous advantages are possible using relay technology. A subscriber station that is in a coverage hole in the absence of relay may have full functionality with the assistance of an RS. Coverage holes may be due to building penetration losses, or due to extreme shadowing by buildings or foliage, or may be due to extreme path loss into underground railway facilities. Relay technology mitigates the negative effects of coverage holes by careful placement and design of RS so that path loss from the SS to the RS is small due to geographic proximity. The system design also assures that communications between the RS and the BS is possible by using advantaged antenna locations or elevated antennas or directional antennas or by using transmit powers not possible in a SS due to battery constraints.

Also as illustrated in Figure 1, relay technology may also be used to achieve range extension. In this case the path loss from the SS to the BS is too large to achieve full functionality and the distant SS is constrained to reduced information rates consistent with the SS to BS link budget. In most cases the uplink from the SS to the BS is constrained before the downlink BS to SS link since downlink transmit power is typically larger. This topic was addressed quantitatively in contribution IEEE C802.16e-04/417 [6]. The referenced contribution shows quantitative improvement in uplink coverage resulting from the exploitation of relay for the uplink path.

One caveat is relay technology may disrupt traditional hand-off performance. Traditionally, a SS will be handoff to another BS for a more favorable link quality. Adding RS will impact the handoff decision and indirectly impact the system capacity (e.g., the average number of handover legs may be reduced). It is recommended that careful examination on the handoff impact be included in the TG.

Using range extension due to relay, the 802.16 system designer may also be able to reduce the number of base stations required to serve a given geographic area thus enhancing the economic viability of the overall system. Both installation and maintenance costs will be reduced if low-cost relay stations replace base stations otherwise required to meet a coverage requirement. When used for this purpose, RS are carefully placed so that the effective coverage area of the BS plus multiple RS is significantly larger than the BS alone. Of course, this application of relay requires that the complexity of an RS be much less than the complexity of a BS. An important goal of the MMR Task Group is therefore to enable minimum complexity RS designs.

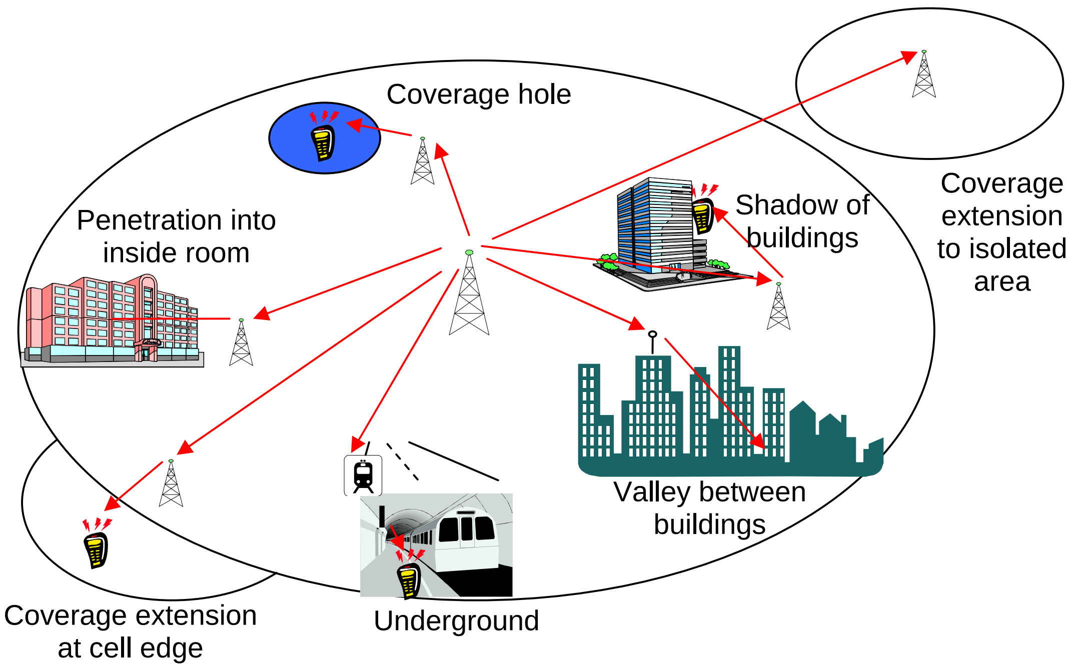

Figure 1. Conceptual Architecture for Relay Station-Based MMR

Relay stations are assumed to perform a very limited subset of functions of base stations. Relay stations must be physically small and easily installed requiring only a source of power. It is anticipated that RS might be installed on lamp posts or traffic signals or even within some public transportation vehicles. It is presumed that RS can be effective using less transmit power than a base station.

