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Performance Evaluation of Wimax Network Based On Probability Transition Matrix

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ABSTRACT
Although operating on the same general principles as Wi-Fi; sending data from one computer to another via radio signals, WiMAX is much faster (70 megabits per second) and covers more distance (blanket a radius of 50km) than Wi-Fi. As fourth generation wireless mobile communications, WiMAX provides group of users with a connection and a queue of fixed length. Performance of such wireless technology is analyzed using SIMO, MIMO, Markov arrival process (MAP) and so on. In this paper a probability transition matrix is used to evaluate performance of network and two Connection Admission Control (CAC) schemes have been proposed to ensure Quality of Service (QoS). Finally, blocking probability due to proposed CAC has been measured to evaluate proposed scheme. Entire analysis is kept independence of modulation and coding scheme.
Keywords - Blocking Probability, Connection admission control (CAC), Probability Transition Matrix, Quality of Service (QoS), WiMAX.

I. Introduction

Worldwide Interoperability for Microwave Access (WiMAX) is one of the recent broadband wireless digital communications systems around today. WiMAX systems are expected to deliver broadband access services to residential and enterprise customers in an economical way. The new technology is similar to Wi-Fi in that it allows users to connect to the Internet without wires [1]. But unlike Wi-Fi, which might be able to cover a whole building or city block, WiMAX can provide high-speed Internet access and cover vast distances per base station, which can be up to 30 miles in radius [2].

The WiMAX umbrella includes 802.16-2004, 802.16-2005. IEEE 802.16-2004 is known as fixed WiMAX and IEEE 802.16-2005 is known as mobile WiMAX [3]. IEEE 802.16-2004 utilizes OFDM to serve multiple users in a time division fashion in a sort of a round-robin technique, but done extremely quickly so that users have the perception that they are always transmitting/receiving. IEEE 802.16-2005 utilizes OFDMA and can serve multiple users simultaneously by allocating sets of tones to each user [4] [5].

IEEE 802.16 standards are apprehensive with the air interface between a subscriber's transceiver station and a base transceiver station. The fixed WiMAX standard IEEE 802.16-2004 provides fixed, point-to-multi point broadband wireless access service and its product profile utilizes the OFDM 256-FFT (Fast Fourier Transform) system profile. 802.16-2004 standard supports both time division duplex (TDD) and frequency division duplex (FDD) services. IEEE 802.16-2005(802.16e) adds mobility features to WiMAX in the 2 to 11 GHz licensed bands based on the WiMAX standard 802.16a. 802.16e allows for fixed wireless and mobile Non Line of Sight (NLOS) applications primarily by enhancing the OFDMA (Orthogonal Frequency Division Multiple Access).

WiMAX technology provides higher speed connection up to 63 Mbps for Down Link and 28 Mbps for Up Link [6]. It can be used to connect 802.11 hot spots to the Internet, provide campus connectivity, and provide a wireless alternative to cable and DSL for last mile broadband access.
The WiMAX physical layer is designed in a way which works with different specifications for licensed and unlicensed frequency bands. One of them is based on a single carrier (SC) to support line of site (LOS) with high data rates, others use orthogonal frequency division multiplexing (OFDM), and OFDMA to support both LOS and NLOS [7] [8] [9] [10]. WiMAX uses only the physical layer and MAC of data link layer of OSI 7 layer model and the specific names of each physical layer interface is following [11].

MAC was mainly designed for point-to-multipoint broadband wireless access applications and is based on collision sense multiple access with collision avoidance (CSMA/CA). The basic function of WiMAX MAC is to provide MAC service data units (MSDUs) between the physical layer and the higher transport layer and organizes them into MAC protocol data units (MPDUs) for transmission over the air [12].

The WiMAX MAC layer consists of service specific convergence sub layer and it facilitates mapping for the MAC layer, internet protocol (IP), asynchronous transfer mode (ATM), Ethernet, point to point protocol (PPP).

The MAC incorporates several features suitable for a broad range of applications at different mobility rates, such as the following:

- Privacy key management (PKM) for MAC layer security.
- Broadcast and multicast support.
- Manageability primitives.
- Fast handover and mobility management primitives.
- Provide three power management levels, normal operation, and sleep and idle.

