Designing a Reduced Mesh Network for Wi-MAX with Optimized Number of Link using QUALNET 5.0.1

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ABSTRACT
Telecom networks in India are planning to offer 4G data communication services for general subscribers. Also 3G networks are developing at the same time. Providing uninterrupted voice & data service at low cost to subscribers will be the prime concern for network service providers For telecom network the installation cost is very high because it uses costly optical interfaces along with air interface. We have designed a new network with minimum optical fiber link without degrading the performance of the network. The network has less amount of jitter and less end to end delay. So this network will be useful for 3G and above . QUALNET 5.0.1 simulator (licensed Version) has been used for checking the network performance.

Keywords
4G, low cost, optical fiber link, jitter, end to end delay, QUALNET 5.0.1

1. INTRODUCTION
Wi-Max technology is a wireless metropolitan network (WMAN) communications technology that is largely based on wireless interface defined in IEEE 802.16 standard. The IEEE 802.16 standard [1] defines two modes of operation: point-to-multi-point (PMP) and MESH mode. In the PMP mode, subscriber stations (SS) connect to the base station (BS) in single hop transmissions. Mesh mode, however, allows BSs to communicate with each other, thus forming a wireless multi-hop mesh network. The original purpose of this Wi-Max technology is to provide last mile broadband wireless access. Providing diverse broadband service economically to every-one is a major challenge for Wi-Max service providers. Therefore planning of a cell with robust back bone structure is very crucial. Here back bone network deals with base stations relay stations & their connections through optical link. Cost of the laying wire is prohibitively expensive. But putting optical fiber links is also essential for proper operation & robustness of the network. So optimizing numbers of link will reduce establishment cost of a network

In this paper we put our contribution to develop efficient mesh network with minimum number of link without degrading the network's performance by maintaining approximately same value of jitter and end to end delay as the network take with all links.

2. NETWORK TOPOLOGY:
Topology of a network is the geometric representation of the relationship of all the links and linking device (Usually called nodes) to one another. There are four basic topologies: mesh, star, bus and ring. Here we used mesh network for connecting base stations in a cluster. The mesh network is a robust and it is better privacy, security concern. In a mesh topology every device has a dedicated point to point link to every other device. So for a n node mesh network we need n (n-1) / 2 number of links. If n=7 then no of link is 21. So this topology is expensive.

3. Architecture of the Mesh Network:
The performance of IEEE 802.16 mesh networks is dependent on the ability of the management layers to schedule links. The performance of IEEE 802.16 mesh networks is dependent on the ability of the management layers to schedule links. A large hexagonal cell is divided in seven small hexagonal cell & a seven cell hexagonal cluster is formed which shown in fig 1. Master Base Station is in 7th position of fig 1 all other positions are the relay station or small base station. Master Base Station & all relay stations are interlinked via optical fiber cable. Every cell is look like a hexagon. Antenna height, band-width and other parameters in every relay station are same. The height of master base station is double than relay station.

Bellman Ford routing protocol is used to send packets form one base station to other base station. In mesh network dedicated path is available to reach but may be travelling distance become longer dedicated path. Bellman Ford algorithm will find out the shortest path for transmitting packets from a node to another. Increasing traffic load can be maintained with proper routing. Routing table will be updated time to time for forwarding packets from one base station to another.

By optimization process number of links in a mesh network can be reduced controlling jitter, end to end delay value. These two parameters can control the speed of the network. Basic criteria for maintaining required quality of service is not to degrade the speed of communication. The performance of a mesh network is shown below:

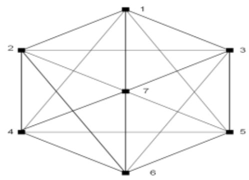

Fig 1: Schematic Diagram Of A Cluster With Only Base Stations' Position.