Transmit power requirements for RS should be a topic addressed in the TG.

Relay station placement can be part of the initial system design or methods might be developed for relay placement as a function of data collected during initial system operation. In either case, RS will be carefully placed within the service area taking into account anticipated coverage holes and range extension goals.

The MMR system design will assure that Relay Stations have low complexity and are easy to install and maintain.

5.2 Subscriber Station Enhanced Multihop

It has been noted in [7] that careful relay station placement is important. For the same physical environment, relay may improve system performance only slightly or significantly depending upon the characteristics and placement of the RS. Clearly, system performance is improved by using more relay stations. While the complexity of relay stations is low, it is not zero so that system cost will limit the number of relay stations that are placed. It is conjectured that enabling Subscriber Stations to function as mobile relay stations will improve system performance by using these relay opportunities when the subscriber station is in an advantaged location. Of course, the location of a subscriber station cannot be controlled by the service provider. Nevertheless, if methods can be developed to assess the desirability of using a subscriber station as a relay in real time, it may be possible to further improve the performance of MMR systems. For example, in a large office building some users may be located deep in the interior while others are near windows. This user location scenario would probably be nearly static over time. Thus, it is possible that the system could determine a means of using the advantaged user location near a window as a relay. Figure 2 is a conceptual illustration of subscriber-based relay.

Two types of relay enhanced subscriber stations are envisioned. One is a nomadic device probably, but not necessarily within portable computing device. The other is a subscriber device permanently installed and powered by a vehicle. It is not anticipated that hand-held subscriber devices would be used as subscriber station relays. Subscriber stations that function as relays are dual mode devices that operate in the normal subscriber mode as required and in a relay mode as requested by the system. The relay function will be under the centralized control of the system. The location of the subscriber relay will, of course, be determined by the subscriber and will be a random variable in system performance estimation analyses for the TG.

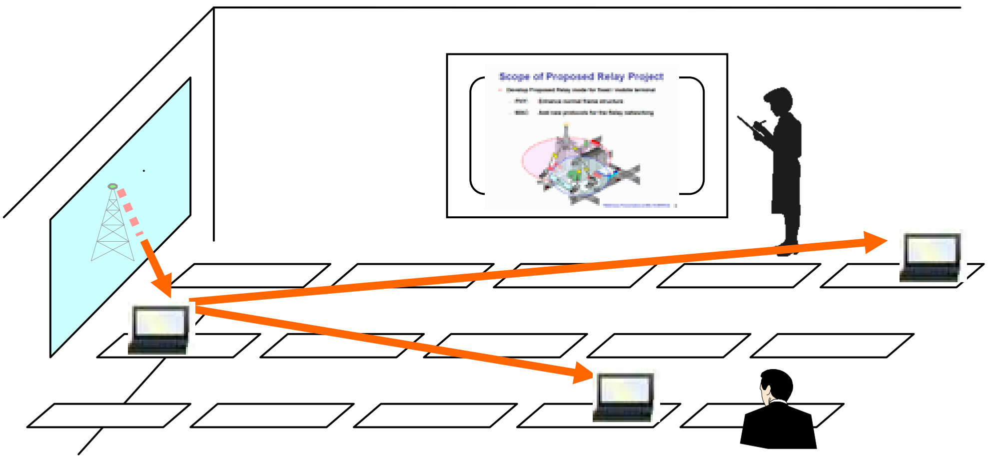

Figure 2. Conceptual Architecture for Subscriber-Based Relay

6 Challenges

There are numerous challenges in the development of relay-enhanced 802.16. A number of anticipated challenges and issues are listed below.

Frame structure: IEEE 802.16-2004 includes a mesh mode of operation whose specification defines a frame structure that is incompatible with the most popular modes of operation of the standard. It is expected that the PMP-mode frame structure will be modified for MMR in a manner that unmodified SS can function within the relay-enhanced system. It is expected that more than one proposal for a modified frame structure will be proposed. The creation of a meaningful metric for comparing frame structures must be created by this Task Group. Frame structures for relay-enhanced 802.16 have been proposed in [13][14][15].

