Enabling Enhanced Relay Station Grouping in IEEE 802.16j for Handoff Minimization

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Abstract

The IEEE 802.16j has been developed to improve the performance of existing IEEE 802.16e network by incorporating the Multihop Relay technology.The Relay Station (RS) grouping is one optional mechanism in IEEE 802.16j MR standard to overcome Handoff problems. The concept of RS grouping is to group neighboring RSs together to form an RS group with larger coverage. This paper designs an RS enhanced grouping algorithm to minimize handoffs and changing the group size according to the user mobility.

I. Introduction

IEEE 802.16j MR standard has been developed to provide throughput improvement, coverage extension, and capacity enhancement to the existing IEEE 802.16e protocol. IEEE 802.16j has the potential to provide substantial performance enhancements, several issues that were not addressed in IEEE 802.16e may be encountered. For example, frequent handoffs may occur during the movements of MSs since the RS cells are smaller than the BS cells. Moreover, the unbalanced resource allocation of different RSs may result in system throughput can be expected. RS grouping mechanism in IEEE 802.16j was implemented to reduce the issues such as frequent handoff. However, a smaller RS group size may also lead to higher packet loss rate due to more frequent handoffs between RS groups .In this paper Enhanced RS grouping enabled IEEE 802.16j MR networks has been proposed. As we have pointed out, Changing of RS group size according to the usage will improve the throughput and also reduce the frequent handoff. The main idea of Enhanced RS grouping is to put adjacent RSs together to form an RS group, where the RS members are required to simultaneously receive and transmit the same data. Therefore, the handoff frequency can be reduced since no handoff procedure would be triggered, even when an RS crossing event within the RS group occurs. In addition, since the radio resources of the RS members are aggregated together, the resources can then be more flexibly and efficiently allocated to achieve higher spectrum utilization. However, to the best of our knowledge, no RS grouping strategy has been proposed or discussed in the literature. We argue that different grouping criteria may lead to various performance results. Thus, improved average system throughput can be expected. However, a smaller RS group size may also lead to higher packet loss rate due to more frequent handoffs between RS groups. In conclusion, when implementing the Enhanced RS grouping mechanism in IEEE 802.16j MR networks where the group size is changed according to the handoff rate of user’s availability, the performance tradeoff between throughput and handoff frequency should seriously be considered.

II. IEEE802.16j Multihop Relay Technology

A. Network Architecture

The IEEE 802.16j standard is expected to enhance the system performance of IEEE 802.16-based networks through multihop-relaying technologies. In this network, an MS can access the MR-BS either through a multihop relaying path (e.g., MS1, MS3, and MS4) or directly (e.g.,MS2). In addition, a station (BS or RS) is called an access station if it provides network attachment functionality to a given MS or RS. On the other hand, an RS is a subordinate RS of another station if that station serves as the access station for that RS. For instance, RS2 is the access station of RS3, and RS3 is a subordinate RS of RS2. The wireless links that directly connect access stations with their respective subordinate RSs are called relay links, whereas the links between MSs and their corresponding access stations are known as access links. Since an RS can only be subordinated to one station, the MR-BS and the RSs in this MR network form a tree-based MR topology. Note that it has been shown that the throughput decreases as the number of hop counts increases; thus, we only investigate two-hop IEEE 802.16j networks in this paper.

B. Frame Structure

The frame structure of IEEE 802.16j MR systems is extended from that of IEEE 802.16e networks, which also adopt orthogonal frequency-division multiple access (OFDMA) as the primary channel access mechanism for NLOS communication. The basic unit of resource for allocation in OFDMA is a slot, which comprises a number of symbols in the time domain and one sub channel in the frequency domain. The timeline is divided into contiguous frames, each of which further consists of a DL and an uplink (UL) sub frames. In IEEE 802.16j, the DL and UL sub frames shall include one access zone for MR-BS↔RS and MR-BS↔MS transmissions and may include one relay zone for RS subordinate MS transmissions, respectively.

