Efficient Communication Routing Through WiMax Network During Disaster

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Abstract: During emergency situation like flood, volcano, tsunami etc., the communication has to reach all the people in that area within a short span of time ensuring the necessary quality of service (QoS). The time at which the information is conveyed save a lot of life. In this paper we propose a communication through a Wi-max technology which broadcast information to all the nodes within the location. The node cooperates among them so that the information is conveyed to all the nodes within the coverage range of the Wi-max. Many cities are affected by some natural disaster where many lives are lost. The implementation of this technology cannot prevent the natural disturbance and certainly give warnings to people and save the valuable human lives. The WiMax network is implemented in Qualnet and various network parameters are measured when the node is mobile and non-mobile.

Keywords: Broadcast, Cooperative nodes, QoS, WiMax.

1. Introduction
Wireless communication plays a major role in modern communication. The Ad hoc network can be readily formed and that does not require any infrastructure. These advantages are considered for conveying the information or warning the people about the dangerous situation like floods in coastal area or about volcano occurrence or about a land slide in hilly region etc. For the emergency situation like these the best solution is to convey the information through the wireless medium as constructing a wired medium will not be possible and there are chance that the wired connection will get damaged during the natural disaster like these events.

Since we have to cover a geographical area of few kilometers this best technology available for us is the Wi-Max technology. Wi-Max is an alternative technology to digital subscriber line and cable broadband access. Wi-Max technology is based on the IEEE 802.16 standard. Wi- Max stands for Wireless microwave access. It uses the frequency in terms of gigahertz.

The Wi-Max 802.16a standard can cover an area of 30 miles. It supports the data rate of 70 Mbps with frequency of operation at 10 Ghz and 66 Ghz spectrum. The Wi-Max 802.16e operates in the range of 2 Ghz to 6 Ghz. The biggest problem faced in the wireless communication is the communication over the non-line of sight region and multipath issues. The use of orthogonal frequency division multiplexing (OFDM) helps it to overcome these issues. Wi-Max also provides duplex communication with Time division multiplexing or frequency division multiplexing (FDM).

Wi-Max uses OFDM which helps is transmitting more amounts of data without any interference. OFDM technique uses multi carrier modulation with a frequency division multiplexing technique. At the receiver the desired carrier signal alone has the maximum value and the adjacent carrier signal
magnitude is zero. So the chance of interference is nil due to the principle of orthogonality. Also the use of OFDM technique helps in using the spectrum very efficiently compared to FDM technique. The figure 1 represents the spectrum of OFDM with multiple carriers. The figure 2 indicates how effectively the spectrum is utilized in OFDM when compared to the FDM technique.

![Fig.1. Spectrum of OFDM with multiple carriers](image1)

![Fig.2. Spectrum usage comparison of FDM and OFDM](image2)

The network communicates from the station to the access point. There will be stationary nodes gaining the access from the access point. Under the emergency situation the information is conveyed to the fixed node in each access point. The fixed node then cooperates with the other nodes in its access point to broadcast the information to all the nodes. As the information about a dangerous situation is got by the authority he can immediately convey the information in the dangerous region. So with a few seconds the information will reach all the nodes over there. The geographical location will be passed through the Wi-Max network there by people will be well aware of the location of danger and can save guard themselves from staying away from the location. This technology not only warns the people but also help the rescue team by giving the indication of the affected place and where there have to move so that they can rescue more people.

2. Related work
The performance improvement in IEEE 802.16e is done concentrating the physical layer by improving the Bit Error Rate (BER) [1]. Further improvement in the performance is achieved by using error control codes. Low density parity check codes and convolution codes are used to improve the performance. To overcome the effect of fading orthogonal frequency division multiple access technique is used, where there is multiple carrier signals. The WiMax also provides non line of sight coverage and this is beneficial as most of the technology provides only line of sight coverage [2]. The WiMax can also be connected to PSTN network and internet as shown in the WiMax architecture diagram in figure 3 [3]. The quality of service (QoS) has to be maintained when the data are transmitted between these networks. The WiMax has the advantage of connecting to the existing network also by providing better QoS. For the transmission of information using the direct sequence spread spectrum technique, there interference produced by a group of ultra wide band transmitter and for IEEE 802.16 these effects is carried out for various parameter like receiver bandwidth, number of user etc., and the
level of interference is found out to be below the threshold level and it was concluded the effect of the interference will not disturb the Wi-Max system [4][5].

