

Towards for Admission Control in WIMAX Relay Station Mesh Network for Mobile Stations out of Coverage Using Ad-Hoc

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Abstract—WIMAX relay station mesh network has been approved by IEEE 802.16j as a standard to provide a highly data rate transmission, the RS was implemented to extend the coverage zone of the BS, for instance the MSs previously were out of the coverage of the BS they become in the coverage of the RS, therefore these MSs can have Admission control from the BS through the RS. This paper describe a problem in the mesh network Relay station, for instance the problem of how to serve the mobile stations (MSs) which are out of the Relay station coverage. This paper also proposed a solution for mobile stations out of the coverage of the WIMAX Relay stations mesh Network. Therefore Ad-hoc network defined as a solution by using its admission control schema and apply it on the mobiles inside and outside the Relay station coverage.

Keywords—WIMAX, Relay station, Mesh network, Ad-Hoc, WiFi, Generic Algorithm.

I. INTRODUCTION

WIMAX (World wide Interoperability for Microwave Access) this broadband services is growing exponentially, it is a solutions that provide high-Speed broadband access. WIMAX will revolutionize broadband communications in the developed world and bridge the digital world in developing countries, provide affordable wireless broadband access for all [1], [2] and other broadband wireless access (mobile station (MS)). Mesh network is about connecting (MSs) with each other through (BS) called centralized or without the (BS) between each other called decentralized in WIMAX. These technologies have primarily focused on providing high data rate connectivity wirelessly between fixed stationary sites (Base station (BS) and relay stations (RS)) Relay stations (RS) to give more zone coverage of (BS) to support more (MS) [3]. The overall area is divided

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into stationary sites (Base station (BS) and relay stations (RS)) Relay stations (RS) to give more zone coverage of (BS) to support more (MS) [3]. The overall area is divided into meshes, meshes managed by a single node called as mesh base station (MBS). However it serves as the interface for WIMAX base mesh to the external network. A transmission can occur between two MSs within a mesh or within two meshes [6]. A transmission within a single mesh may or may not involve the BS where as transmission between MSs in two different meshes must route through the BS. In other case, MSs routes its packets to its MS via several MSs in between, MS and route it to BS and then the BS forwards the packet to the destination MSs throw MS. Finally the MS of destined MSs routes the packet to the MS via several MSs in the route. In mesh network the admission control involve in the scheduling and providing QoS to the MSs[3],[4]. To provide QoS guarantees to different connections, admission control is required: if a new connection request arrives and the network does not have sufficient resources to provide it the QoS requested, the service provider should reject the request. A more relaxed rule would be: limit admission control decision (to reject) to applications with real-time hard constraints for example, IP telephony and video conferencing. For other requests (e.g., audio/video streaming, web browsing) if there are insufficient resources, one can provide throughput less than requested by them. Of course here also a service provider may decide to reject an admission request if he is unable to provide beyond a certain fraction of requested throughput [4].

II. MOTIVATION

WIMAX provide a high data rate transmission using mesh network (infrastructure mode); however, some problems have been appeared such as providing services for MSs which are out of the coverage area, anew stander for WIMAX (IEEE 802.16j) so-called Relay Stations, even though the Relay station overcome the problem of MS out of the coverage a new problem start growing, this problem represented in the MSs which are out of the coverage of the base station and Relay station, in additional the Relay station is highly cost. One of the researches in the admission control for the Ad-Hoc network approved in a paper under the title “a distributed call admission controller for Ad-Hoc networks”[4].

In this paper the call admission controller is based on

service curve provisioning. Service curve reflects the status of network and depends on the number of active nodes, their activity index, and the back-off procedure used for contention resolution [4], [5]. The service curve along with the aggregated traffic function can be used to calculate maximum delay and maximum backlog. Proposed a call admission procedure for wireless ad hoc networks, the technique is a measurement based call admission controller using a sequence of probing packets. It is assumed that the size of the probing packets is small and therefore the probing sequence does not consume a large amount of bandwidth. They have used a service curve approach. The service curve is defined as the amount of service given to the user over a backlogged interval. It discussed — and also illustrated by numerical examples — that the service curve truly reflects the performance of the network. A lightly loaded network has a service curve which is close to the vertical axis and a heavily loaded network has a service curve close to the horizontal axis. This observation can be used to propose a call admission procedure: a call request is accepted if the service curve is considerably far from the horizontal axis [5].