III. IEEE 802.16J Relay Station Grouping mechanism

Although deploying RSs in IEEE 802.16 networks can provide significant throughput or coverage enhancements, several issues regarding the relaying architecture of IEEE 802.16j should be addressed. These issues include frequent handoffs, redundant control overhead, and low spectral efficiency. It is perceived that these issues will result in unpredictable performance reduction for IEEE 802.16j MR networks. Therefore, the IEEE 802.16j standard provides the optional RS grouping mechanism to reduce the impacts of these issues. The concept of an RS grouping is that adjacent RSs could be grouped together as an RS group, which acts as a virtually regular RS to its associated MSs. The grouping criteria are decided MN by the controlling MR-BS, based on the targeted performance requirement. Note that the coverage of an RS group is larger than that of its regular member RSs, and no handoff event would be triggered, even though an RS-cell crossing event within the same RS group occurs. Consequently, the MSs under the RS grouping mechanism will experience lower handoff probability. On the other hand, MR-BSs can manage RS groups using only one set of control header; hence, the control signal overheads are reduced.

To support an RS grouping, the original IEEE 802.16j frame structure should be modified. Specifically, access zones should handle the transmissions between BSs and RS groups, whereas relay zones should handle the transmissions between RS groups and subordinate MSs. From the mobility management point of view, we note that implementing RS grouping will not incur extra to IEEE 802.16j. As previously mentioned, for movement between the RS cells of an RS group, an MS will not initiate the handoff procedure. The MS CDMA periodic ranging process with aggregated ranging sub channel allocation can be employed to handle the RS reselection during intra-RS-group movement. On the other hand, when the MS roams from an RS group to another RS group, since an RS group can be seen as a legacy BS, the conventional MAC layer handoff procedure is directly applied for this scenario.

IV. Proposed Enhanced Relay Station Grouping Algorithm for IEEE 802.16j Multihop Relay Networks

This section proposes an IEEE 802.16j Enhanced RS grouping algorithm to reduce the handoff frequency of mobile users under prescribed IEEE 802.16j MR network performance requirements.

A. System Assumptions and the Concept of our Enhanced RS Grouping Algorithm

To accommodate general scenarios, our algorithm makes no assumptions of the underlying IEEE 802.16j MR network topology, the user mobility behavior, and/or the packet traffic pattern. Specifically, within a considered BS, the IEEE 802.16j RSs can arbitrarily be deployed, and the coverage area of each RS can be irregular. In addition, the MSs within the considered BS can randomly move. In such an arbitrary environment, we only require that the handoff-rate information between each two RS cells should be available. The handoff rate between two RS cells, i.e., RS cell 1 and RS cell 2, is the total rate that the resident MSs handoff from RS cell 1 to RS cell 2 or from RS cell 2 to RS cell 1. Note that the handoff-rate information can simply be derived from the statistical data that are collected by the network service providers. To design the RS grouping algorithm in our considered environment, we first specify the factors that may affect the grouping result. First, the group size is a factor that has the potential to influence the spatial diversity gain and the handoff frequency. It can be observed that utilizing a smaller group size will result in more RS groups. Such a grouping policy is beneficial to spatial reuse, although it causes higher handoff frequency. Even with the same group size, different grouping orders may lead to different numbers of handoff events. Once an RS grouping layout is provided by applying the most desired group size and grouping order, determining which set of RS groups to simultaneously transmit data further impacts the efficiency. Taking all the preceding factors into account, we propose our Enhanced RS grouping algorithm. Based on the handoff-rate information, first we constructs the handoff-minimizing RS grouping result for a preferred group size. After a few minutes the Handoff rate is calculated for the RS Groups. This Handoff rate is considered to be the new Handoff rate and the RS group is changed according to the new Handoff rate. This will improve the performance.

ENHANCED GROUPING ALGORITHM

1. Input

Group size X, handoff rate, set of RS

2. Output

Minimized Handoff rate

3. Procedure

1. Select RS pair with highest handoff rate
2. Of this pair, RS that has high handoff rate to other RS is taken as starting member of group
3. Ungrouped RS join group in descending order of handoff rate to the group.
4. Repeat until it attains preferred group size
5. Few minutes later, Calculate the Handoff rate for the RS Groups
6. Goto step 1
7. The operation is shown in Algorithm and is explained as follows: According to the functionalities, the RS grouping procedure is partitioned into four main portions.