The rest of the paper is organized as follows: Section 2 illustrates probability transition matrix with two scheme of CAC. Section 3 deals with Queue transition matrix and Section 4 describes blocking probability due to admission control decision. Section 5 depicts and discusses results of the theoretical analysis and finally Section 6 concludes the entire analysis.

II. Probability Transition Matrix

Evaluation of Probability Transition Matrix has been done based on single cell in a WiMAX network with a base station and multiple subscriber stations. The base station has the authority to allocate different number of sub channels to different subscriber stations in the basis of priority [13].

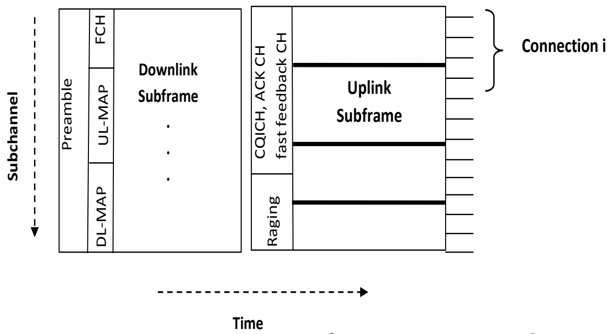

Figure 1: Frame structure of WiMAX in time division duplex-orthogonal frequency division multiple access mode

Mode of transmission of WiMAX network has totally depends on modulation level and coding rate and can be determined using SNR.

Table 1: IEEE modulation and coding scheme

Rate ID	Modulation label (Coding)	Information bits/Symbols	Required SNR(dB)
0	BPSK(1/2)	0.5	6.4
1	QPSK(1/2)	1	9.4
2	QPSK(3/4)	1.5	11.2
3	16 QAM(1/2)	2	16.4
4	16 QAM(3/2)	3	18.2
5	64 QAM(2/3)	4	22.7
6	64 QAM(3/4)	4.5	24.4

Upon considering Nakagami-m fading model for each subchannel [13] the following terms are used:
γ = Instantaneous received Signal to noise Ratio (SNR) in each time slot.
rn = thresholds correspond to the required SNR specified in the WiMAX standard where rate ID n Є {0,1,2,………,N} and r0 < r1<………..< rN+1 = ∞.

- Γn ≤ γ ≤rn+1 indicate the subchannel in channel n. it should be gamma
- When γ < r0 , no packets is transmitted

From Nakagami-m distribution, the probability of using rate ID:

$$\Pr(n) = x = \frac{\Gamma\left(m,\frac{m\Gamma n}{\bar{\gamma}}\right) - \Gamma\left(m,\frac{m\Gamma n+1}{\bar{\gamma}}\right)}{\Gamma(m)} \quad (1)$$

Where, $\bar{\gamma}$ is the average SNR, m is the Nakagami fading parameter (m ≥ 0.5), Γ(m) is the gamma function and Γ(m, γ) is the complementary incomplete gamma function.

The row matrix rs whose elements rk+1 correspond to the probability of transmitting k packets in one frame in one subchannel s(s Є C) as follows:

rs= [r0 … rk …r9] (2)

Where, r(In×2) = Pr(n) in which In is the number of transmitted bits per symbol corresponding bits per symbol corresponding to rate ID , n and

$$r0 = 1\text{-}\sum_{k=1}^{9} r_k \quad (3)$$

We assume that each sub channel is allocated to only one subscriber station:

$$r_s = [\ r_0\ r_1 r_2 r_3 r_4 r_5 r_6 r_7 r_8 r_9\ ] \quad (4)$$

Suppose each subscriber channel has assigned three sub channels that is C = $\{s_1 s_2 s_3\}$. Then row matrix for sub sub channel s_1 :

$$r_{s_1} = [\ r_0\ r_1 r_2 r_3 r_4 r_5 r_6 r_7 r_8 r_9\ ] \quad (5)$$

The matrix for pmf of total packet transmission rate can be obtained by convoluting matrices r_s as follows:

$$R = r_{s_1} * r_{s_2} * r_{s_3} \quad (6)$$

The matrix R has a size $1 \times R+1$ indicates maximum number of packets can be transmitted in one frame where $R = (9 \times |C|) = 9 \times 3 = 27$, $|C|$ indicates number of element in C.

