Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Mobile Station (MS) Classifications for Efficient Resource Utilization**
Data Submitted	**08-Jan-2007**
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Re:	Call for Technical Proposals regarding IEEE Project P802.16j (IEEE 802.16j-06/034).
Abstract	The document describes MS classifications for efficient resource utilization.
Purpose	The document is provided as input for the IEEE 802.16j baseline document.
Notice	
Release	
Patent Policy and Procedures	

Mobile Station (MS) Classifications for Efficient Resource Utilization

1. Introduction

Radio resource management is very important for wireless networks, especially for relay-based multi-hop networks such as upcoming IEEE802.16j networks. Generally the data destined to a MS (Mobile Station) served by a Relay Station (RS) is firstly transmitted from Base Station (BS) to the RS and then relayed from the RS to the MS. The transmission occupies the radio resource twice and may result in capacity degradation. On the other hand, the introduction of RSs in the network allows radio resource reuse and thus the network throughput can be enhanced because far-apart RSs can simultaneously use the same radio frequency without interference. Therefore, how to efficiently utilize the radio resource among BS and RSs is a very important topic for relay-based wireless networks.

This contribution proposes a method about MS classifications for efficient resource utilization in IEEE 802.16j networks.

2. Assumptions

In this contribution, it is assumed that not only has a BS the channel information between BS and MS but also the channel information between RS and MS. Generally, BS has such kind of information for AMC, power control or handover purposes. This information can be used directly for MS classifications purposes.

This kind of channel information can also be obtained from ranging and network entry, as shown in Fig.1. During the ranging process, BS and RS monitor all the ranging signals in the ranging channel to obtain the SNR of a MS. After RS gets the SNR information of the MS, it reports the SNR information to BS. Then BS is aware of the channel quality between RS and MS. Other methods, like [1] can also be utilized to obtain such information.

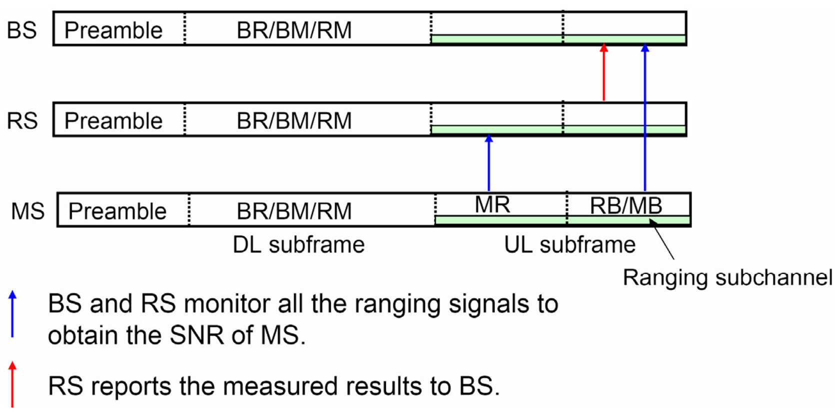

Fig.1 Obtain channel quality information between RS and MS

3. Proposed Method

Generally, one RS serves many MSs. In the case of coverage hole, MSs can only receive strong signals from a RS. While, in an overlapping area of BS and RS, MSs can hear signals from multiple sources (BS, RS and possible adjacent RSs). In order to efficiently utilize the radio resource and achieve spatial diversity, MSs are classified into different categories based on the serving area they reside in by utilizing the channel quality information between MS and BS/RS. In the following, how to classify MS and advantages of such classification are elaborated in detail.

3.1 MS Classifications for Coverage Hole

Considering the network shown in Fig.2, we define "MS_{inside}" as the MSs that can receive much stronger signals from the RS than from BS, and "$MS_{overlap}$" as the MSs that can receive comparable signals from both BS and RS. This classification allows efficient resource reuse and the achievable spatial diversity gain. For the case of $MS_{overlap}$, the spatial diversity gain can be achieved by transmitting data to $MS_{overlap}$ from both BS and RS at the same time using cooperative transmission in [2]. For the case of MS_{inside}, BS can reuse the resource that is allocated for RS transmitting to MS_{inside} for the transmission to its own MSs so as to achieve resource reuse.

