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PERFORMANCE OF ADAPTIVE LIFE TIME BASED VERTICAL HANDOFF ALGORITHM IN HETEROGENEOUS NETWORKS

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The convergence of heterogeneous wireless networks combines existing wireless networks. An effective combination of different wireless networks should enable them to complement each other and provide high-speed data rate, wide area coverage, and quality of service (QoS) guarantee. In Next Generation Wireless Systems (NGWS), seamless handoff between different wireless access networks plays a vital role. One of the major challenges for seamless mobility is the creation of a vertical handoff protocol. In this paper, the performance of vertical handoff is studied using the integration of third generation (3G) cellular and wireless local area networks (WLAN). The effect of application-based signal strength threshold (ASST) and path loss exponent on an adaptive lifetime-based vertical handoff (ALIVE-HO) strategy is studied in terms of number of handoffs, aggregated throughput, and packet delay. Therefore the vertical handoff performance can be optimized in wireless and mobile networks. The present work is done for different channel conditions as well as different mobility schemes.

KEYWORDS: *NGWS; vertical handoff; ALIVE-HO; ASST.*

I. INTRODUCTION

Rabid progress in wireless networking and communication technologies has created several wireless communication systems such as GSM, GPRS, UMTS and WLAN. Each network has its own characteristics such as coverage area and data rate [1]. These networks are complementary to each other and hence their integration can realize unified NGWS. NGWS are envisaged to offer appreciable improvements compared to current networks such as high bandwidth, integrated services, quality of Service provisioning, low cost, Seamless mobility of users, and wide coverage [2].

Integrating two very different technologies introduced a number of technical and logistical issues that must be resolved in order to maximize the benefits reaped from such integration. The integration of WLAN and cellular networks has been recently a subject of great interest on one hand, cellular networks provide global coverage at limited data rates; on the other hand, WLANs provide higher data rates within hotspots. Cellular service providers will be able to offload heavy traffic to WLANs, saving the Cellular network resources for users located outside WLAN coverage. Then, by combining these technologies, a converged system can provide both universal coverage and broadband access.

In this paper, ALIVE-HO algorithm is presented for WLAN-3G network and the effect of ASST and path loss exponent on it is studied. Analytical model is provided and the performance of the algorithm is evaluated in terms of number of handoffs, aggregated throughput, and packet delay. The choice of ASST can be optimized based on the handoff performance metrics.

The rest of the paper is organized as follows: Section II provides an overview for the related works. The analytical model to study the effect of ALIVE-HO algorithm is presented in section III. Section IV presents the performance metrics of ALIVE-HO algorithm. Simulation results are provided in section V. Section VI summarizes the conclusion reached at the end of this research effort.

II. RELATED WORK

Several papers have addressed the performance of handoff algorithms. In [15], the performance of adaptive hysteresis vertical handoff scheme is studied. The proposed adaptive hysteresis vertical handoff can increase lots of average data rate than the fixed hysteresis vertical handoff scheme. Moreover, the proposed adaptive hysteresis vertical handoff scheme can reduce the ping-pong handoff rate as well. In [16], Simulation study of the relative signal strength with hysteresis and threshold (RSS-HT) algorithm for varying hysteresis and threshold are studied. Increasing the hysteresis value results in decreasing the average number of handoffs but increasing delay in handoffs also decreasing the threshold value causes increase in the probability of handoff and therefore the number of handoffs. In [10] a comprehensive survey of the vertical handoff decision (VHD) algorithms is presented and tradeoffs between their complexity of implementation and efficiency are made. In [17] the design of an adaptive multi-attribute vertical handoff decision algorithm is presented and the use of fuzzy logic concepts to combine multiple metrics from the network to obtain useful handoff initiation schemes is demonstrated. In [11] the effect of an application-based signal strength threshold on an adaptive preferred-network lifetime-based handoff strategy was studied, in terms of signaling load, available bandwidth, and packet delay for an inter-network roaming mobile. The performance of the algorithm was studied for different threshold values and for mobility rate up to 5 m/s. In [19] a survey of the current handoff decision techniques was given. It describes a few recent works in vertical handoff (VHO) decision stage and exposed a summery of most major decision algorithms.

III. ANALYTICAL MODEL

A. System model

The paper studied the overlapping of 3G cellular and WLAN networks. The mobile terminal (MT) is allowed to communicate with both networks but it can connect to only one network at a time.

The system assumes that the coverage areas of the WLAN access point (AP) and UMTS base station (BS) overlap, and that the MT always gives priority to the use of the WLAN whenever it is available. The simulation model assumes a MT moving away from the WLAN access point in a straight line with a constant speed *V*.

Within the WLAN, the RSS can be expressed as:

$$RSS = P_T - L - 10n \log (d) + f(\mu_s , \sigma_s) \tag{1}$$

Where P_T is the transmitted power, *L* is the constant power loss, *n* is the path loss exponent, *d* is the distance between the mobile terminal and WLAN AP, and $f(\mu_s, \sigma_s)$ is the shadow fading with mean $\mu_s = 0$ and standard deviation σ_s.

B. ALIVE-HO algorithm

The paper uses ALIVE-HO algorithm to perform an efficient vertical handoff between cellular and WLAN network which use the RSS as a unique input for the algorithm, to estimate the duration through which the WLAN usage will be beneficial for the active applications.