The total packet transmission rate per frame can be obtained using below equation:

$$\varphi = \sum_{k=1}^{U} k \times [R]_{k+1} \quad (7)$$

To ensure the quality of service (QoS) performances of the ongoing connections, the following two Connections admission control (CAC) schemes for subscriber station is proposed. They are:

2.1 CAC Based on Threshold

Number of outgoing connections has been limited using a threshold C. Upon arrival of new connection, the CAC module checks C with the total number of connections including the incoming one is less than or equal. Then, new connection has been accepted or rejected upon fulfilling above condition.

Below equation has been used in this regard:

$$Q = \begin{bmatrix} q_{0,0} & q_{0,1} & 0 & 0 \\ q_{1,0} & q_{1,1} & q_{1,2} & 0 \\ 0 & q_{2,1} & q_{2,2} & q_{2,3} \\ 0 & 0 & q_{3,2} & q_{3,3} \end{bmatrix}$$

$q_{c,c} = f_1(\rho) \times f_1(c\mu) + (1-f_1(\rho)) \times (1-f_1(c\mu)),\ c=0,1,2,3$ (8)

$q_{c,c+1} = f_1(\rho) \times (1-f_1(c\mu)),\ c=0,1,2$ (9)

$q_{c,c-1} = (1- f_1(\rho)) \times f_1(c\mu),\ c=1,2,3$ (10)

2.2 CAC Based on QUEUE

Based on status of queue, Queue aware CAC scheme determines the connection acceptance probability α_x where x is the number of packets in the queue in the current time slot x Є {0, 1, 2, …… , X}. X indicates the size of queue. Below equation has been used in this regard:

$$Q_x = \begin{bmatrix} q_{0,0}{}^{(x)} & q_{0,1}{}^{(x)} & 0 & 0 \\ q_{1,0}{}^{(x)} & q_{1,1}{}^{(x)} & q_{1,2}{}^{(x)} & 0 \\ 0 & q_{2,1}{}^{(x)} & q_{2,2}{}^{(x)} & q_{2,3}{}^{(x)} \\ 0 & 0 & q_{3,2}{}^{(x)} & q_{3,3}{}^{(x)} \end{bmatrix}$$

$q_{c,c}(x)=f_1(\alpha_x\rho)\times f_1(c\mu)+(1-f_1(\alpha_x\rho))\times(1-f_1(c\mu)),c=0,1,2,3$ (11)

$q_{c,c+1}(x) = f_1(\alpha_x\rho) \times (1-f_1(c\mu)),\ c=0,1,2$ (12)

$q_{c,c-1}(x) = (1-f_1(\alpha_x\rho)) \times f_1(c\mu),\ c=1,2,3$ (13)

III. Queue Transition Matrix

Entire system can be expressed through a transition matrix P where P can be expressed as below

$$\boldsymbol{P} = \begin{bmatrix} P_{\mathbf{0,0}} & \cdots & P_{\mathbf{0,A}} & \cdots & \cdots & \cdots & \cdots \\ \vdots & \cdots & \vdots & \cdots & \cdots & \cdots & \cdots \\ \vdots & \ddots & \vdots & \cdots & \cdots & \cdots & \cdots \\ P_{\boldsymbol{R},\mathbf{0}} & \cdots & P_{\boldsymbol{R,R}} & \cdots & \cdots & P_{\boldsymbol{R,R+A}} & \cdots \\ \ddots & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots \\ \cdots & P_{\boldsymbol{x,x-R}} & \cdots & \cdots & P_{\boldsymbol{x,x}} & \cdots & P_{\boldsymbol{x,x+A}} \\ \ddots & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots \end{bmatrix} \quad (14)$$

Where, $P_{x,x'}$ represent the changes in the number of packets in the queue(the number of packets in the queue changing from x in the current frame to x' in the next frame).