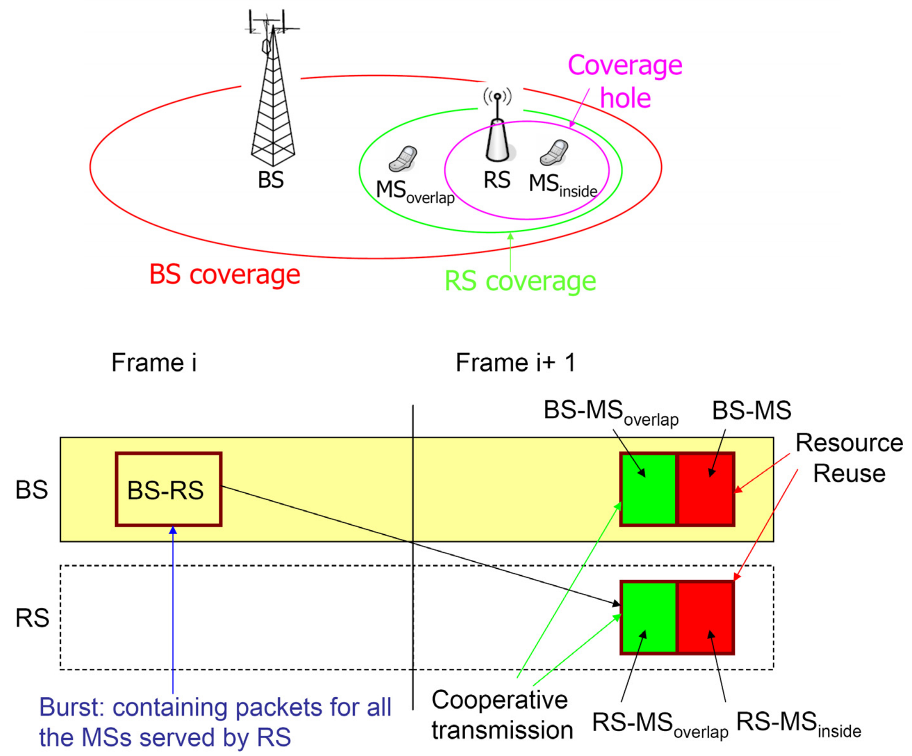

Fig.2 MS classification for both diversity gain and resource reuse in coverage hole application[1]

Fig.2 shows that: 1) Spatial diversity gain is achieved at $MS_{overlap}$, which receive signals from both BS and RS. 2) Resource reuse is achieved, when RS transmits data to MS_{inside} and BS reuses the resource for transmissions to its own MSs.

3.2 MS Classifications for Adjacent RSs

Fig.3 shows the MS classifications in network with two adjacent RSs. Without losing generality, we classify MSs served by RS_0 as follows: "MS_{inside}" are the MSs which can receive much stronger signal from RS_0 than from BS and RS_1, "$MS_{overlap}^{RS_0 \cap BS \cap RS_1}$" are the MSs which can receive comparable signals from RS_0, RS_1 and BS, "$MS_{overlap}^{RS_0 \cap BS}$" are the MSs which can receive comparable

[1] Here, different frame relay, i.e. RS receives packet of MS in frame i and transmits the packet to MS in frame i+1, is used as an example. However, the following proposed techniques can not only be used in different frame relay but also in the same frame relay.

strong signals from RS_0 and BS, but weak signals from RS_1, " $MS_{overlap}^{RS_0 \cap RS_1}$ " are the MSs which can receive comparable strong signals from RS_0 and RS_1, but weak signals from BS. On the basis of these classifications, different operations can be applied to different MS types to achieve spatial diversity gain and resource reuse gain, as shown in Fig.3.

