Service Performance Evaluation for WiMAX Networks Based on Node Trajectory

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Abstract: WIMAX is a wireless communications standard designed to provide 30 to 40 megabit-per-second data rates, [1] with the 2011 update providing up to 1 Gbit/s [1] for fixed stations. The name "WiMAX" was created by the WiMAX Forum, which was formed in June 2001 to promote conformity and interoperability of the standard. The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL". [2]. This paper aim to spot the light on how node trajectory within the WiMAX cell may effects the network performance, also how QoS parameters and the choice we make in the network configuration might changes how the network react and how it may have a direct effect on its performance.

Keywords-component; WIMAX, QoS, Trajectory.

I. RELATED WORK

"Performance Analysis of QoS Parameters for Wimax Networks "by V. Mehta et al International Journal of Engineering and Innovative Technology (IJEIT). The objective of this paper was to discuss the performance of WIMAX networks while changing QoS parameters and how well the network performs in the process. [3].

"Evaluation of WiMAX QoS in a developing country's environment" by E. Sedoyeka et al Inst. of Finance Manage. (IFM), Dar es Salaam, Tanzania. This paper discussed findings from a study which investigated WiMAX Quality of Service (QoS) as experienced by the end users [4].

"Performance analysis of VoIP over mobile WiMAX (IEEE 802.16e) best-effort class" by H.R Othman, Fac. of Electr Eng., Univ. Teknol. MARA (UiTM), Shah Alam, Malaysia This paper introduced how different trajectory is applied to The MS with the encoder of G.711 and G.729 in order to identify which encoder gives the best performance to the VoIP application [5].

"Using time-of-day and location-based mobility profiles to improve scanning during handovers" by P. Boone et al Sch. of Comput. Sci., Carleton Univ., Ottawa, ON, Canada. This paper focuses on capturing the mobility patterns of users. By using time-of-day and location-based mobility profiles [6].

II. QUALITY OF SERVICE (QOS) IN WIMAX NETWORKS

WiMAX gives network operators the opportunity to provide a wealth of services to differentiate their offerings and attract a tiered range of subscribers.

It features a variety of flow types that can be used to optimize performance for voice, data, and video. Offering Voice/data/video convergence makes sense for enterprises and service providers alike.

For example, effective voice over IP (VoIP) communications require QoS features that can quickly identify voice traffic and prioritize it to assure high-quality audio and service level adherence. Without a robust QoS implementation, it is not possible to ensure low latency and low jitter that are necessary to provide carrier grade services such as VoIP and IPTV.

- Unsolicited Grant Service (UGS)

UGS is primarily intended for Constant-Bit-Rate (CBR) services such as VoIP, which means that achieving low latency and low jitter is very important. At the same time, low percentage of packet drops is possible. UGS flows are configured to send fixedsize packets at recurring intervals with as little latency and jitter as possible. UGS has the following set of features: UGS flows are buffered separately from each other and from flows in service classes such as nrtPS and BE. UGS service flows are given strictly higher priority versus nrtPS and BE service flows, which implies that the system serves nrtPS and BE packets only after it has finished transmitting all outstanding UGS packets. In the upstream, the system uses UGS to bypass the normal request-grant mechanism for upstream traffic by allowing the BS to give automatic grants to a UGS flow. Also, over-the-air latency in a WiMAX network is small (5-40 ms) relative to the latency on an IP backbone (100ms), which inherently ensures minimal latency.

- Real-Time Polling Service (rtPS)

The Real-Time Polling Service (rtPS) on the other hand is designed to support real-time service flows that generate variable size data packets on a periodic basis, such as MPEG video. The service offers real-time, periodic, unicast request opportunities, which meet the flow's real-time needs and allow the Subscriber Station (SS) to specify the size of the desired grant. A major drawback to using this QoS approach is the impact on the overall sector throughput. Polling overhead can reach up to 60% when using 3.5MHz channel. This service requires more request overhead than UGS, but supports variable grant sizes for optimum data transport efficiency. Unlike UGS, the polling overhead exists even when the flows are idle, and for as long as they are active.