To construct matrix $P_{x,x'}$ we have to construct matrix $V_{x,x'}$ which will be a diagonal matrix of below from considering connection C=3:

$$V_{x,x'} = \begin{bmatrix} V_{0,0} & 0 & 0 & 0 \\ 0 & V_{1,1} & 0 & 0 \\ 0 & 0 & V_{2,2} & 0 \\ 0 & 0 & 0 & V_{3,3} \end{bmatrix} \quad (15)$$

So the matrix V will be like below form:

$$\boldsymbol{V} = \begin{bmatrix} V_{\mathbf{0,0}} & \cdots & V_{\mathbf{0,A}} & \cdots & \cdots & \cdots & \cdots \\ \vdots & \cdots & \vdots & \cdots & \cdots & \cdots & \cdots \\ \vdots & \ddots & \vdots & \cdots & \cdots & \cdots & \cdots \\ V_{\boldsymbol{R},\mathbf{0}} & \cdots & V_{\boldsymbol{R,R}} & \cdots & \cdots & V_{\boldsymbol{R,R+A}} & \cdots \\ \ddots & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots \\ \cdots & V_{\boldsymbol{x,x-R}} & \cdots & \cdots & V_{\boldsymbol{x,x}} & \cdots & V_{\boldsymbol{x,x+A}} \\ \ddots & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots \end{bmatrix} \quad (6)$$

The diagonal Matrix element are determined by,

$$[v_{x,x}]_{c+1,c+1} = \sum\nolimits_{r=a} f_a(C\lambda)\,[R]_r \quad (17)$$

$$[v_{x,x-n}]_{c+1,c+1} = \sum\nolimits_{a-r=n} f_a(C\lambda)\,[R]_r \quad (18)$$

$$[v_{x,x+m}]_{c+1,c+1} = \sum\nolimits_{r-a=m} f_a(C\lambda)\,[R]_r \quad (19)$$

- $[v_{x,x}]_{c+1,c+1}$ indicates the probability that the number of packets in the queue does not change
- $[v_{x,x-n}]_{c+1,c+1}$ indicates the probability that the number of packets in the queue decreases by n
- $[v_{x,x-n}]_{c+1,c+1}$ indicates the probability that the number of packets in the queue increases by n.
- $[\mathbf{v}]_{\boldsymbol{i,j}}$ denotes the element at row i and column j of the matrix v.

Here,

A = maximum number of packets that can arrive from one connection in one frame.

D = min (R, x) that indicates maximum number of packets that can be transmitted in one frame by all of the allocated sub channels allocated to that particular queue.

R = maximum number of packets can be transmitted in one frame.

r Є {0,1,2,……,D}

a Є {0,1,2,……,(c×A)}

n = {0,1,2,……,D}

m = {0,1,2,……,(c×A)}

$P_{x,x'}$ is the combination of both connection-level and and queue-level transitions as follows:

$P_{x,x'} = Qv_{x,x'}$ (20)

$P_{x,x}' = Qxv_{x,x'}$ (21)

IV. Blocking Probability

Blocking probability refers to the probability that an arriving connection will be blocked due to admission control decision. For the threshold based CAC scheme the performance can be measured by the following equation:

$$p_{tb} = \sum_{x=0}^{X} \pi(C,x) \quad (22)$$

The above equation states that blocking probability is calculated from the steady state probability vector of the system states π, which can be obtained by solving the following equations:

$$\pi P = \pi \quad (23)$$

$$\pi\mathbf{1} = \mathbf{1} \quad (24)$$

Where, **1** is the column matrix of ones and π is stationary in times.

The steady state probability denoted by $\pi(C,x)$ for the state that there are C connections and x packets in the queue.

V. Results and Discussion

Table 2: IEEE modulation and coding scheme Result

Rate ID(n)	Information bits/ Symbols(In)	R(In×2) = Pr(n)	Required SNR (dB), Γn
0	0.5	r1=Pr(0)	6.4
1	1	r2=Pr(1)	9.4
2	1.5	r3=Pr(2)	11.2
3	2	r4=Pr(3)	16.4
4	3	r5=Pr(4)	18.2
5	4	r6=Pr(5)	22.7
6	4.5	r7=Pr(6)	24.4

Suppose one subscriber station has been provided three subchannel C = {s1, s2, s3}.

