SINR BASED VERTICAL HANDOFF ALGORITHM BETWEEN GPRS AND WiMAX NETWORKS

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ABSTRACT

Next generation wireless network is foreseen as the combination of heterogeneous wireless networks capable of providing enhanced services to mobile users. Vertical handoff is a crucial issue in providing service to mobile users, in a heterogeneous network. To maintain continuous service during vertical handoff period, the handoff procedure should consider the noise and interference in the networks. In this article, we have proposed an algorithm based on the received signal to inference plus noise ratio (SINR) for handoff between GPRS and WiMAX networks. Here SINR from WiMAX network is converted to the equivalent SINR of the GPRS network and vice-versa, so that the handoff algorithm can have the knowledge of achievable bandwidths in both the networks. This helps in taking a handoff decision. Simulation study on handoff between GPRS and WiMAX networks using QualNet showed that consideration of received SINR during the vertical handoff period maintains better system throughput.

Keywords: *Vertical handoff, SINR, GPRS, WiMAX.*

1. INTRODUCTION

The demand of cellular and broadband services indicates that the next generation wireless communication will be dominated by cellular and broadband services. The 3rd generation cellular network, General packet radio Service (GPRS) [1] is capable of providing IP based voice and packet data services to mobile users. The advantage of GPRS is that, it can provide a data rate up to 115 Kbps although theoretically it is 171.2 Kbps. Moreover, resource is utilized only when data is transmitted and billing is required only for the amount of data transmitted rather than for the connection time. It operates between 900 MHz and 1900 MHz. On the other hand, the 4th generation IEEE 802.16 or WiMAX (World-wide Interoperability for Microwave Access) can provide IP based quality of services (QoS) to mobile users [2]. The capability of providing high speed seamless service to mobile users within a range of 31 miles at low cost with adequate security has made WiMAX more demandable in the market. It can operate at two different frequencies [3]. The frequency between 2 to 5 GHz can cover up to 5 miles where as operating at the frequencies between 11 to 66 GHz covers to an extent of 31 miles. Vertical handoff being a handover process between two dissimilar network technologies, it becomes more challenging while the user requires services during this handoff period. Vast research is going on for integration of GPRS and WiMAX networks maintaining continuous service to users during the handoff period.

The paper is organized as follows. We describe the system model for vertical handoff as well as the method to determine SINR in section 2 and proposed system integration architecture in Section 3. Simulation setup and results are discussed in section 4. Finally, section 5 gives the conclusions.

2. SYSTEM MODEL

In order to provide guaranteed QoS, the vertical handoff algorithm must be QoS aware. Traditional received signal strength (RSS) based vertical handoff algorithm cannot achieve this [4,5]. Therefore we have considered a SINR based model similar to that proposed by Yang et al [6] described in the following sections.

2.1. SINR based vertical handoff techniques

According to Shannon capacity formula, maximum achievable data rate R_{ij} between a user i and base station j can be given by

$R_{ij} = W \log2 (1+\gamma_{ij}/\Gamma)$ (1)

Where W is the bandwidth of the network, γ_{ij} is the SINR received by the user i from the base station j and Γ is the dB gap between uncoded M-QAM and channel capacity, minus the coding gain.

If R_{ws} and R_{gs} are maximum achievable data rate from WiMAX and GPRS respectively, then they can be represented in terms of the receiving SINR from the two networks as:

$R_{ws}= W_{ws} \log2(1+ \gamma_{ws}/\Gamma_{ws})$ (2)

$R_{gs}= W_{gs} \log2(1+ \gamma_{gs}/\Gamma_{gs})$ (3)

Where, γ_{gs} and γ_{ws} are SINR received from GPRS and WiMAX respectively.

Since, the data rate of both the networks are different, therefore to compare the SINR of the two network, the SINR form the source must be converted to the SINR of the destination. Thus, assuming the data rates R_{ws} R_{gs} to be equal, the relationship between the SINR of GPRS as well as WiMAX can be obtained as given below:

$\gamma_{gs}= \Gamma_{gs} ((1+ \gamma_{ws}/\Gamma_{ws}) W_{ws}/W_{gs} -1)$ (4)

Knowing the data rate from both the networks, the SINR from WiMAX can be converted to the equivalent SINR of GPRS using the equation (4). Now the SINR from GPRS and WiMAX can be compared to make the handoff decision. As soon as the equivalent SINR received from the GPRS network is less than the SINR received from the WiMAX network, the mobile station will handoff itself to the WiMAX network.