A cognitive system is used to make the physical layer of Wi-Max to adapt to the change in the wireless channel. It is based on Support Vector Machine technique that is used for adaptation of Wi-Max physical to the wireless channel. The effect of BER for cognitive improves the performance of the system [6][7].To improve the quality of service Handover decision and execution layer (HDEL) is used to provides seamless connectivity when the node moves across the heterogeneous network[1]. It provides the quality of service when the node moves from Universal Mobile Telecommunication System to Wi-Max network or vice versa. Some important parameter like handover latency is also considered so as to improve the quality of service. Handover latency is the time taken by a node to get access to a new network or time taken to get access while moving from one Wi-Max to another Wi-Max. The handover is done for two reasons, the one when the node moves out of range from its connected network. The second reason is when there is multiple access point the node switchover to a new one so as to improve the some of its performance.

The routing of the data from the WiMax to the nodes should be energy efficient routing. The nodes under the coverage of the WiMax should receive the signal without any compromise in the QoS.[8][9][10][11] The receiving nodes act as a sink node for the WiMax transmitted data. For sending the confidential information key is used at the transmitter and the receiver. The payload increases as the data has to be encrypted at the transmitter and decrypted at the receiver. The modulation technique and the coding technique are adaptive in nature. The reason behind this is to ensure that the network bandwidth is used effectively. The data is encoded in different layers. This ensures fairness in the overall network and thereby the loss in the data is minimized.

![WiMax Architecture](image)

3. QoS Requirement
Quality of Service plays a major role in a real time application. That too in an emergency situation the quality of service plays a major role. The protocol stack of 802.16 is shown in the figure 4a. The physical layer as shown in the figure is responsible for modulation of the signal, Whereas Medium access layer (MAC) takes care of security and uniform distribution of services to all the nodes. The following are the important parameter to be considered to offer a better QoS. Figure 4b shows the flow chart for handing over the connection.

- Handover Latency.
- Offering required Bandwidth.
- Congestion free transmission.
**A. Handover Latency**

When the node moves from one place to another the connectivity of the node has to be maintained. For this purpose handover mechanism is used. When the node moves away from an access point the receiving power of the node decreases which is inversely proportional to the square of the distance. When the received power moves below the threshold level then the node searches for another access point from which the received power is above the threshold. The process of handing over the control from one access point to another is termed as the handoff. Now the handover latency is the time taken to get access while moving from one Wi-Max to another Wi-Max.

**B. Offering Required Bandwidth**

The bandwidth requirement is very important and it is application dependent. For the application like video transmission or video conference the bandwidth should be high and if the quality of video transmission is better then more amount of bandwidth should be allocated based on the video quality. For the transmission of data the bandwidth requirements of the channel is less. For the application like conveying the information during the emergency situation using the Wi-Max technique the bandwidth requirement is less as the data is alone transmitted.

**C. Congestion Free Transmission**

The data transmitted over the channel should reach the destination at the correct time. Any delay in the reach of the information will result in major disaster. So for on time delivery of the data required bandwidth should be provided.

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### Fig.4a. Protocol Stack of 802.16

**4. Functionality in handover process**

The functionality in handover process is divided into three stages. The Stages are as follows

- The signal Strength of the receiving node.
- Managing Handover.
- Taking the control over the node.

**A. The Signal Strength of the receiving node**

The signal strength of the receiving node is monitored continuously and when the received signal strength falls below the threshold level, the receiving node searches for the next access point where the signal is well over the threshold level. As soon as the node identifies the next access point then the access point takes over the control of the node.