Then row matrix for sub channel s1 using average SNR = 5

rs1 = [0.71 0.15 0.05 0.06 0.01 0.01 0.01 0.01 0.00 0.00]

R = rs1 * rs2 * rs3

= [0.3505 0.2219 0.1201 0.1258 0.0587 0.0345 0.0308 0.0251 0.0134 0.0090 0.0051 0.0022 0.0014 0.0008 0.0005 0.0002 0.0001 0.0001 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000]

The total packet transmission Rate: φ=1.9109

Threshold based CAC Algorithm using connection arrival rate = 0.8 and connection termination rate=1.3

$$Q = \begin{bmatrix} 0.6770 & 0.3230 & 0 & 0 \\ 0.1307 & 0.6086 & 0.2607 & 0 \\ 0 & 0.0194 & 0.6668 & 0.3138 \\ 0 & 0 & 0.0022 & 0.6758 \end{bmatrix}$$

Determining the Queue-Aware CAC Algorithm using threshold values of packets, Bth=80; Maximum number of packets in queue, X=150; Connection Arrival Rate =0.8; Connection Termination Rate=1.3

$$Q_x = \begin{bmatrix} 1.0000 & 0 & 0 & 0 \\ 0.1931 & 0.8069 & 0 & 0 \\ 0 & 0.0287 & 0.9713 & 0 \\ 0 & 0 & 0.0032 & 0.9968 \end{bmatrix}$$

Establishing the transition Matrix by specifying the following parameters:

- Number of ongoing connection for each subscriber station, C =3.
- The size of the queue of a subscriber station under consideration, X = 150.
- Connection arrival rates, ρ = 0.8.
- Connection termination rates, μ= 1.3.
- Queue aware CAC threshold values of packets, B_{th} = 80.
- Packet arrival rate for a connection which is identical for all connection in same queue, λ = 1.2
- Packet arrival and packet transmission is determined for each frame, T = 2

$$P = \begin{bmatrix} P_{0,0} & P_{0,1} & P_{0,2} & P_{0,3} & P_{0,4} \\ P_{1,0} & P_{1,1} & P_{1,2} & P_{1,3} & P_{1,4} \\ P_{2,0} & P_{2,1} & P_{2,2} & P_{2,3} & P_{2,4} \\ P_{3,0} & P_{3,2} & P_{3,2} & P_{3,3} & P_{3,4} \\ P_{4,0} & P_{4,1} & P_{4,2} & P_{4,3} & P_{4,4} \end{bmatrix}$$

$$P_{0,0} = \begin{bmatrix} 0 & 0.0659 & 0 & 0 \\ 0 & 0.1035 & 0.0275 & 0 \\ 0 & 0.0045 & 0.0598 & 0.0157 \\ 0 & 0 & 0.0003 & 0.0283 \end{bmatrix}$$

$$P_{0,1} = \begin{bmatrix} 0.2220 & 0.0543 & 0 & 0 \\ 0.0483 & 0.0852 & 0.0191 & 0 \\ 0 & 0.0037 & 0.0415 & 0.0106 \\ 0 & 0 & 0.0002 & 0.0191 \end{bmatrix}$$

$$P_{0,2} = \begin{bmatrix} 0.1405 & 0.0360 & 0 & 0 \\ 0.0306 & 0.0566 & 0.0128 & 0 \\ 0 & 0.0025 & 0.0277 & 0.0071 \\ 0 & 0 & 0.0002 & 0.0128 \end{bmatrix}$$

$$P_{0,3} = \begin{bmatrix} 0.0760 & 0.0244 & 0 & 0 \\ 0.0166 & 0.0383 & 0.0086 & 0 \\ 0 & 0.0017 & 0.0186 & 0.0047 \\ 0 & 0 & 0.0001 & 0.0085 \end{bmatrix}$$

$$P_{0,4} = \begin{bmatrix} 0.0797 & 0.0161 & 0 & 0 \\ 0.0173 & 0.0252 & 0.0058 & 0 \\ 0 & 0.0011 & 0.0125 & 0.0031 \\ 0 & 0 & 0.0001 & 0.0056 \end{bmatrix}$$

$$P_{1,0} = \begin{bmatrix} 0 & 0.0595 & 0 & 0 \\ 0 & 0.0934 & 0.0359 & 0 \\ 0 & 0.0041 & 0.0779 & 0.0227 \\ 0 & 0 & 0.0004 & 0.0407 \end{bmatrix}$$

$$P_{1,1} = \begin{bmatrix} 0 & 0.0659 & 0 & 0 \\ 0 & 0.1035 & 0.0275 & 0 \\ 0 & 0.0045 & 0.0598 & 0.0157 \\ 0 & 0 & 0.0003 & 0.0283 \end{bmatrix}$$