2.2. Determination SINR at the mobile station from GPRS and WiMAX networks

If γ_{ij} is the SINR received by user i from the jth GPRS base station gbs_j, then

$$\gamma_{ij} = G_{ij} P_j /(P_B + \sum_{k \in gs, k \neq j} G_{ik} P_k) \quad (5)$$

Where P_j is the transmitting power of the j^{th} base station (gbs_j), Gij is the channel gain between user i and gbs_j and PB is the background noise power at user receiver end.

On the other hand, if γ_{ij} is the SINR received by i^{th} user from the j^{th} WiMAX base station wbs_j, then

$$\gamma_{ij} = G_{ij} P_{ij} /(P_B + \sum_{k \in wx} G_{ik} P_k - G_{ij} P_{ij}) \quad (6)$$

Where P_k is the total transmitting power of wbs_k , P_{ij} is the transmitting power of wbs_i to user j and G_{ij} is the channel gain between user i and wbs_j.

3. INTEGRATION ARCHITECTURE FOR GPRS AND WIMAX

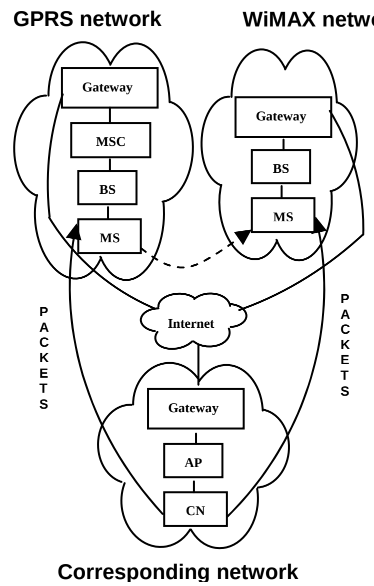

Figure 1: Proposed integration architecture of GPRS and WiMAX networks

The proposed integration architecture of GPRS and WiMAX networks is shown in the figure 1. The corresponding network is considered to be a Wi-Fi network. The mobile station (MS) is initially attached to the base station (BS) of the GPRS network and moving from GPRS to the WiMAX network. Mobile switching centre (MSC) is used to transmit and receive data to and from external networks. The corresponding node (CN) from Wi-Fi network sends application data to the MS during its transition from GPRS to WiMAX. With the help of gateways as well as the internet, the application services from CN reach the MS anywhere anytime. The throughput in any of the network is measured in terms of the number of bits received by the MS per second.

4. SIMULATION

We have used a network simulator, QualNet 4.5 [7] to carryout simulation of the proposed protocol.

4.1. Simulation setup

We have carried out the simulation of the vertical handoff scenario between GPRS and WiMAX. In our scenario, WiMAX operates in 2.4 GHz ISM frequency band and GPRS operates in GSM 900 frequency band ranging from 900 MHz to 1800 MHz. This simulation considers the SINR received from GPRS and WiMAX.

In our scenario, we have considered four wireless subnets, one for WiMAX and the other for GPRS network, the third one for the correspondent network and the fourth for connecting these networks. The GPRS, which is under GSM technology, consists of a mobile switching centre (MSC), a base station (BS), a gateway and a mobile station (MS). The base station as well as the mobile station has a wireless link to its subnet. The base station has wired connection to the mobile switching centre which has also wired connection to the gateway. The gateway has a wireless connection to the internet. On the other hand, WiMAX consists of a base station (BS) and a gateway. The third subnet consists of a correspondent node (CN), a gateway, and an access point (AP). An application of constant bit rate of data (CBR) is used to send data from the correspondent node to the mobile station. Initially the mobile station is connected with the GPRS network and it moves towards the WiMAX network during the simulation process.

The size of the physical terrain (in meters) in which the nodes are being simulated is in Cartesian co-ordinate. Terrain-dimensions is (1500, 1500) in square meters.

Noise power =T*k*B*f where, temperature T is 290.0 Kelvin, k is the Boltzmann constant (= 1.379 x 10-23 Joules/Kelvin), B is the bandwidth in Hz, and f is a constant called the noise factor. Here noise factor considered is to be 10. We have used BELLMANFORD routing protocol in our simulation study.