Relay of Control Messaging: Efficient relay strategies may be possible that use different communications paths for subscriber application data and for control messaging. For example, it may be possible to use a non-relayed high-reliability (for example high power and/or low order modulation and low rate coding and/or low data rate) downlink for control messaging and a separate relayed path for subscriber application data. It should not be presumed *a priori* that control messaging will follow the same communications paths as the applications data.

Broadcast Messaging: Support of relay will require either modifications to the FCH, DL-MAP, UL-MAP and possibly the creation of a RELAY-MAP.

Scheduling: Efficient scheduling for relay stations will be a significant challenge for this Task Group. It is expected that details of scheduling algorithms will not be standardized but will be left for manufacturers to differentiate themselves from one another. However, the definition of the specific information input to the scheduling processes must be standardized.

L2 Routing Algorithms: Because all paths are attached to a base station at one end, it is expected that L2 routing will be straightforward. Nevertheless, it is expected that L2 routing is an area that will not be standardized thus allowing manufacturers to differentiate themselves from one another. The definition of specific information input to routing procedures and a general framework for node discovery and path selection must be standardized by this Task Group.

Spectrum: While IEEE 802.16-2004 and 802.16e typically operate using licensed spectrum, Task Group LE is defining procedures enabling these systems to operate within License Exempt spectrum with minimum inter-system interference. The MMR Task Group should take into account the technology being considered in TG LE. The MMR Task Group should consider methods for exploiting License Exempt spectrum for relay.

Adaptive Directional Antenna Technology: Adaptive antenna technology is another means of extending base station range and of improving throughput. This Task Group should be aware of the cost-benefit trade off of this competing technology and should be prepared to contrast and compare these technologies. In addition, consideration should be given to using directional antennas (both adaptive and non-adaptive) within a relay-enhanced system design. Note that directional antennas itself cannot solve the severe shadowing problem.

MMR–SS Motivation: It is likely that subscriber stations in advantaged locations can enhance overall system performance if they can be utilized to relay other user's application data. Concepts for motivating a subscriber to allow his or her equipment for the relay of other subscriber's information must be created. Consideration of this problem should be delayed until studies have been completed that quantify the system benefit of MMR-SS relay.

Relay Station Mobility: While FRS are indeed at a fixed geographic location, NRS, MRS, MMR-SS and MMR-MS have varying degrees of mobility. Thus, relay-enhanced handover mechanisms with associated signaling and measurements will be required in the MMR-enhanced system.

MMR Use Cases: Comparison of various relay strategies will require quantitative performance results. Comparisons will be facilitated if analysts utilize common use cases.

> **It is recommended that the proposed MMR Task Group define use cases that will include a) user types, b) traffic models for each user type, c) several user environments, and d) specific path loss models. These use cases would then be used by all MMR TG contributors for quantitative comparisons of relay concepts.**

Management of Relay Control Messaging: The anticipated relay strategy will be centrally controlled and will therefore require control messaging from the control manager to all Relay Stations and/or Mobile & Subscriber Stations. Careful management of this control messaging will be a challenge for the proposed Task Group to assure that system capacity is not unnecessarily degraded.

It is recommended that the impact of control messaging for relay be one factor considered in the complexity-benefit trade off study for Mobile Multihop Relay.

RS Power Control: RS power directly impacts the coverage area of the RS. RS should not be allowed to transmit power equal to or exceeding a fully functional BS. RS power also contributes to the interference of nearby stations. For optimal control, centralized and adaptive power control for RS may be needed.

7 Conclusions

Mobile Multihop Relay is expected to reduce the complexity of future implementations of IEEE 802.16. This complexity reduction is due to the possibility of using fewer base stations to achieve a specified quality of service than would be possible without relay. In order to achieve this goal, the scope of the MMR Task Group must be sufficiently broad to include concepts such as multiple relays (more than two hops), cooperative relay (combining information from multiple paths to achieve increased reliability), mobile station relaying (to increase the opportunities for successful relay), and others as discussed above.

In order to compare relay strategies it is important that a common set of definitions be agreed upon by the Study Group and proposed Task Group. Section 4 above presents a set of definitions for discussion within the Study Group and agreement for the Task Group. This set is not comprehensive and additional definitions are forthcoming.

Finally, there are many challenges that must be addressed for MMR. Some of these challenges are presented in Section 6. This list of challenges is not comprehensive.

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9 Revision History

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1.0	2005.11.11	Initial submission for MMR Study Group in Session 40 of IEEE 802.16		all authors