III. PROBLEM BACKGROUND

In the IEEE 802.16, Mesh network have been applied, as we know Mesh network define as centralize infrastructure however there is Ad-Hoc mode also applied in WIMAX, to provide any service to any mobile station we need for admission control[5].

Even though a lot of research had been done in the area of admission control and its scheduling, there are many problems waiting to be solve, in the this part we will describe three scenarios talking about mesh network in WIMAX these scenarios as followed [5],[6]:

- First Scenario

In the Mesh network for IEEE 802.11 WIFI, one of the problem that solved was to give a coverage to MSs which are out of the coverage through Ad-Hoc network with MSs in the coverage. Fig. 1 shows how MSS's may served by the BS through MS in the coverage.

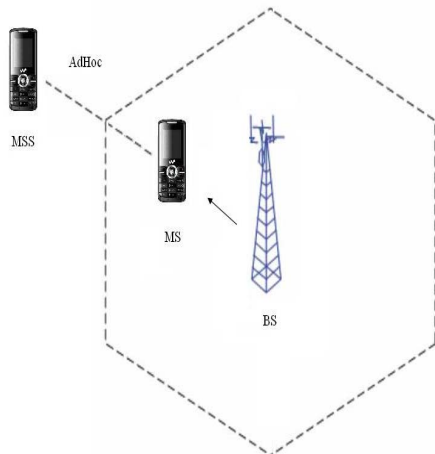


Fig. 1 MSS served by BS through MS

- Second scenario

In 2006, the IEEE approved a project, called P802.16j (802.16j), for a mobile multi hop relay (MMR) specification to extend base station reach and coverage without the backhaul requirement.

The MMR base station (BS) provides the primary area of coverage in the diagram. It also has a backhaul connection, such as leased copper or fiber optics. The relay station (RS) extends the base station coverage.

A mobile subscriber station (MS) can connect to a base station, an MMR base station or a relay station.

Relay station provide Better coverage, Higher Capacity, Enhanced QoS, Reduction in transmit power at the BS and the MS and Longer MSS battery life.

Next figure shows the Relay station gives coverage to the MS out of the coverage of the BS.

We note that the MS doesn't need for Ad-Hoc with MS to get served, however the MS got admission control and scheduling to have all the services.

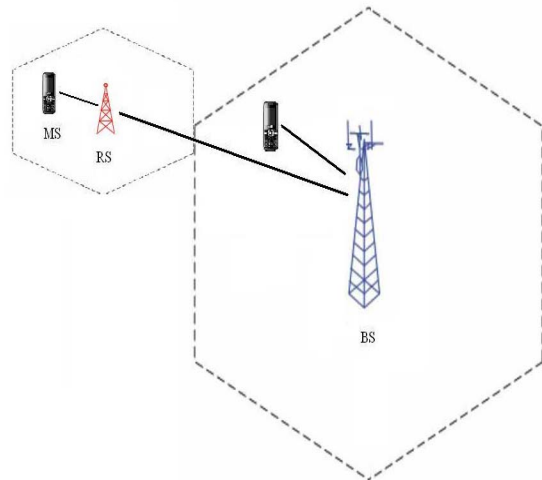


Fig. 2 The coverage of the RS

- Third Scenario

In the mesh networks many researchers solve the admission control which is one of the main problem for the mobile stations (MS) who are out of coverage area of the Base station (BS). Then the Relay stations (RS) was applied as part of a new solution to expansion the zone of the coverage area for the (BS) in the mesh network. However, after this improvement a new problem approaches in this field.

There are still Limited accesses of (MSs) out of the coverage area of the (RS) which need to have Reasonable connections quality to these (MSs) that are away from the (BS). Fig. 3 shows this problem.