3.1. End to End Delay of Mesh Network:

Due to queuing and different routing paths, a data packet may take a longer time to reach its destination. The end-to-end delays experienced by the packets for each flow the individual packet delay are summed and the average is computed.

dend-end = N[dtrans+dprop+dproc] …..(1)

Where dend-end is end-to-end delay, dtrans is transmission delay, dprop is propagation delay, dproc is processing delay and N is number of links[2]

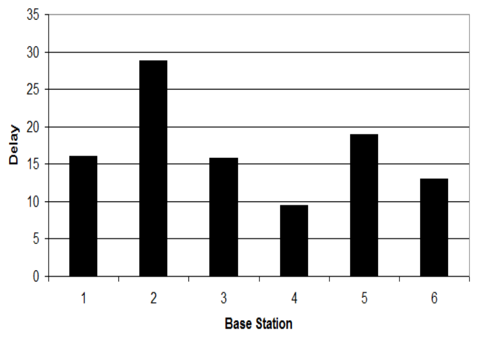

Fig 2: End To End Delay Of Mesh Network

3.2. Jitter of Mesh Network Delays:

As the packets transmit from source to destination will reach the destination with different. A packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary unpredictably. This variation in delay is known as Jitter. The jitter increases at switches along the path of a connection due to many factors, such as conflicts with other packets wishing to use the same links, and nondeterministic propagation delay in the data-link layer. Jitter can seriously affect the quality of streaming audio and/or video. A network could possibly have zero Jitter. Jitter for respective precedence bits are calculated and compared. [2]. For reliable operation of a network Jitter must be low and flatten

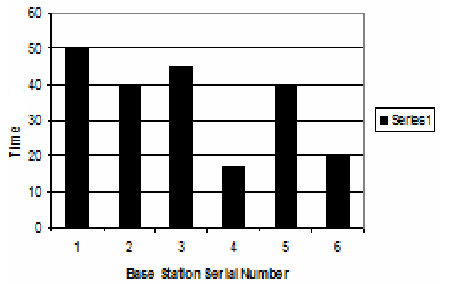

Fig 3: Average Jitter of Mesh Network

4. Reduction of number of link and System Performance:

As the number of link in mesh network is more so cost of installing is more. Therefore reduction in number of links **is** one of the major concerns of network designer. This paper will present a network architecture where effects of jitter or end to end delay will reduce from mesh network. This network is obtained from mesh network. Through algorithm we check network performance by reducing one link at time to at least two links will be there for each node.