4.1.1 GPRS network parameters

Transmission power =20.0 dBm
Handover received signal strength threshold = -90.0 dBm
Channel bandwidth 200 KHz
Channel Frequency:
Downlink Frequency = 900MHz + 0.2*n
Uplink Frequency = Downlink + 45 MHz
Where n is ARFCN number and 0<n <124 for GSM 900

4.1.2 WiMAX network parameters

Transmission Power =20.0 dBm
Channel bandwidth =20 MHz
Frequency of channel =2.4GHz
Station-handover-received signal strength trigger (dBm) = -78.0

4.1.3 Antenna parameters

In this simulation study, Omni-directional Antenna model is used for both the networks. Gain, height and efficiency of the antenna in GPRS network are 0.0 dB, 1.5 meter and 0.8 respectively and in WiMAX these are 12.0dB, 10.0 meter and 0.8 respectively. Different losses associated with antenna in both the networks are mismatch loss =0.3 dB, cable loss =0.0 dB and connection loss =0.2 dB.

4.2. Simulation results

The data rate calculated here for the two networks depends on the SINR received from the respective network.

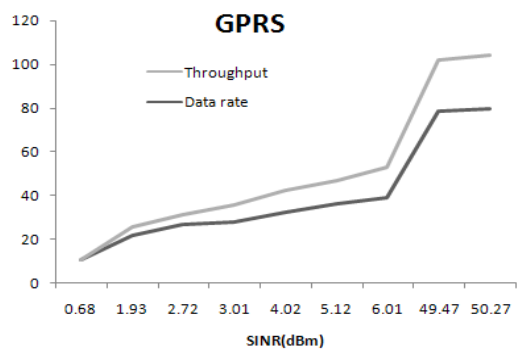

Figure 2: SINR(dBm) vs. data rate (Kbps) and throughput in GPRS network

The SINR versus data rate graph shows that increase in SINR results in the increase in the data rate of the network. On the other hand, the throughput of a network depends on the number of bits received by the mobile node. The bits during transmission are affected by the background noise and interference associated with the network. Therefore, throughput depends on the strength of the SINR received by the mobile station. The SINR versus throughput (figure 2 and 3) shows that less the noise and interference in a network results in more throughput of the system.

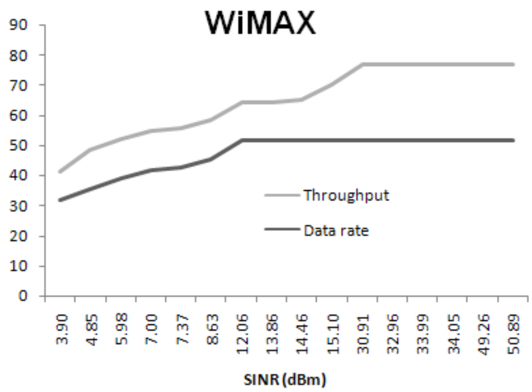

Figure 3: SINR(dBm) vs. Data rate (Kbps) and throughput in WiMAX network

5. CONCLUSIONS AND FUTURE WORKS

Providing seamless service to mobile users during the vertical handoff period is a crucial task. SINR is the real signal strength received by a mobile station. SINR based approach is adaptable to any network condition due to the consideration of noise and interference. Therefore, we can use it to provide continuous services to mobile users as well as make more efficient handoff decisions than using a RSS based approach. Future work lies for analyzing handoff latency and reducing the number of handoffs.

ACKNOWLEDGMENTS

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REFERENCES

[1] www.mobilein.com/GPRS.pdf
[2] C. Chang, A Mobile-IP Based Mobility System for Wireless Metropolitan Area Networks, ICPPW'05, p.429-435, 2005.
[3] www.WiMAXforum.org
[4] O. M. Eshanta, M. Ismail, K. Jumari and P. Yahaya, VHO Strategy for QoS-Provisioning in the WiMAX/WLAN Interworking System, Asian Journal of Applied Sciences, Volume: 2, Issue: 6, Page(s): 511-520, 2009.
[5] M. Liu, Z. Li, X. Guo, and E. Dutkiewicz, Performance Analysis and Optimization of Handoff Algorithms in Heterogeneous Wireless Networks, IEEE Transaction on Mobile Computing, vol. 7, no. 7, pp. 846-857, 2008.
[6] K. Yang, I. Gondal, B. Qiu and L. S. Dooley, Combined SINR Based Vertical Handoff Algorithm for Next Generation Heterogeneous Wireless Networks, IEEE GLOBECOM, 2007.
[7] http://www.scalable-networks.com/products/qualnet/