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Impact of Mobility Management on Heterogeneous Wireless Network

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Abstract: Most of the real life networks are heterogeneous which always combine the best features of two or more networks .An integration of available wireless networks viz: Cellular and Wireless Local Area Network (WLAN) on expandable and flexible platform is called as Radio Resource Management for heterogeneous networks. Along with resource utilization, end to end delay and throughput are also important parameters for analysis of heterogeneous networks. The existing research work has focused on the effect of packet size and mobility management independently on heterogeneous networks.

This paper presents mobility management for heterogeneous networks.Here Heterogeneous network to be considered is integration of two prominent radio access technologies viz. cellular and Wireless Local Area Network (WLAN). The developed algorithm considers Common Radio Resource Management scheme using packet size of 256, 512, 1024 bit. The two mobility pattern pause 5 and pause 60 are created with log movement to nodes. The heterogeneous network created with 21 nodes along with MAC protocol 802.11b and data rate of 11 Mbps. The simulation is done for 50 seconds. The simulation results show that End-to-End Delay, Throughput and Bandwidth Utilization of the heterogeneous networks are improved by mobility management as a one of important aspect in heterogeneous network. The Network Simulator (NS-2) is used to demonstrate the functionality and evaluate the performance of the algorithms developed.

Keywords: Heterogeneous network, Radio Resource Management (RRM), Mobility, Rate Control.

I. INTRODUCTION:

There are many strengths and weaknesses of third generation cellular system. The radio resource management is an important task for fourth generation cellular system. For proper utilization of resources Wireless Cellular Network are integrated with Wireless Local Area Network (WLAN) [1]. The integrated network is called as Heterogeneous Network. In heterogeneous networks two networks are available to subscribers, depending on subscriber requirement the calls are diverted to particular network i.e. either cellular or WLAN. While selecting network for connectivity network capacity, strength of signal and subscriber location are also taken into consideration.

The architecture of heterogeneous network [2] considers three basic entities Subscriber, Service Provider (SP) and Network Provider (NP) as shown in figure 1.

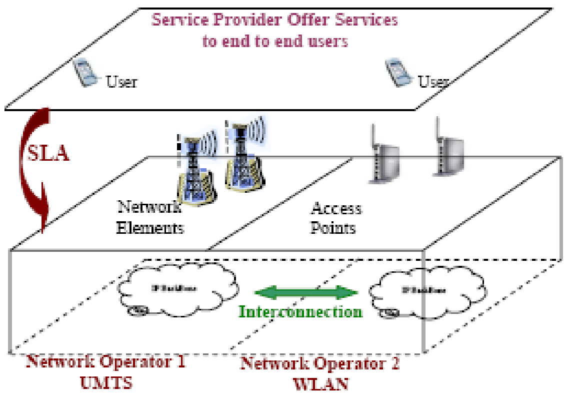

Fig.1.Architecture of Heterogeneous Network

The Subscriber buys service from Service Provider which in turn purchases batch capacity from Network Provider. The Service Provider allows Network Provider to capitalize on spare radio capacity while incurring little extra cost .The Service Providers can easily attract customers where as Network Providers do not normally have direct access to subscribers. All the marketing, sales, billing i.e. "front and back" office functions are done by Service Provider. The service level agreement between Subscriber and Service Provider includes i] multiple level of QoS metric for multiple user priority classes, ii] user priority, iii] QoS degradation and up gradation .

The management functions of Service Provider are call admission control (CAC), QoS degradation and upgradation, Resource Management (RRM). The above management functions indicate Service Provider can be a good candidate to integrate resources on flexible and expandable platform [2].

The role of Service Providers and architecture indicates only idea about how to integrate resources in flexible manner but no algorithms are suggested for implementation [2].