4.1. Reduction of Link One at a Time:

4.1.1 Average Jitter & End to End Delay:

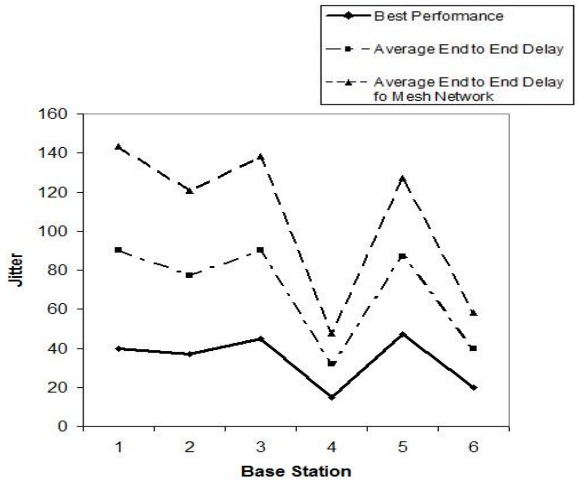

Fig 4: Average Jitter

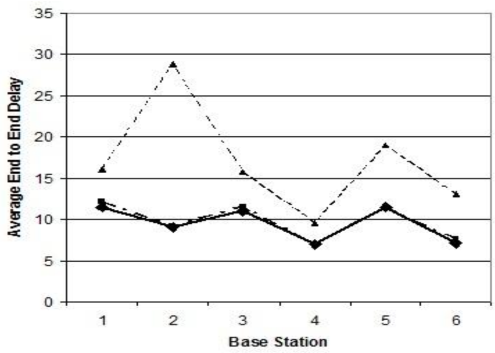

Fig 5: Average End To End Delay

4.2. Reduction of More than One Link at a Time:

4.2.1. Average Jitter & End to End Delay:

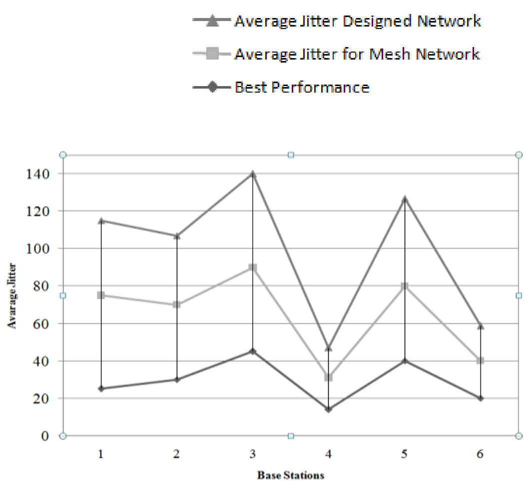

Fig 6: Average Jitter

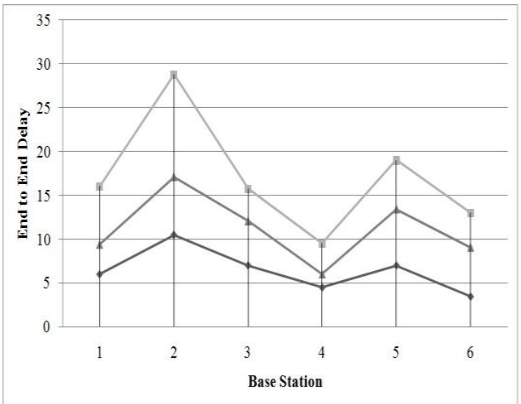

Fig 7: Average End to End Delay

5. Final Network with Performance:

Final architecture is derived by omitting those links whose omitting have not degrade the system performance also boost the speed of network and reduce noise effect. But there is a restriction that one node have minimum two optical fiber link. Network can able to heavy traffic. Generally link 3-4 and 2-5 keep idle if circumstances arrived then those links have been activated. But if they have been kept activated then also there is no deviation on system performance. This network has enough safety margins in terms of speed and noise.

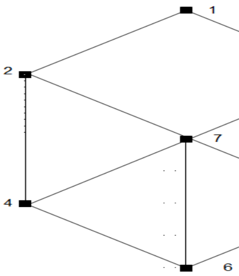

FIG 8: Schematic Diagram of Modified Network

5. 1. Average Jitter & End to End Delay:

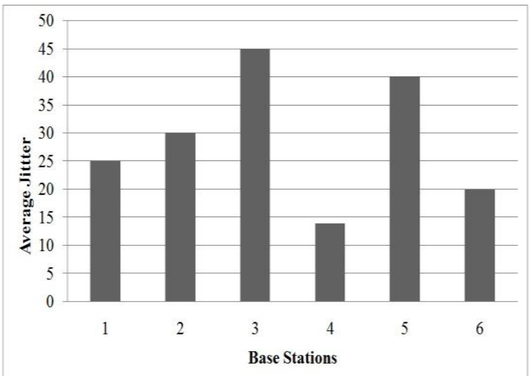

FIG 9: Average Jitter of Designed Network

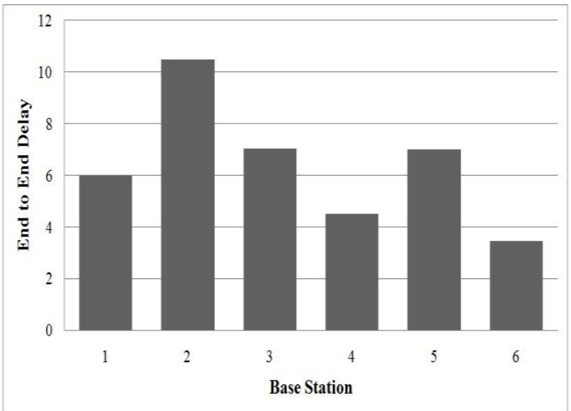

FIG 10: Average End to End Delay of Designed Network

6. Reduction Algorithm:

For reduction of optical links End to End Delay, Jitter, Error probabilities have been considered. Initial stages 7 base-stations have 1:1 optical link. First of all every base station's N number of users communicate with rest other base station's N number of users. For every cycle if all the nodes are communicating with each other there is (N*66) packets will transmit and same number of packets will come as feedback or acknowledgement. Calculate time required to reach to destination, jitter and error probabilities for this transmission. Identify the maximum error prone and maximum time consuming paths. Also repeat the same experiment for all other links and take outputs. Remove the highest error probable and time consuming path, which have no effect on system performance. Note the outputs. After that remove 2 links and repeat the same experiment. Continue the same experiment till every base station has minimum two optical links. [3]

Conclusion:

Proposed network is less affected by noise also. Its delay has been reduced from that of a fully mesh network. More over the design consist only 9 optical fiber links as against 21 links in Mesh network. Hence installation cost of the network is reduced. As every base-station has a minimum of two optical links present so the probability of failure of network is reduced and robustness of the network is increased. Finally this new robust, low cost network is able to give higher speed with less noise. So this network can be used beyond 3-G

7. REFERENCES

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