$$P_{1,2} = \begin{bmatrix} 0.2220 & 0.0543 & 0 & 0 \\ 0.0483 & 0.0852 & 0.0191 & 0 \\ 0 & 0.0037 & 0.0415 & 0.0106 \\ 0 & 0 & 0.0002 & 0.0191 \end{bmatrix}$$

$$P_{1,3} = \begin{bmatrix} 0.1405 & 0.0360 & 0 & 0 \\ 0.0306 & 0.0566 & 0.0128 & 0 \\ 0 & 0.0025 & 0.0277 & 0.0071 \\ 0 & 0 & 0.0002 & 0.0128 \end{bmatrix}$$

$$\boldsymbol{P_{1,4}} = \begin{bmatrix} 0.0760 & 0.0244 & 0 & 0 \\ 0.0166 & 0.383 & 0.0086 & 0 \\ 0 & 0.0017 & 0.0186 & 0.0047 \\ 0 & 0 & 0.0001 & 0.0085 \end{bmatrix}$$

$$\boldsymbol{P_{2,0}} = \begin{bmatrix} 0 & 0.0410 & 0 & 0 \\ 0 & 0.0644 & 0.0405 & 0 \\ 0 & 0.0028 & 0.0879 & 0.0307 \\ 0 & 0 & 0.0005 & 0.0550 \end{bmatrix}$$

$$\boldsymbol{P_{2,1}} = \begin{bmatrix} 0 & 0.0595 & 0 & 0 \\ 0 & 0.0934 & 0.0359 & 0 \\ 0 & 0.0041 & 0.0779 & 0.0227 \\ 0 & 0 & 0.0004 & 0.0407 \end{bmatrix}$$

$$\boldsymbol{P_{2,2}} = \begin{bmatrix} 0 & 0.0659 & 0 & 0 \\ 0 & 0.1035 & 030275 & 0 \\ 0 & 0.0045 & 0.0598 & 0.0157 \\ 0 & 0 & 0.0003 & 0.0283 \end{bmatrix}$$

$$P_{2,3} = \begin{bmatrix} 0.220 & 0.0543 & 0 & 0 \\ 0.0483 & 0.0852 & 0.0191 & 0 \\ 0 & 0.0037 & 0.0415 & 0.0106 \\ 0 & 0 & 0.0002 & 0.0191 \end{bmatrix}$$

$$P_{2,4} = \begin{bmatrix} 0.1405 & 0.0360 & 0 & 0 \\ 0.0306 & 0.0566 & 0.0128 & 0 \\ 0 & 0.0025 & 0.0277 & 0.0071 \\ 0 & 0 & 0.0002 & 0.0128 \end{bmatrix}$$

$$P_{3,0} = \begin{bmatrix} 0 & 0.0225 & 0 & 0 \\ 0 & 0.0353 & 0.0392 & 0 \\ 0 & 0.0015 & 0.0852 & 0.0380 \\ 0 & 0 & 0.0005 & 0.0681 \end{bmatrix}$$

$$P_{3,1} = \begin{bmatrix} 0 & 0.0410 & 0 & 0 \\ 0 & 0.0644 & 0.0405 & 0 \\ 0 & 0.0028 & 0.0879 & 0.0307 \\ 0 & 0 & 0.0005 & 0.0550 \end{bmatrix}$$

$$P_{3,2} = \begin{bmatrix} 0 & 0.0595 & 0 & 0 \\ 0 & 0.0934 & 0.0359 & 0 \\ 0 & 0.0041 & 0.0779 & 030227 \\ 0 & 0 & 0.0004 & 0.0407 \end{bmatrix}$$

$$P_{3,3} = \begin{bmatrix} 0 & 0.0659 & 0 & 0 \\ 0 & 0.1035 & 0.0275 & 0 \\ 0 & 0.0045 & 0.0598 & 0.0157 \\ 0 & 0 & 0.0003 & 0.0283 \end{bmatrix}$$

$$P_{3,4} = \begin{bmatrix} 0.2220 & 0.0543 & 0 & 0 \\ 0.0483 & 0.0852 & 0.0191 & 0 \\ 0 & 0.0037 & 0.0415 & 0.0106 \\ 0 & 0 & 0.0002 & 0.0191 \end{bmatrix}$$