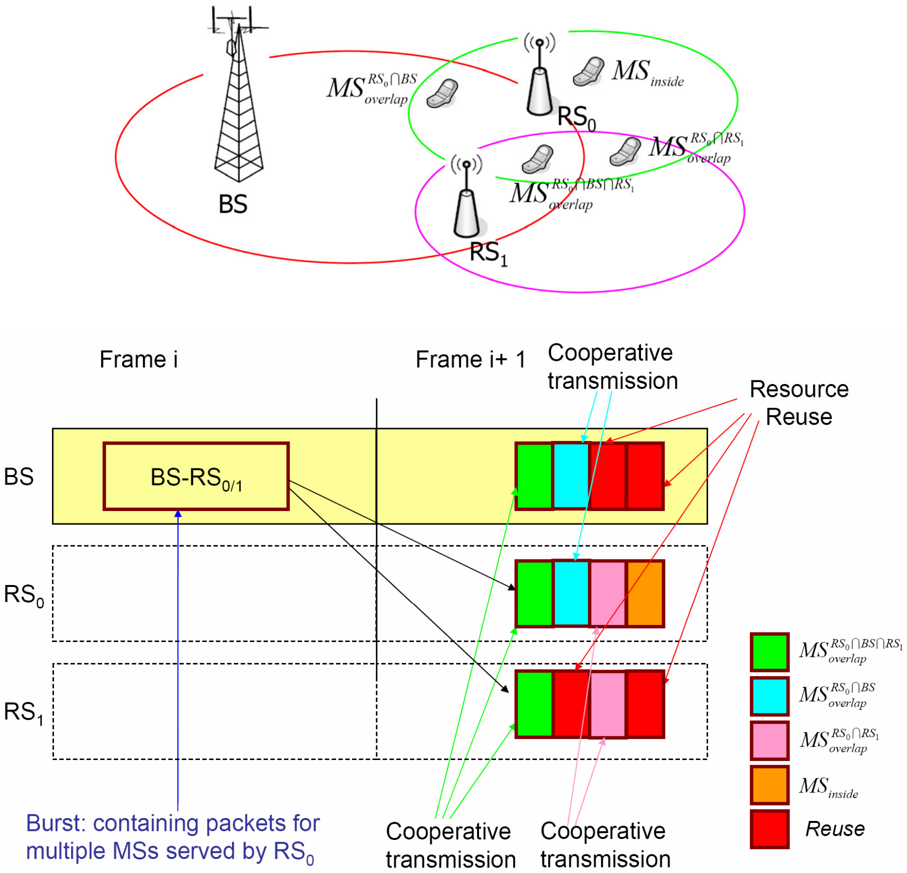

Fig.3 MSs classifications for both diversity gain and resource reuse

Fig.3 illustrates: 1) Spatial diversity gain is achieved for $MS_{overlap}^{RS_0 \cap BS \cap RS_1}$, $MS_{overlap}^{RS_0 \cap BS}$ and $MS_{overlap}^{RS_0 \cap RS_1}$. 2) Resource reuse is achieved, when i) BS and RS_0 cooperatively transmit to $MS_{overlap}^{RS_0 \cap BS}$, and RS_1 transmits to its own MSs simultaneously; ii) RS_0 and RS_1 cooperatively transmit to $MS_{overlap}^{RS_0 \cap RS_1}$, and BS transmits to its own MSs at the same time; iii) RS_0 transmits to MS_{inside}, BS and RS_1 transmit to their own MSs respectively.

3.3 MS Classifications for Manhattan Model

The MS classifications in sections 3.1 and 3.2 can be easily extended to Manhattan model, shown in Fig. 4. For Manhattan model, all MSs are classified into different categories under different BS/RS transmission scenerios.

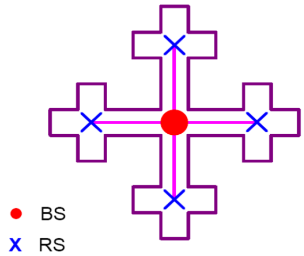

Fig.4 Manhattan model

There are total $2^N-1=31$ different BS/RS transmission scenarios, where N is the number of BS and RSs in one cell. For simplicity, BS is denoted as RS_0, while the RSs are denoted as RS_i, i=1, 2, 3, 4, as shown below

- ✓ 5 RS_i (i=0,1,…,4) transmit simultaneously, 1 case
- ✓ 4 out of the 5 RSs transmit simultaneously, 5 cases
- ✓ 3 out of the 5 RSs transmit simultaneously, 10 cases
- ✓ 2 out of the 5 RSs transmit simultaneously, 10 cases
- ✓ 1 out of the 5 RSs transmits, 5 cases

In each transmission scenario, MS_{inside} and $MS_{overlap}$ can be defined by similar method in section 3.1 and 3.2. After that, different operations can be performed to achieve resource reuse for MS_{inside} and spatial diversity for $MS_{overlap}$.

4. Summary

Radio resource management is very essential for IEEE 802.16j networks. In order to efficiently utilize the radio resource, MS shall be classified into different types to achieve different performance gains, such as diversity gain and resource reuse gain.

5. Proposed Text

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6.3.6.7 Relaying Support for Scheduling

6.3.6.7.1 Distributed Scheduling

[Insert the following text in this section]

To efficiently utilize radio resource, BS shall perform MS classifications to identify which part of radio resource can be reused among BS and RSs. The MS classifications can be conducted on the basis of channel quality information, which is generally available at BS for AMC, power control or handover purposes or can be obtained from ranging or network entry processes, between MS and BS/RS. Since RS can generate its own MAP for resource allocation in distributed scheduling, BS shall coordinate RSs for resource reuse on the basis of the MS classifications so as to enhance the system performance.

6.3.6.7.2 Centralized Scheduling

[Insert the following text in this section]

In order to efficiently utilize the radio resource and achieve spatial diversity gain, BS shall perform MS classifications to identify which part of radio resource can be reused among BS and RSs. The MS classifications can be conducted on the basis of channel quality information, which is generally available at BS for AMC, power control or handover purposes or can be obtained from ranging or network entry processes, between MS and BS/RS. On the basis of the MS classifications, the scheduling can be performed to maximize the resource reuse and network throughput.

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6. References

[1] IEEE C80216j-06_181, MS channel detection of RS in relay system, ETRI.

[2] IEEE C80216j-07_124, Cooperative Relaying in Downlink for IEEE 802.16j, Siemens, Samsung Thales, ETRI, DoCoMo Beijing Labs, DoCoMo USA Labs, Nokia.