1) Input parameters: At the beginning of the procedure, three parameters are required as the inputs, where X denotes the preferred group size.
2) Output results: The outputs of the procedure are the final grouping result.
4) Procedure: The handoff rate between two RS cells, i.e., RS cell 1 and RS cell 2, is the total rate that the resident MSs hand off from RS cell 1 to RS cell 2 or from RS cell 2 to RS cell 1, under which RS pairs with higher handoff rates will have higher priority to be selected

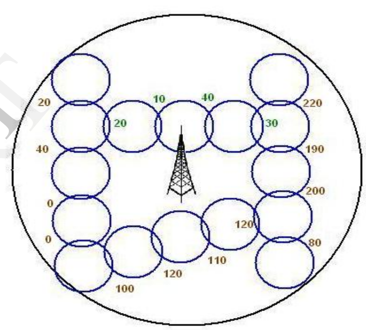

Fig .1.RS With New Handoff rate

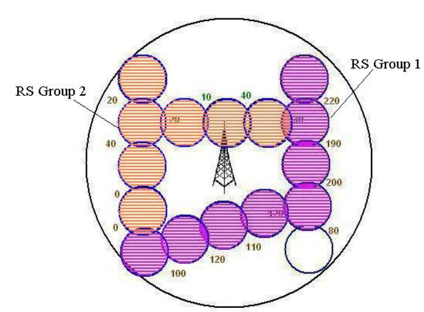

Fig.2.RS grouping through new handoff rate

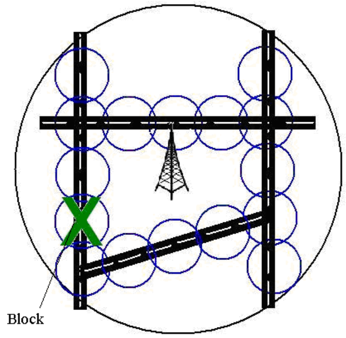

Fig.3. Block in BS

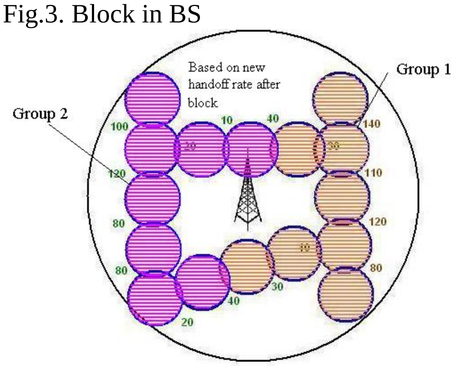

Fig.4. Changing of Group with new Handoff rate

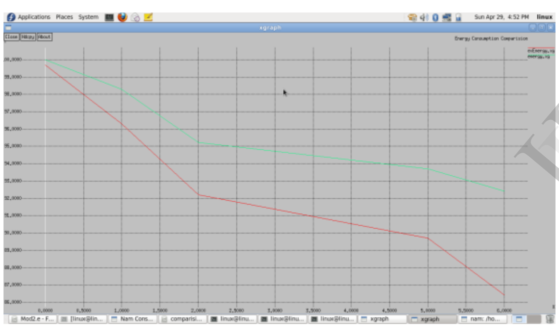

Fig.5. Comparision of Energy between RS Grouping and Enhanced RS Grouping

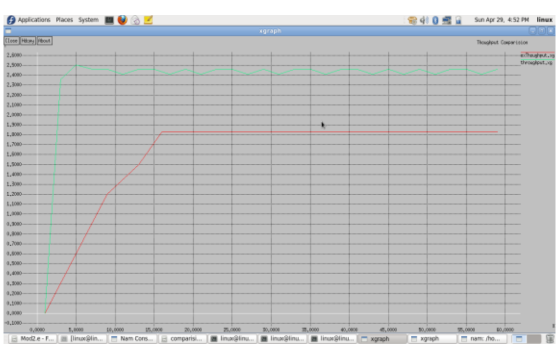

Fig.6. Comparision of Throughput between RS Grouping and Enhanced RS Grouping

V. Conclusion

The IEEE 802.16j MR standard has been developed to provide performance enhancement to the existing IEEE 802.16enetwork. However, issues such as frequent handoffs, which were not encountered in IEEE802.16e, may occur in IEEE 802.16j. The RS grouping is one optional mechanism in the IEEE 802.16j MR standard to overcome these problems. This paper has investigated the Enhanced RS grouping performance enhancement in terms of throughput and handoff frequency. RS pairs with higher handoff rates will have higher priority to be selected and changing the group size according to the user mobility. The simulation results will show that the handoff frequency of the considered.,The simulation results have indicated that, for the case of fixed users, groupings with smaller group sizes can result in better throughput performance, When user mobility is considered, the throughput value increases as the group size increases.

VI. References

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