$$P_{4,0} = \begin{bmatrix} 0 & 0.1002 & 0 & 0 \\ 0 & 0.0160 & 0.0326 & 0 \\ 0 & 0.0007 & 0.0707 & 0.0424 \\ 0 & 0 & 0.0004 & 0.0761 \end{bmatrix}$$

$$P_{4,1} = \begin{bmatrix} 0 & 0.0225 & 0 & 0 \\ 0 & 0.0353 & 0.0392 & 0 \\ 0 & 0.0015 & 0.0850 & 0.0380 \\ 0 & 0 & 0.0005 & 0.0681 \end{bmatrix}$$

$$P_{4,2} = \begin{bmatrix} 0 & 0.0410 & 0 & 0 \\ 0 & 0.0644 & 0.0405 & 0 \\ 0 & 0.0028 & 0.0879 & 0.0307 \\ 0 & 0 & 0.0005 & 0.0550 \end{bmatrix}$$

$$P_{4,3} = \begin{bmatrix} 0 & 00595 & 0 & 0 \\ 0 & 0.0934 & 0.0359 & 0 \\ 0 & 0.0041 & 0.0779 & 0.0227 \\ 0 & 0 & 0.0004 & 0.0407 \end{bmatrix}$$

$$P_{4,4} = \begin{bmatrix} 0 & 0.0659 & 0 & 0 \\ 0 & 0.1035 & 0.0275 & 0 \\ 0 & 0.0045 & 0.0598 & 0.0157 \\ 0 & 0 & 0.0003 & 0.0283 \end{bmatrix}$$

Blocking probability taking connection arrival rate=0.46 and packet arrival rate=1.2:

0.9331 0.9320 0.9310 0.9303 0.9297 0.9292 0.9287 0.9284 0.9281 0.9279 0.9277 0.9275 0.9274 0.9272 0.9271

Fig. 2 and Fig. 3 depict blocking probability against connection termination rate and packet arrival rate by plotting results in graph.

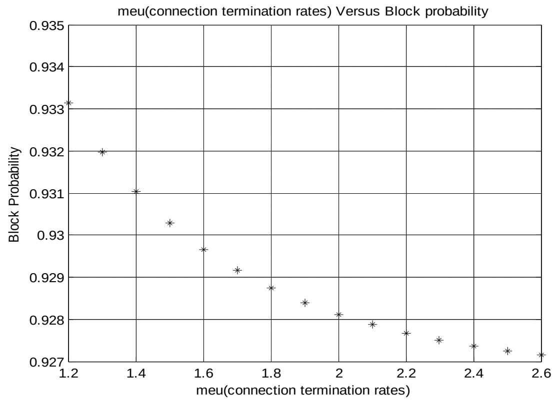

Figure 2: Blocking probability against connection termination rate taking connection arrival rate=0.46 and packet arrival rate=1.2

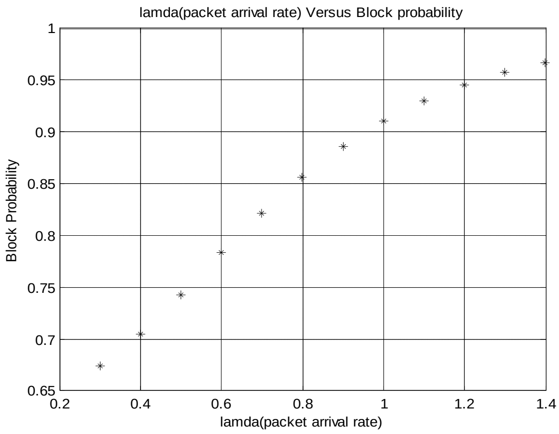

Figure 3: Blocking probability against packet arrival rate taking connection arrival rate=0.46 and connection termination rate =1.6

VI. Conclusion

The paper deals with traffic performance of a WiMAX network based on Probability Transition Matrix. Based on our analysis, blocking probability depends on connection termination rate and packet arrival rate in a manner that if connection termination rate increases, blocking probability decreases negative exponentially and if packet arrival rate increases blocking probability also increases. For analyzing blocking probability against connection termination rate, constant value of connection arrival rate and packet arrival rate has been considered and constant value for connection arrival rate and connection termination rate has been considered while analyzing blocking probability against packet arrival rate. Network researchers should analyze blocking probability before consider any new model to ensure Quality of service of WiMAX network.

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