The algorithms suggested in paper "An algorithm for radio resource management in integrated cellular/WLAN networks" by Ioannis Modeas, Alexenderos Kaloxylos is without any analysis and does not present how system parameters can be improved [4]. The selection of routing protocols and the effect of packet size for heterogeneous network are considered without mobility pattern in paper "Effect of packet size on various MANET routing protocols" by Manoj Tolani and Rajan Mishra. The handoff techniques and impact of packet size are not considered while performing mobility management in "user mobility modeling in cellular communications networks" Dipl.-Ing.Plamen I. Bratanov [8].

This paper presents algorithms developed to analyze the combined effect of packet size along with mobility management for heterogeneous networks. The simulation results show that End-to-End Delay, Throughput and Bandwidth Utilization of the heterogeneous networks are improved by packet size and mobility management as a combined task.

II.MOBILITY MANAGEMENT:

Mobility management is also one of the paramount factors in heterogeneous networks. The mobility models should be used under realistic traffic and different environmental conditions. The effect of mobility has been analyzed in terms of Throughput, End-to-End Delay and Bandwidth Utilization. The vertical handoff, where the Mobile Station changes its current access port or Base Station during connection, is probably the most obvious and explored mobility management procedure. The mobility model must consider both the heterogeneity of the traffic systems and subscriber units.

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These mobility management functions relate the factors like land use, population density, vehicular traffic, income per capita.

Depending upon the above factors two models are possible:

i] Mobility model: depending on user speed and density.
ii] Call or telegraphic model: depending on call arrival rate and call duration.

From the literature survey three models have been used for mobility management. The first model is Fluid model, having limitations such as i] It describes aggregate traffic and therefore is hard to apply to situation where individual movement patterns are desired. ii] Average velocity is used instead of individual velocity.

The second model is Markovian model which is used only for pedestrian subscribers instead of vehicular subscribers.

The third model is Gravity model where many parameters have to be calculated. It is very difficult to model geography with many regions. The mobility model requires actual movement of subscriber units in vehicular traffic. The subscriber is distinguished with three points in the cell such as cell starting points, cross road points and cell leaving points [8] as shown in figure3.

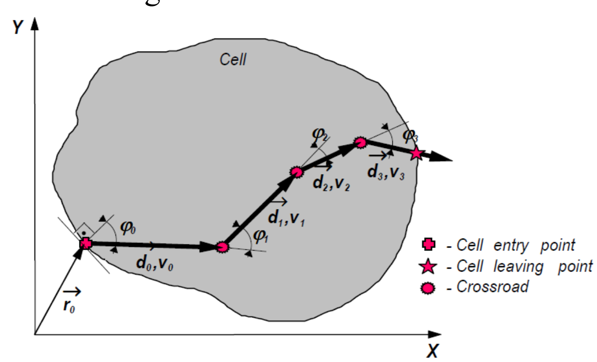

Fig2. Tracing a mobile within cell

Taking in to consideration work presented by Dipl.-Ing.Plamen I. Bratanov [8], the model used here depends on three factors viz:
i] Change in direction ii] street length iii] average velocity.

The analysis of the factors mentioned above is as shown below:
i] If $\overline{r}_0$ (x_0, y_0) denotes the initial position, then successive locations of the mobile user moving in random direction is denoted as

$$\overline{r}_1 (x_1, y_1) = \overline{r}_0 + \overline{d}_0 (d_1, \text{Ø}_0),$$

$$\overline{r}_2 (x_2, y_2) = \overline{r}_1 + \overline{d}_1 (d_2, \text{Ø}_1),$$

Where, Ø is change in direction with respect to previous direction.