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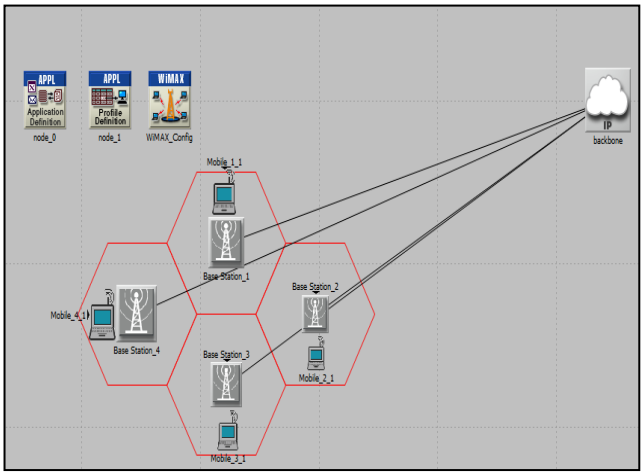
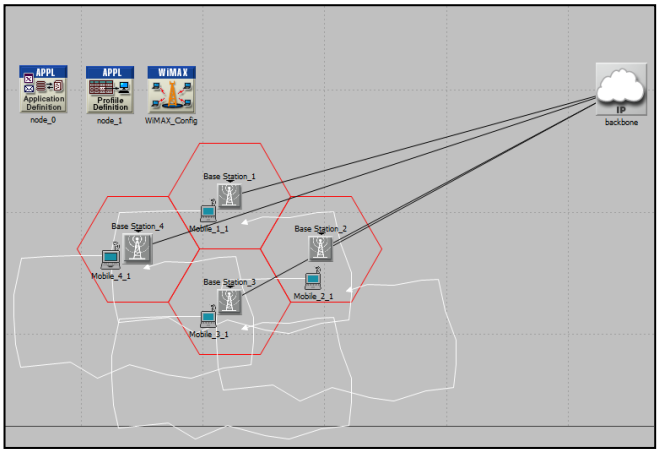
III. WIMAX Network model Design

4 cells were created and connected to the backbone which represents the core service provider. WiMAX configuration model was implemented in order to set the QoS parameters discussed earlier. The network model is shown below:



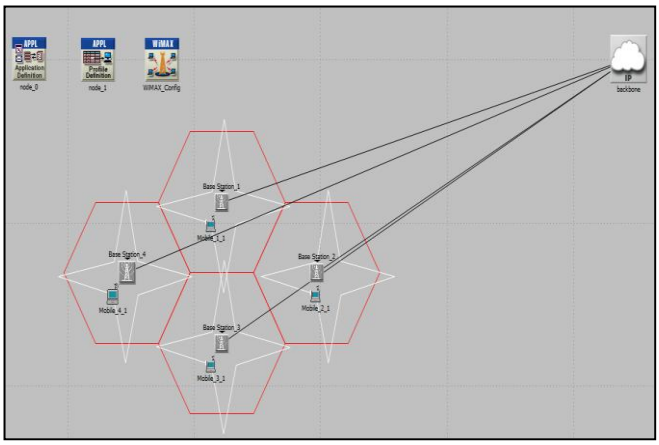
A. random waypoint Trajectory model

In order to simulate the node trajectory effect along with setting the correct QoS parameters, a trajectory model had to be implemented. Two different models were implemented:
The random waypoint model mimics a random movements of the node, in this model the node sometimes travels outside the WIMAX cell and returns back. This model trajectory is shown below:



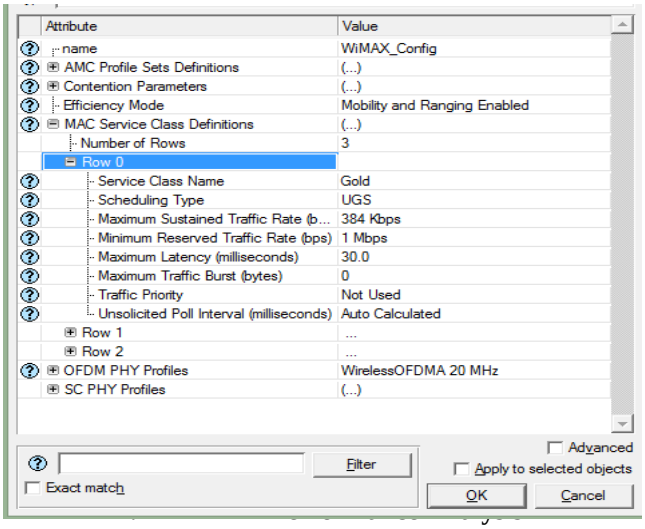
B. star trajectory model

Another trajectory model was implemented and in this model the node movement is bounded by the cell. This model is shown below:

