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Coverage Driven Distance Metric Based Relay Placement Mechanism For Relay Networks

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Abstract: *In recent years various methods have been proposed for deploying Wi MAX networks to improve coverage and network throughput rate. Multi-hop relay network architecture that introduces relay stations will increase the network throughput and coverage both at the same time. But here the deployment of the relay stations is one of the most important issues that determine the network efficiency. Large numbers of relays are most expensive to purchase, deploy and maintain. Here in this paper we proposed relay deployment mechanism aiming to determine the best deployed locations for relays and distance aware mapping rate for MSs to maximize the network throughput with improved Quality of services. And finally we employ modulation and coding schemes (MCSs) for adjusting the transmission rate according to MS distance from RS and the channel condition. Through simulation we proved that the relay station not only extends the base station coverage with maximal constellation order network throughput rate can also be improved significantly. The performance advantage of relay placement mechanism for deploying Multi-hop Relay (MR) and its MSs through put rate is verified.*

I. INTRODUCTION

IN THE IEEE STANDARD 802.16j it has less metropolitan area network (WMAN) consists of a base station (BS), mobile stations (MSs), and subscriber stations (SSs). The BS serves as a gateway between the WMAN and external networks and supports MSs and relay stations (RSs) with Internet access. In literature, there have been several studies . QoS scheduling frameworks for IEEE 802.16e networks, aim- at improving the network throughput. However, the network performance still highly depends on the network deployment. In considering the deployment issue in IEEE 802.16e networks, the cost is expensive for achieving full coverage by deploying only BSs. Therefore, the relay station (RS) interconnected between the BS and MSs (or SSs) for WMANs is proposed in the new version of IEEE 802.16j standard [4]. The RSs are WMAN and hence to reduce the cost of infrastructure construction. Another, the RSs interconnecting the BS and MSs (or SSs) can reduce the communication distance and therefore improve the network capacity by applying efficient modulations. In the 802.16j networks, the BS is in charge of bandwidth assignment [5], [6] and routing [7] tasks for RSs, MSs, and SSs. The standard of 802.16j defines two types of RSs, transparent and nontransparent RSs. A transparent RS can be served as a forwarding agent to improve the trans- mission efficiency between the BS and MSs, but it does not participate in the scheduling task in a WMAN. The BS has to announce and handle all control messages, including dedicated channel, downlink/uplink (DL/UL) map, and DL/UL channel descriptors, for MSs [8].

This indicates that a transparent RS is only in charge of forwarding the data. On the contrary, a nontransparent RS can perform all the tasks of transparent RS plus the transmission scheduling [9]. Therefore, the BS due to the help of relaying operations from the non-transparent RS can still serve the MSs that are located outside the coverage area of the BS

II. PROPOSED APPROACH

1) Partitioning Phase: Given k RSs, this phase aims to divide the given region A into k partitions with equal traffic demands for balancing the loads of RSs. Two steps will be executed in this phase. Recall that the region A can be fully covered by the BS, which is located at the central point of A. Region A consists of n sub regions A_1 , A_2 , . . . , A_n . Sub region A_i can be considered the district belonged to region A. For example, region A is a city, and each A_i denotes a district of this city. First, region A is equally partitioned into k partitions

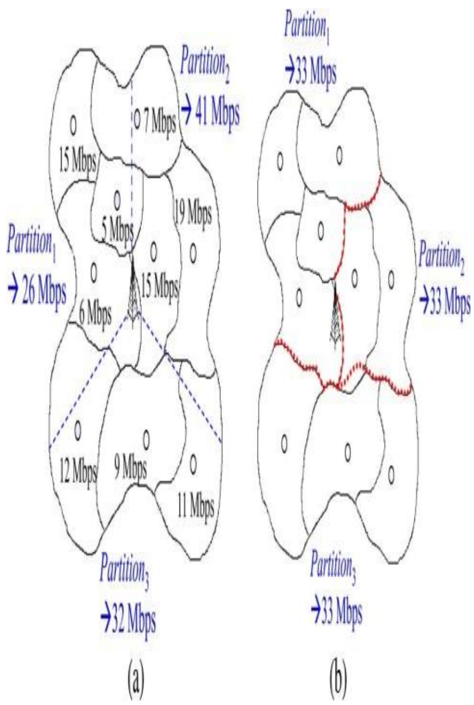
Since an RS will be deployed in each partition, the next step is to find a promising region for deploying an RS in a partition. Therefore, the next three phases would be executed repeatedly for each partition. The *bright-region identification* phase aims to identify a bright region that is a promising region for deploying the RS. For sub region A_i, it is improper to deploy and RS deployed very close to the BS, the rate between the RS and P_i will be reduced significantly, which increases the transmission delay from the MSs to the RS. On the other hand, if the RS is deployed far away from the BS, the rate between the RS and the BS will be poor. Fig. 3 depicts that the bright region of A_1 is the promising zone for deploying the relay. Fig. 4 depicts the union of bright regions of n sub regions.