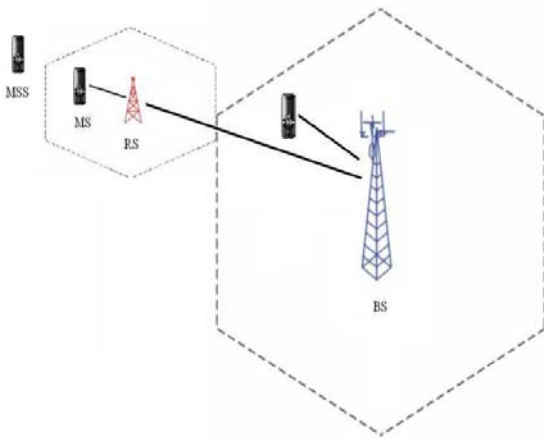


Fig. 3 How can a MSS out of the coverage range of the RS be served

Our duty to propose a solution that gives somehow coverage to the MSS's that out of relay station coverage as well as the MSs in the BS or RS coverage.

• Forth Scenario

If there is a relay station terminology, and last one cover only the beach and in the other side of Island also the relay station cover only the beach, in this case the MS in the sea or the ocean will not have coverage however some relay station will be on the ferries or the ships, our disappoint here is the highly cost of using the relay stations anywhere it will seems like we have a very short wireless communication.

Next figure shows how MSS in the sea haven't coverage yet.

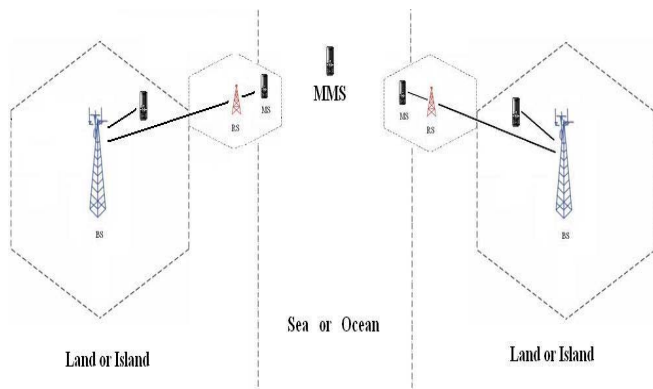


Fig. 4 MSS in the sea not under the coverage

IV. PROPOSED SOLUTION

The standard concerned about relay stations has not been finalized yet, a first drafted was launched early this year, characterized by IEEE 802.16j. Also, few researches Papers were already published about Admission control in relay station.

However, Modeling Admission control in relay stations in the mesh network is still a hot topic and requires lots of research. As far we are concerned, no proposed solution for

this problem of this combination was found in the literature. A good approach to configure the call Admission control is with the use of fuzzy controlled based on linguistic rule base system specified by if then rule base generic algorithm.

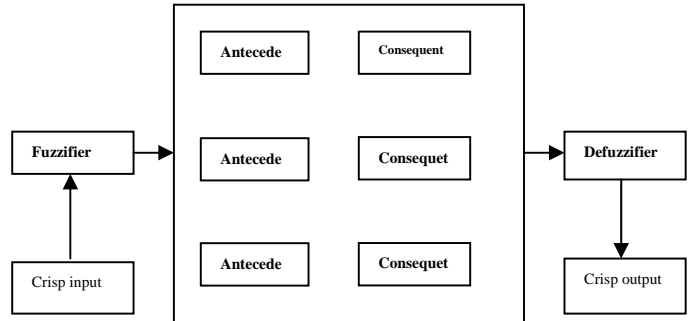


Fig. 5 Rule base system

The algorithm will be triggered with an output variable of degree of acceptance or rejection depending on the (BS) loading state and traffic intensity. Fuzzy logic was proven to have a strong decision making especially in situation where input variables are vague, uncertain or incomplete. A basic system configuration is shown in Fig. 6.