Since the moving direction of a mobile is uniformly distributed between [-π, π] the probability density function of change in direction is

$$pdf(\text{Ø}0) = \begin{Bmatrix} \frac{1}{2\pi} & for\ -\pi \leq \text{Ø}_0 < \pi \\ 0 & otherwise \end{Bmatrix}$$

------------ [2.1]

For boundary crossing mobile, if Ø_0 is angle between normal of cell boundary and moving direction of the mobile then,

$$pdf(\text{Ø}0) = \begin{Bmatrix} \frac{1}{2\pi} \cos \text{Ø}_0 & for\ -\pi \leq \text{Ø}_0 < \pi \\ 0 & otherwise \end{Bmatrix}$$

---------------- [2.2]

The probability density function of random movement Ø_i is given as:

$$pdf(\text{Ø}_i) = \frac{1}{1+\omega 90^\circ + \omega -90^\circ + \omega 180^\circ} \cdot \frac{1}{\sigma_{\text{Ø}}\sqrt{2\pi}} \cdot$$

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$$\left[e^{\frac{\emptyset_i^2}{2\sigma^2\emptyset}} + \omega_{90^\circ} e^{\frac{\left[\emptyset_i - \frac{\pi}{2}\right]^2}{2\sigma^2\emptyset}} + \omega_{-90^\circ} e^{\frac{\left[\emptyset_i + \frac{\pi}{2}\right]^2}{2\sigma^2\emptyset}} + \omega_{180^\circ} e^{\frac{\left[\emptyset_i - \pi\right]^2}{2\sigma^2\emptyset}} \right]$$

………. [2.3]

Where $\omega_{90^\circ}, \omega_{-90^\circ}, \omega_{180^\circ}$ are the Weight Factors corresponding to probabilities. $\sigma_\emptyset =$ Standard deviation of direction distributions, assumed to be equal for all four distributions. The findings of statistical analysis are $\omega_{90^\circ} = 0.75, \omega_{-90^\circ} = 0.5, \omega_{180^\circ} = 0.0625, \sigma_\emptyset = 0.125$

ii] The probability density function of street length, for random course is

$$d_i = \sqrt{{d_{i,x}}^2 + {d_{i,y}}^2}$$

Where street network pattern to be consider is irregular. Then equation 4.1 becomes:

$$pdf(d_i) = \begin{cases} \frac{d_i}{{\sigma_d}^2} \cdot e^{-\frac{d_i^2}{2{\sigma_d}^2}} & for\ d_i > 0 \\ 0 & for\ d_i \le 0 \end{cases}$$

……..…… [2.4]

Where $\sigma_d = \bar{d}\sqrt{\frac{2}{\pi}}$

The mean street length $\bar{d}$ may depend on the location of subscriber,

Consider $\bar{d}$ = 80-110 m in city where as $\bar{d}$ =110-170 m outside city

$$pdf(d_i) = \begin{cases} \frac{d_i}{{\sigma_d}^2} \cdot e^{\frac{d_i^2 + \bar{d}^2}{2{\sigma_d}^2}} I_0\left[\frac{d_i\bar{d}}{{\sigma_d}^2}\right] & for\ d_i > 0 \\ 0 & for\ d_i \le 0 \end{cases}$$

Where $0.75\bar{d}\sqrt{\frac{2}{\pi}} < \sigma_d < 1.5\bar{d}\sqrt{\frac{2}{\pi}}$

………. [2.5]

Here $\bar{d}$ is average length of major roads.

iii] At the same time average vehicular and pedestrian subscribers are calculated with average velocity v_i and covering distance d_i.

$$pdf(\omega_i) = \begin{cases} \frac{1}{1+\omega_{mr}}\left[\frac{v_i}{{\sigma_\vartheta}^2} \cdot e^{\frac{v_i^2+\bar{v}^2}{2{\sigma_\vartheta}^2}} I_0\left(\frac{v_i\bar{v}}{{\sigma_v}^2}\right) + \omega_{mr}\frac{1}{\sigma_\vartheta\sqrt{2\pi}} \cdot e^{\frac{(v_i-\overline{v_{mr}})^2}{2{\sigma_\vartheta}^2}}\right] & for\ v_i > 0 \\ 0 & for\ v_i \le 0 \end{cases}$$

ω_{mr}= Weight factor for fraction of cars on major roads, v_i, v_{mr}= Mean Velocities of city and major road traffic, σ_ϑ- deviation. The statistical analysis shows Wmr = 0.5,$\bar{\vartheta}$ = 10 km/h, $\overline{\vartheta\ mr}$ = 35km/h and $\sigma\vartheta$ = 10km/h. These are the values for vehicle users .The pedestrian users have $W_{mr} = 0$, $\bar{v}$ = 3.6 km/h, $\bar{v}_{mr}$ = 0 km/h σ_{V} = 2.9 km/h.