2) Bright-Region Identification Phase: This phase aims to identify a bright region that is a promising region for deploying an RS. Herein, a location in region A is said to be a bright point if an RS deployed at this location can improve the transmission rate between the BS and P_i. Otherwise, the point is said to be a shadow point. The bright and shadow regions are the collection of all br Given location h, this part helps make a decision whether deploying an RS at location h can reduce the latency of trans- mission directly from P_i to the BS. Compared with the existing deployment schemes [10]–[12], the proposed *latency by considering frame structure* takes into consideration the IEEE 802.16j frame structure. In order to improve the network throughput through RS deployment, the *latency constraint* depicted in (15) should be satisfied. However, the evaluation of transmission latency is more complicated since the frame structure designed in The evaluation of the transmission latency can be further considered in two cases, depending on whether the traffic is forwarded by the RS. For the ease of transmission latency calculation, it is assumed that the transmission latency is counted from the start of UL access zone. First, we consider that the data are directly transmitted from P_i to the BS. In case that the data can be completely transmitted within one frame, the latency will be equal to the transmission time. Otherwise, the transmission of u_j requires several frames. Le denote the duration of transmit/receive transition gap and the duration of receive/transmit transition gap, respectively. Let t_{frame} denote the duration of one IEEE 802.16j frame.

III. ALGORITHM ANALYSIS

Here, the details of the four phases designed in the proposed RPM are presented.

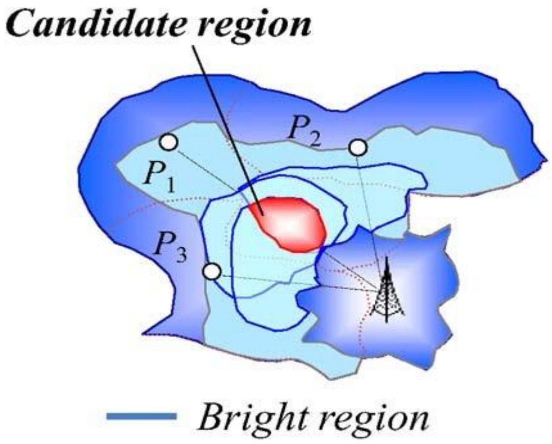
1) Partitioning Phase: Given k RSs, this phase aims to divide the given region A into k partitions with equal traffic demands for balancing the loads of RSs. Two steps will be executed in this phase. Recall that the region A can be fully covered by the BS, which is located at the central point of A. Region A consists of n sub regions A_1 , A_2 , . . . , A_n . Sub region A_i can be considered the district belonged to region A. For example, region A is a city, and each A_i denotes a district of this city. First, region A is equally partitioned into k partitions



fig;1Executing the partitioning phase for k = 3. (a) Initial partitions. (b) Adjusted partitions.