**B. Managing Handover**

As the node moves away from one Wi-max the other Wi-max takes over the control. The first Wi-max leaves the control only after ensuring that the second Wi-max has taken over the control. This is the best policy as the chances of connection being dropped is less.
C. Taking the control over the node
In some case there will be more number of Wi-max, so the node will choose a particular Wi-max during handover based on the fact that the performance does not degrade. The node choses a particular Wi-max for which the packet drop is less and where the quality of service is good.

Fig. 4b. Flow chart for Handing over the connection

5. Simulation layout
The simulation output is shown in the figure 5 below. The WiMax transmits the data to the surrounding nodes in the area considering 1500 X 1500 m². The Simulation will perform reasonably well when we consider large area as the WiMax is meant to cover a large area.

Fig. 5. Simulation of Wi-max for broadcasting data
6. Protocols used in WiMAX
Ad Hoc on Demand Distance Vector is a on demand routing protocol. AODV can route the data for one to one or one to many communication. The term on demand is used as this protocol finds the route between the source and the sink only when the source node needs to transmit the data. The established route is maintained until the source finishes the transmission of the data. To initiate the communication the source node transmits a route request message (RREQ). When there is a valid route available the destination nodes send back a route reply message to the source node (RREP). If there is any link failure then RERR is used to inform the node about the failure in the link.

7. Simulation parameter
The table I shown below gives the area, no of nodes considered and other parameter considered for the simulation in Qualnet.

| Parameter       | Value              |
|-----------------|--------------------|
| Area            | 1500 x 1500m       |
| No of nodes     | 11                 |
| Physical Layer  | IEEE 802.16        |
| MAC             | IEEE 802.16        |
| Routing Protocol| AODV               |
| Mobility        | None / Random waypoint |
| Simulation time | 300 sec            |
| Packet size     | 512 bytes          |

8. Simulated results
The Simulation result is done in Qualnet simulation tool for WiMax network. The simulation is carried out with and without mobility as practically there will be node in movement. The parameters like Total byte received, throughput, packet delivery ratio, average end to end delay and average jitter are compared for Wi-max network with and without mobility.

A. Total bytes received
The total bytes received are around 980000 bytes when there is no mobility and during mobility the received bytes is only 400000 as shown in the figure 6 below. So during mobility there is loss of data.

B. Throughput
The number of successfully transmitted packet in a network is given by the parameter called throughput of the network. The throughput of the network decreases drastically to 1000 from 4200 whenever there is mobility in the network. Due to mobility the data loss is more and hence throughput decreases as shown in the figure 7 below.
C. Packet Delivery Ratio (PDR)
The packet delivery ratio is the ratio of successfully between the total packets successfully received to the total packet transmitted. Without mobility PDR is 95 percent and with mobility it reduces to 25 percent (figure 8).

D. Average end to end delay
The average end to end delay is the time taken for the packet to reach the destination node. The graph 8 shown below indicates how the network performs with and without mobility. It is evident that the delay is more (0.14) when the nodes are mobile in nature compare to 0.04 when nodes are not mobile (figure 9).
E. Average jitter
Jitter represents the variance in the time delay for the packets transmitted in the network. The figure 10 shown below indicates the average jitter for WiMax network with and without mobility. And with mobility the average jitter value is 0.02 than without mobility which comes around 0.05.

![Fig.10. Comparison of Average Jitter](image)

9. Conclusions
In this work, an effort has been made to convey information to the emergency area like flood, land slide etc. The various parameters like total byte received, throughput, packet delivery ratio, Average end to end delay, Average jitter is compared for the Wi-Max network with mobility and without mobility. It is also evident that the network provides better PDR without mobility. This Work if implemented in the emergency areas will certainly help people living over there. Our work will certainly help them in warning about the situation and will make them to act quickly and stay away from the danger and thus saving the valuable human lives.

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