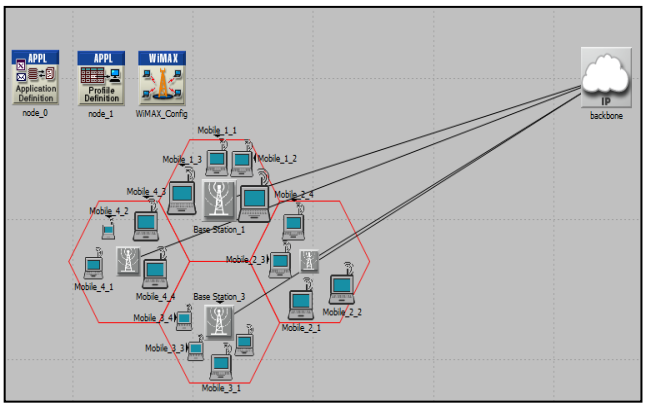


B. QoS and service class Configuration

Service class was implemented and configured, the UGS service class to simulate Voice traffic in WIMAX network. As shown below:

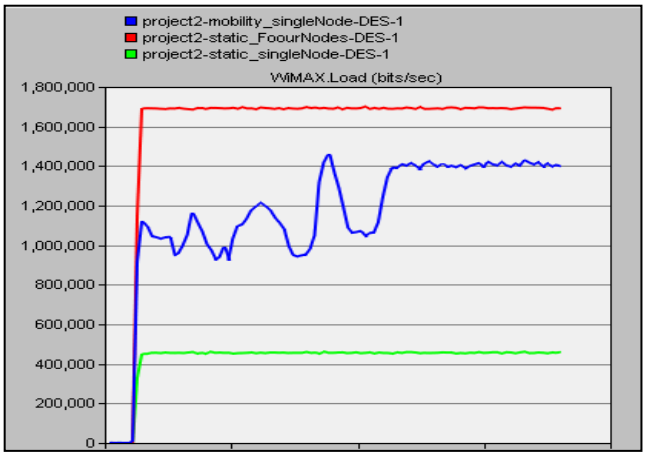


The network model for four nodes was implemented to observe the effect of the No. Of nodes on the performance, the model is shown below:



- No. Of nodes VS Node Mobility:

After running the simulation, the Load (bit/sec) was the 1st metric to consider, 3 scenarios were compared:
Scenario 1: single static node at each cell
Scenario 2: single moving node at each cell
Scenario 3: four static nodes at each cell
Network Load for all three scenarios is shown below:



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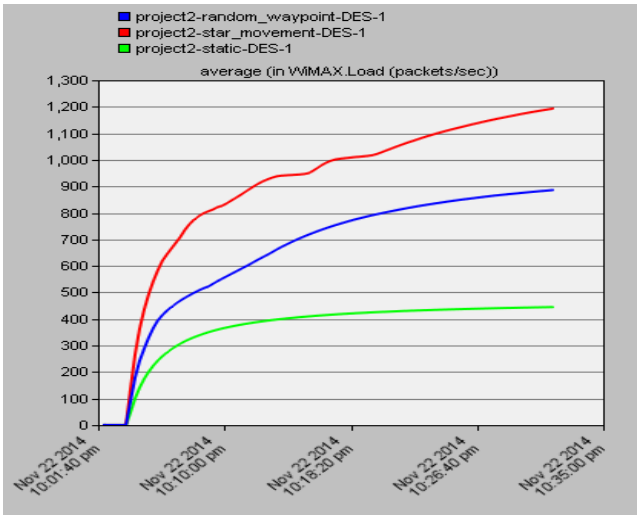
From the load graph we notice that the number of nodes has the highest effects on Load created on the network. We also notice that node mobility has a higher effect than a static node and the fluctuation is due to the fact that random movement was implemented.

- Trajectory type effect

A comparison between the implemented trajectory types (random waypoint and star model) was made, the network average network load was chosen as shown below:



We can notice that static node has the lowest load as expected. The star model has the highest load as it changes position the most (has a star pattern the node moves to the edges of the star and comes back repeatedly).

V. CONCLUSIONS

I conclude form this research that setting the right service class and Qos parameters is essential for the continuity of the service, also the number of nodes has a direct effect on the WIAMX network load and hence the performance. Also the nodes trajectory has the same effect on WIMAX network load as the node continue to exchange link information with the baste station.

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