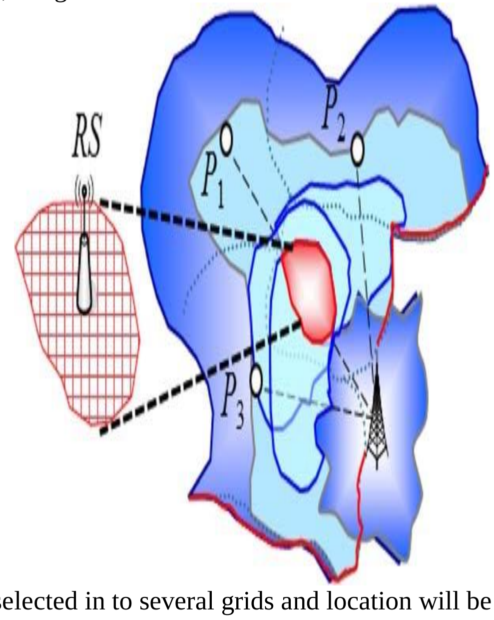
2) Bright-Region Identification Phase: This phase aims to identify a bright region that is a promising region for deploying an RS. Herein, a location in region A is said to be a bright point if an RS deployed at this location can improve the transmission rate between the BS and P_i. Otherwise, the point is said to be a shadow point. The bright and shadow regions are the collection of all bright and shadow points in region A, respectively.

3) Candidate-Region Identification Phase: This phase aims to identify a smaller region from the bright region for further reducing the computational complexity. Two or more bright regions might be overlapped. If the RS is deployed in the over- lapped regions, it can improve the transmission rate of these regions. In this phase, the overlapped region, also referred to as the *candidate region*, that is covered by the maximal number of bright regions will be selected as the candidate region for deploying an RS. As shown in Fig. 5, the candidate region is marked by red ink. Let O_Φ denote an *overlapped region* constructed by a set of *bright region*s BR_1, BR_2, . . . , BR_X, where $\Phi = \{1, 2, . . . , x\}$. Let notation $|O_\Phi|$ denote the *relay benefit* that represents the reduced transmission time if an RS is deployed in O_Φ . The following evaluates the value of $|O_\Phi|$ by calculating the sum of relay benefit:



fig;2 candiadate region that is marked by red link

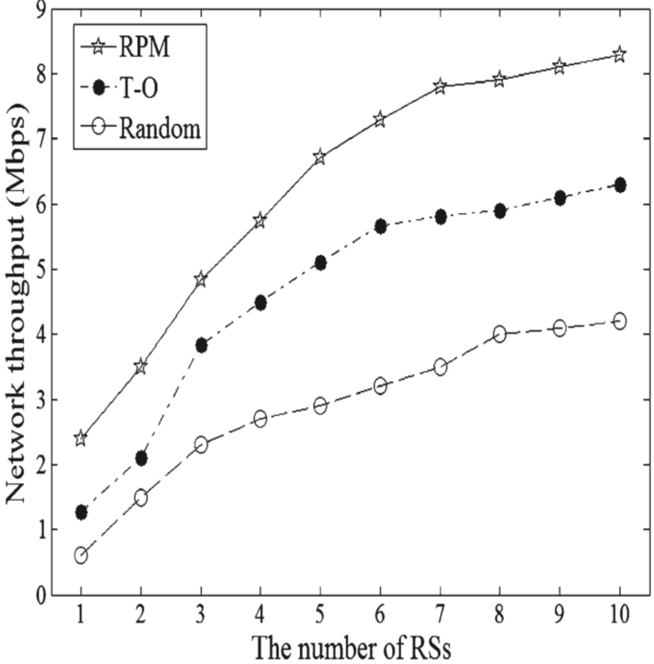
4) Candidate-Location Identification Phase: This phase further partitions the candidate region into a set of equal-sized grids and then evaluates the improved network capacity of each grid if a relay is deployed at that grid. This phase aims to determine the best grid for deploying an RS. A fine-grain partition of the candidate region will increase the computational cost but obtain a location with higher network capacity. By giving a bound of computational resource, the grid size can be determined.



fig;3 candidates region is selected in to several grids and location will be marked by number of lines

C. Algorithm of RPM algorithm and several sub procedures is presented. There are four phases designed in the main algorithm. In the *partitioning* phase, step 1 calls Partition(·) procedure to geographically partition the whole region into k equal-sized partitions. How- ever, the traffic demands of k partitions might be different, resulting in the situation that the loads of k relays are unbalanced. further calls subroutine Partition.and adjust the region of each partition s o all partitions have similar traffic demands. Then, a relay will be allocated to each partition.