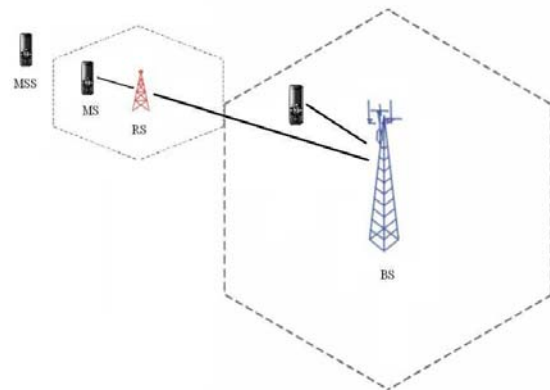


Fig. 6 How can a MSS out of the coverage range of the RS be served

Also, a comparison study will be made between the conventional solutions proposed for modeling call Admission control in WIMAX in general. Traffic intensity will be modeled according the popular Markov Modulated Poisson Process (MMPP) known for modeling multiple QOS class service flow arrivals. However, the outcome of this process will be Fuzzified also to suit our solution. The solution of suitable transmitting station may also be based on fuzzy logic If-then Rule base, depending on the radio distance measurements, round trip time (RTT), Transmitting Mobile Station (TMS) traffic intensity and whether (TMS) is mobile or Static. The decision made base on these inputs will give a suitable compromise of choosing the best candidate to link with a Mesh network.

The algorithm will be triggered with an output variable of degree of acceptance or rejection depending on the (BS) loading state and traffic intensity. Fuzzy logic was proven to

have a strong decision making especially in situation where input variables are vague, uncertain or incomplete.

The frame in WIMAX is 32-bit comparing to the WIFI which is 8-bit; the idea is to reconstruct the admission control for the WIMAX to be like WIFI Ad-Hoc.

We will consider that the solution may applicable as well as the WIFI, the expectation for this case is the MSS may got a services as WIFI also the admission control in the relay station may give a scheduling through another MS in the coverage.

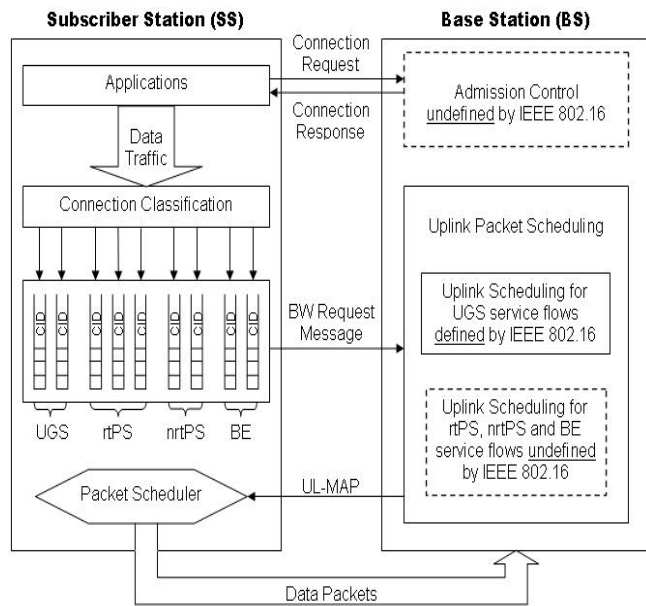


Fig. 7 Admission control for IEEE 802.16.

V. THEOREM AND MATHEMATICS PRESENTATION

The new approach depend on the admission control for Ad-Hoc in the WIFI, however, the comparrison between the frame in WIMAX Vs WIFI shows the new schema IEEE802.16 frame is bigger than WIFI, in fact we can consider the mathematical design for the Ad-Hoc admission control for the same use in the WIMAX. Let we have some background about the WIFI admission control. In the WIFI the CAC algorithm will accept the call if the induced service curve will stay above the universal service curve [6].

Mathematically, the call is accepted if:

$$S^2(t) > \mathcal{S}^2(t) \quad (1)$$

For all $0 < t < W$, where $\mathcal{S}^2(t)$ is the universal service curve and W is the temporal extent of the maximum window over which the prospective call is backlogged. The call should be rejected if (1) is violated. Note that the universal service curve is a fixed curve for each network and is distributed among all nodes during the process of registration [7].

In the WIMAX there is not much change, subsequently we may consider:

$$S^2_w(t) > \mathcal{S}^2_w(t) \quad (2)$$

Where $\mathcal{S}^2_w(t)$ is the universal service curve, however W in the WIMAX is bigger than W in WIFI, and that because of the frame size in the WIMAX bigger than WIFI frame.