On above mentioned parameters, for finding impact of mobility pattern in heterogeneous networks scenes are created which depend on velocity of subscriber and results are simulated by using Network Simulator (NS-2).

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III] SELECTION OF SIMULATION PARAMETERS:

The real time simulator (NS-2) is used to evaluate the performance of priority based vertical handoff as well as combined effect of packet size and mobility management. For heterogeneous wireless network the simulation parameters considered along with AODV agent and different packet sizes are as shown in Table 1. The simulation parameters for heterogeneous network select 21 nodes. The simulation is done with AODV routing protocol as it is the best routing protocol for heterogeneous network with minimum delay and maximum Throughput. The MAC protocol 802.11b is used to support WLAN network. The data rate of 11 mbps is selected as it supports non-real time applications. The table below gives the list of parameters used during simulation.

Simulation parameters	Values
Number of nodes	21
Playground size	1000*1000m
Simulation Time	50 seconds
Routing Protocol	AODV
MAC Protocol	802.11b
Data Rate	11 mbps
Mobility type	Log movement
Speed	2 mbps
Pause time	50 seconds
Capacity	5e#4.7 e6
Reserved B.W	0.1 e6
Grad Step	0.05
Rate control	EXP(1) sec
Packet size	256, 512,1024

Table1: Various important parameters set in different scenarios.

IV] DISCUSSION ON RESULTS:

B] Impact of Mobility Pattern:

The impact of mobility pattern has been simulated for packet size of 512 bit, Bandwidth with different rate control and mobility pattern with different scenes.

Condition 1: Taking into consideration packet size of 512 bit, Bandwidth of 4 MHz with rate control 1 and mobility pattern of pause 5, the simulations for End- to- End Delay, Throughput and Bandwidth Utilization are as shown below:

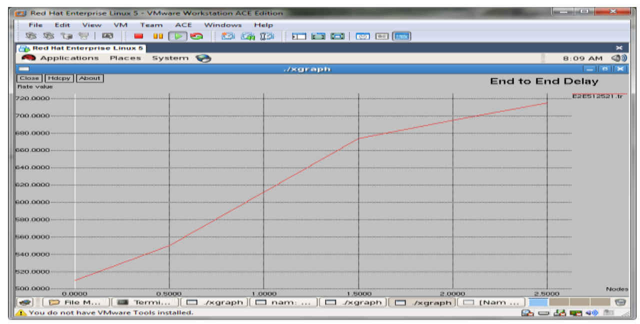

Fig.3 Graph showing End- to- End Delay.

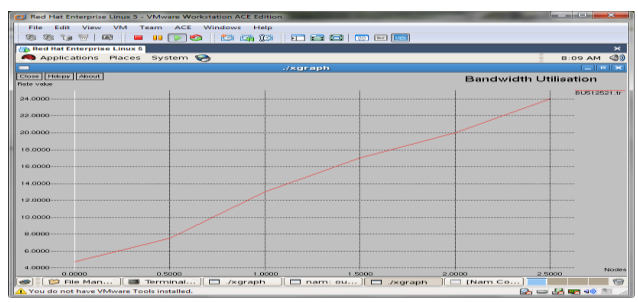

Fig.4 Graph indicating Bandwidth Utilization.

