CHAPTER V

DISCUSSION AND CONCLUSION

5.1 Discussion on data transfer problem

As a consequence of WiMAX technology development, many service providers have deployed it as their new wireless broadband services. Moreover, the multi-hop relay network, IEEE 802.16j, enables multi-hop communication in IEEE 802.16e networks by enhancing the coverage, per user throughput, and system capacity of IEEE 802.16e. Thus, using RSs can significantly reduce the deployment cost of the system.

Considering the IEEE 802.16j frame structure standard [11-13, 18-22], its supports two approaches and both approaches cause limitation to the relay zone utilization, especially on over the 3-hop scenarios. Therefore, [45] proposed the frequency reuse mechanism on the existing frame structure as mentioned in [11-13] to relieve the problem of relay zone utilization limit. Unfortunately, the obtained result of [45] is only slightly improved. Different from the previous mechanism, the NC-BR allows RSs to combine multiple wireless transmissions into single transmission using the network coding technique. The result has shown that the relay zone utilization is significantly improved.

Based on the mechanism of [11-13, 18-22], a frame structure has been designed to serve this mechanism. However, this structure causes serious problems of the wireless multi-hop networks, as mentioned previously, because of the signal interference avoidance constraint. Thus, whenever the number of RS hops increases, the number of the relay zones is automatically increased. For this reason, the utilization of the relay zone is critically degraded. This affects to throughputs and delays of the entire network.

According of the proposed mechanism, the NC-BR, its frame structure is modified to have just 3 relay zones which are independent from the number of RS hops. As the result, the relay zone utilization is highly maintained. So, the performance metrics

of the entire network are improved from the original mechanism at least 24-140% for throughput gained, and 53-83% for the delay improvement.

5.2 Conclusion on data transfer problem

Wireless technology is an important development in the communication area. People need to exchange their data from every corner of the world. However, implementing a basic communication system needs to implement several base stations (BS) in order to cover a large communication area. In doing so, a high investment cost and the network complexity arise. As a consequence, the development of the IEEE 802.16j Multi-hop relay network brings a significant change in the world because number of BSs is replaced by RSs. Thus, the complexity of the entire network and the investment cost are reduced. In addition, the RSs enhance coverage and capacity to the MS. However, implementing multi-hop relay network in a large scale WiMAX network has problems of the throughput degradation and the incremental of end-to-end delay when the number of hops is increase.

Therefore, in this paper, the foremost study in applying the Network Coding technique to WiMAX has been performed and evaluated. Thus, a Network Coding-Based Relay scheme, called NC-BR, and the corresponding frame structure are proposed. The proposed solution allows a RS to combine two sets of data in the wireless backhaul using the XOR operation, and transmit it in a single transmission instead of two. Consequently, the throughput and the delay are improved. Additionally, the jitter is smaller. Thus, the transmission situation is obviously improved and suitable to serve several types of transmitted data.

5.3 Discussion on path finding problem

Solving the shortest-travel time path on the road network problem of existing methods are facing with low accuracy and time complexity problems, especially in the high traffic congestion environment. However, the proposed algorithms can dissolve these problems because the number of vertices to be calculating is reduced by half and

a large number of considered edges are decreased. These reductions are depended on edges categorization from edges characteristics.

Our system has presented that simple implementation are possible, groups of members can be formed by most navigation system user where as user own mobile equipment that meet our requirement (mobile computer, GPS receiver and digital map). This will allow most user of difference navigation system equipment provider get advantage from system by receiving much more accuracy shortest travel time path. Future research could be the working on reducing storage space used by our data structure of Hierarchical index on road network (HIRN).

5.4 Conclusion on path finding problem

Shortest Path problems are inevitable in road network applications such as city emergency handling and drive guiding system, in where the optimal routings have to be found. As the traffic condition among a city changes from time to time and there are usually a huge amounts of requests occur at any moment, it needs to quickly find the solution. Therefore, the efficiency of the algorithm is very important. Some approaches take advantage of preprocessing [7-10] that computes results before demanding. These results are saved in the memory and could be used directly when a new request comes up. This can be inapplicable if mobile devices have limited memory and storages. This project aims to investigate the single source shortest path problems and intends to obtain a general conclusion by examining two approaches, Dijkstra's shortest path and A* algorithm.

With the proposed algorithms, the adaptive travel time path selection algorithms (ATTPS) and Hierarchical index on road network (HIRN) system design, prove that the algorithms run on less number of computation, and more accurate results are presented than other existing methods. Time complexity of ATTPS are $O(mn)$, where N is number of vertices in graph and n is subset of number of vertices only on HIRN level 1, which is n is usually much smaller than N (how much smaller is depend on network categorization

on HIRN). *m* is set of potential vertices to be shortcut in *n*. The proposed algorithms process much less vertices than existing methods because the advantage from the combination of the hierarchy index structure, map positions and stored historical data. Thus, the total process time is smaller than the standard methods, Dijkstra and A*.