The second phase, which is called the *bright-region identification* phase, mainly aims to identify the proper areas for deploying the RS in each partition region. In Steps 3–5, the *RPM* identifies the *bright region* of each sub region by calling BR(·) subroutine, which constructs the *bright regions*. In the *candidate region identification* phase, steps 6–8 derive the overlapped region covered by the maximal number of bright regions in the same partition. The overlapped region is called the *candidate region*. It means that placing an RS at any position of the *candidate region* could obtain maximal benefits in terms of throughput. Finally, in steps 9–20, the *RPM* partitions the *candidate region* into a number of grids and picks out the best grid for deploying an RS.



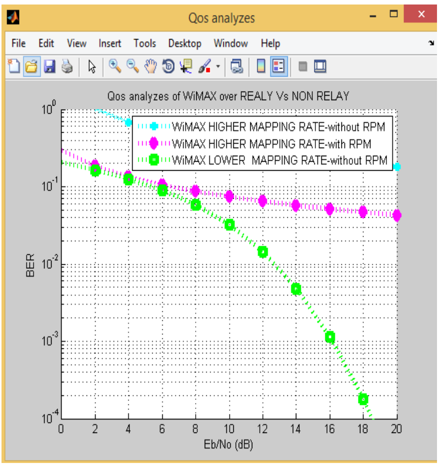
The above fir represent the Comparison of network throughput by varying the numbers of RSs.

IV. SIMULATION

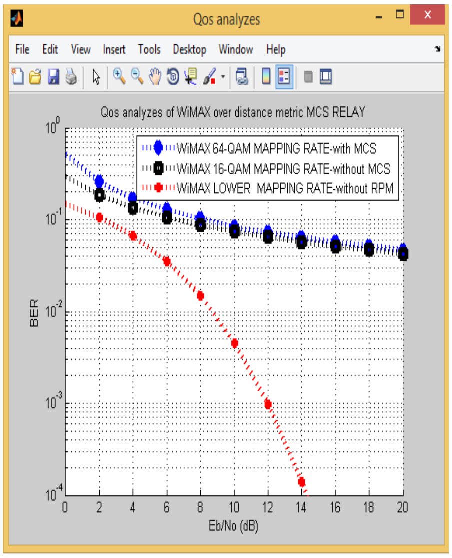
This section presents the performance evaluation of the pro- posed RPM. The proposed RPM . The offered traffic of UGS service is 32 Kb/s, whereas the offered traffic service is randomly generated from 100to 500 Kb/s. Each user establishes one connection belonging to either UGS or PS services. After executing the compared RS deployment algorithms, the QoS scheduling algorithm proposed in [17] is adopted to compare the performance of the three compared deployment algorithms. Each result is obtained from the average of 200 independent runs. The 95% confidence interval is always smaller than 5% of the reported values. The MCSs used in the simulations refers to [4]. Table III gives the parameters and their values considered in the simulation.

IV. SOFTWARE IMPLEMENTATION RESULTS

a)Q*os analysis Relay vs non Relay*



b)Qos analysis with distance



V.TABLE

Level	Modulation & Coding Rate	Received SNR (dB)	Data Rate (bit/symbol)	Distance Range (m)
1	BPSK 1/2	6.4	0.5	$7400 \le d_B^A$
2	QPSK 1/2	9.4	1	$5220 \le d_B^A \le 7399$
3	QPSK 3/4	11.2	1.5	$4250 \le d_B^A \le 5219$
4	16-QAM 1/2	16.4	2	$2320 \le d_B^A \le 4249$
5	16-QAM 3/4	18.2	3	$1900 \le d_B^A \le 2319$
6	64-QAM 2/3	22.7	4	$1120 \le d_B^A \le 1899$
7	64-QAM 3/4	24.4	4.5	$d_B^A \le 1119$

V. CONCULSION

Network planning is an important issue for maximizing the network throughput and capacity for a given WiMAX network. A relay placement mechanism, which is called *RPM*, is proposed for determining the deployment location that satisfies the traffic demand and maximizes the network capacity. The proposed *RPM* first partitions the network region into k partitions according to the historical traffic pattern. Then, the *RPM* takes into consideration the frame structure constraint and bandwidth constraint. For each partition, the *RPM* identifies the bright regions and chooses the best location for deploy- Simulation study reveals that the proposed *RPM* outperforms the existing two mechanisms in terms of network throughput and transmission delay.

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