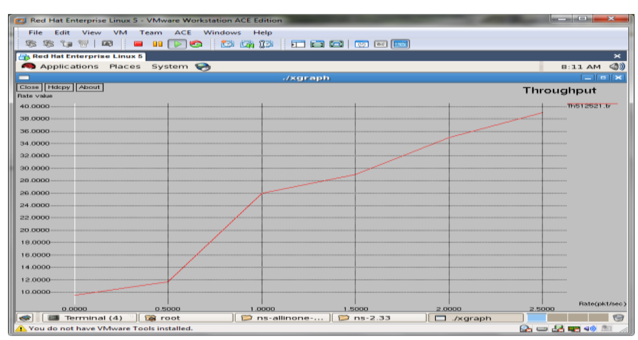

Fig.5 Graph indicating Throughput.

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Condition 4:
Taking into consideration packet size of 512 bit, Bandwidth of 4 MHz with rate control 1 and mobility pattern of pause 60, the simulation parameters End- to- End Delay, Bandwidth Utilization and Throughput are as shown below:

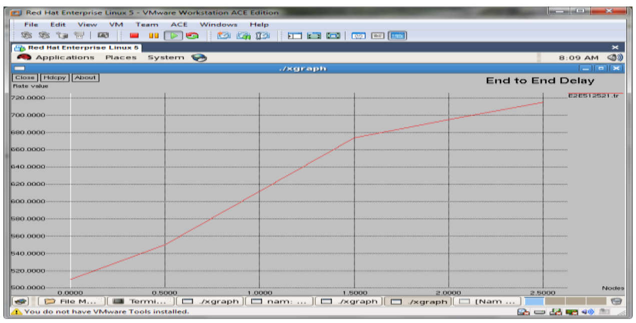

Fig.6 Graph showing End –to- End Delay.

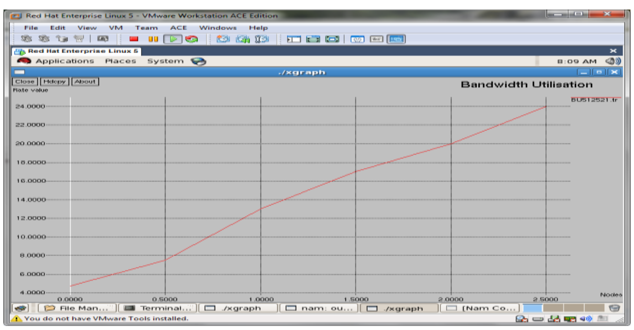

Fig.7 Graph showing Bandwidth Utilization.

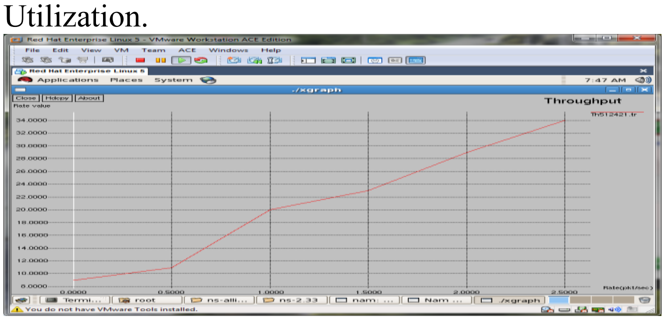

Fig.8 Graph showing Throughput.

The above graph represents the Bandwidth Utilization is improved due to mobility pattern 60.

On the above observations Table3 and Table 4 shows data analysis.

Packet size	End- to- End Delay(msec)	Bandwidth Utilization (%)	Maximum Throughput(kbps)
512	1.7	83	8330

Table3: Data analysis when Bandwidth= 4 MHz and mobility pattern of pause 5.

Packet size	End –to- End Delay(msec)	Bandwidth Utilization (%)	Maximum Throughput(kbps)
512	1.7	90	7353

Table4: Data Analysis when Bandwidth= 4 MHz and mobility pattern of pause 60.

VII] CONCLUSION:

This paper present effect of mobility management on heterogeneous networks. From the data analysis of results it is clear that AODV has higher Throughput when packet size is 512 bit. At the same time Bandwidth Utilization for same packet size is 91% with minimum End-to- End Delay of 1.7 msec.

VIII] REFERENCES:

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