Here, it should be clear we are going to use the handshaking procedure of CSMA/CA, in fact the time represent a great factor for scheduling and the admission control. We will suppose that Ad-Hoc network may be the solution for this matter, we can easily approve the admission control in Ad-Hoc can be applied in the WIMAX, for instant admission control is not more than giving a permission to be in the schedule or reject depending on many factors, for example the priority of the transmission, QoS, the number of empty slots, in this paper we try cover the Ad-Hoc admission control and the applicability of approve it in the WIMAX environment, therefore we will not talk about the all these factors listed above[7]. Figure below shows the CSMA/CA handshaking schema.

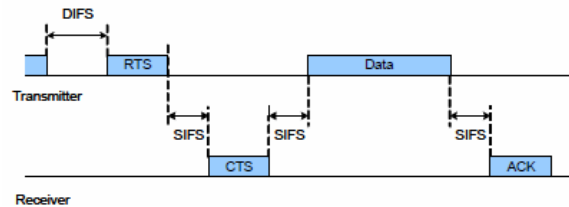


Fig. 8 CSMA/CA handshaking schema

In this case we may consider transmission time of the packet which can be represented by:

$$D_1 = T_{DIFS} + 3T_{SIFS} + T_{RTS} + T_{CTS} + T_{ACK} + L_1/C \quad (3)$$

In the same place we may consider it is same it the same and maybe more possibility to be applicable where the data rate and number of the slots bigger than WIFI, next section will be an approve using a mathematics principles.

VI. MATHEMATICS APPROVE

Let $f = \{1, 2, 3, \dots, n\}$ where n is integer number, and let z is subset from f , Let $J(x)$ is any function applied on the set f with a certain property, mathematically if we can approve any property in the set f , one of the axiom $J(x)$ can be apply on the set z with the same environment, in fact same property For instant, if f is a sequence, and z is subsequence from f , if any function with any property may apply on the set z , it will subsequently apply on z with the same property. Mathematically the function will be approve on the set f if we can apply it on the 1st item of the sequence, and K^{th} and $K+1^{\text{th}}$, in our case it is easily to approve mathematically the applicability of the admission control for the Ad-Hoc in the WIFI on the WIMAX, because the size of the frame is bigger and the number of the slots are more than the WIFI, also the data rate, bandwidth, QoS, all these factors in the WIMAX made WIMAX is a very good environment for apply the Ad-hoc and give the admission control than WIFI.

VII. DISCUSSION

This paper discuss of how to serve the MSS which are out of the BS and Relay station coverage, the proposed solution is to provide the a coverage for those MSS through applying Ad-Hoc network with other MSS in the relay station coverage, the main goal is to provide admission control for those MSS out of the coverage, the solution will be apply the admission control of the Ad-Hoc IEEE 802.11 in the WIFI, and the then the admission control will give either accept for the call or reject depend on the priority of the data, from the reading to this solution we expect that the QoS will be even batter in WIMAX than WIFI hence the frame of WIMAX is bigger comparing to WIFI, in other word the number of the slots will be bigger and then capability of apply it in WIMAX is greater.

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REFERENCES

- [1] Ashima Gupta, Prasant Mohapatra.2007,' Admission Control and Interference-Aware.
- [2] A. Rao and I. Stoica. An overlay MAC layer for 802.11 networks In MobiSys, pages 135–148, 2005
- [3] H.Wu, Y. Liu, Q. Zhang, and Z.-L Zhang SoftMAC: Layer2.5 collaborative MAC for multimedia support in multi-hop Wireless networks. IEEE Transactions on Mobile Computing, to Appear.
- [4] Liang-Liang Xie, Pin-Han Ho.2008,' Dual-Relay MMR Networks', Canada.
- [5] M. Neufeld, J. Fifield, C. Doerr, A. Sheth, and D. Grunwald.SoftMAC—flexible wireless research platform. In HotNets,2005.
- [6] Shiao-Li Tsao.2006,' Sleep Mode and Idle Mode Operations for IEEE802.16j',ChiaoTungUniversity
- [7] Shahrokh Valaee and Baochun Li 2001, Distributed Call Admission Control forAd Hoc Networks.