In discrete time, equation (1) is expressed as:

$$RSS[k] = \mu_{Rss[k]} + N[k] \tag{2}$$

Where *k* is the time index

From (1), (2)

$$\mu_{Rss[k]} = P_T - L - 10n \log (d[k]) \text{ and } N[k] = f(\mu_s , \sigma_s)$$

The averaged RSS, $\overline{RSS}\,[k]$:

$$\overline{RSS}\,[k] = \frac{1}{W_{av}} \sum_{i=0}^{W_{av}-1} RSS[K-i] \tag{3}$$

Where W_{av} is the number of samples.

The rate of change of RSS, *S[k]* can be calculated as [11]:

$$S[k] = \frac{M_1[K]-M_2[K]}{W_s T_s} \tag{4}$$

Where

$$M_1[K] = \frac{2}{W_s} \sum_{i=0}^{\frac{W_s}{2}-1} \overline{RSS}\,[K-W_s+1+i], \tag{5}$$

$$M_2[K] = \frac{2}{W_s} \sum_{i=\frac{W_s}{2}}^{W_s-1} \overline{RSS}\,[K-W_s+1+i] \tag{6}$$

Where W_s and T_s denote the slope estimator window size and the RSS sampling interval respectively.

Then, the estimated MT lifetime within the WLAN, *EL[k]* is as following:

$$EL[k] = \frac{\overline{\mathrm{RSS}}[K] - \gamma}{\mathrm{S[K]}} \tag{7}$$

Where γ denotes ASST, thus, *EL[k]* represents the application specific time period in which the WLAN is likely to remain usable to the MT.

The ASST represents the RSS level for which the application will perform satisfactorily. The ASST is an application dependent parameter so ALIVE-HO algorithm can satisfy different application requirements by the tuning of ASST therefore it can optimize the overall system performance [11] [12] [2].

To improve handoff performance, variable window size is preferred so W_{av} and W_s can be expressed as:

$$W_{av} = max\ (10, \left\lfloor \frac{D_{av}}{VT_s} \right\rfloor) \tag{8}$$

$$W_s = 2*max\ (50, \left\lfloor \frac{D_s}{VT_s} \right\rfloor) \tag{9}$$

Where D_{av} and D_s represent the averaging and slope distance windows respectively, also the symbol $\lfloor\ \rfloor$ represents the greatest lower integer function, and *V* is the MT velocity away from the AP.

C. Moving out and moving in handoff

In this algorithm, the mobility of a MT is classified into two scenarios: moving out of the preferred network (MO), and moving into the preferred network (MI).
The MT will initiate the MO handoff at time *k* if:

$\overline{RSS}\ [k] \le MOT_{\ WLAN}$ (MO threshold) and

$EL[k] \le T_{HO}$ (Handoff delay threshold)

The $MOT_{\ WLAN}$ is usually chosen to be a few dB above the wireless interface sensitivity. This ensures that the mobile terminal associates with a new point of attachment (POA) before losing connection with the old POA.
Also the MT will initiate the MI handoff to the WLAN at time *k* if:

$\overline{RSS}\ [k] > MIT_{\ WLAN}$ (MI threshold) and

Available bandwidth > required bandwidth

We assume that the WLAN is always in good condition, so that the MT always performs MI after an unnecessary MO.

For the proposed ALIVE-HO algorithm, the probability of handoff from WLAN to 3G at instant *k+1* given that the MT is associated with the WLAN at instant *k* ($P_{c|w}\ [k+1]$):

$$P_{c|w}\ [k+1] = Pr\ \{ \overline{RSS}\ [k+1] < MOT_{\ WLAN}\ ,\ EL\ [k+1] < T_{HO} \} \tag{10}$$

The lifetime part becomes more significant for low mobility users. Then $P_{c|w}\ [k+1]$ can be represented by:

$$P_{c|w}[k+1] = Pr\{EL[k+1] < T_{HO} \mid EL[k] > T_{HO}\} \tag{11}$$

$$= Pr\{\frac{\overline{\mathrm{Rss}}[K+1]-\gamma}{\mathrm{S}[\mathrm{K}+1]} < T_{HO} \mid \frac{\overline{\mathrm{Rss}}[K]-\gamma}{\mathrm{S}[\mathrm{K}]} > T_{HO}\}$$

$$= Pr\{\overline{\mathrm{Rss}}[K+1] - T_{HO}\,\mathrm{S}[\mathrm{K}+1] < \gamma \mid \overline{\mathrm{Rss}}[K] - T_{HO}\,\mathrm{S}[\mathrm{K}] > \gamma\} \tag{12}$$

Let $Z[k] = \overline{\mathrm{Rss}}[K] - T_{HO}\,\mathrm{S}[\mathrm{K}]$ then,

$$P_{c|w}[k+1] = Pr\{Z[k+1] < \gamma \mid Z[k] > \gamma\}$$

BY conditional probability this equation can be written as

$$P_{c|w}[k+1] = \frac{\Pr\{\mathrm{Z}[\mathrm{k}+1] < \gamma, \mathrm{Z}[\mathrm{k}] > \gamma\}}{\Pr\{\mathrm{Z}[\mathrm{k}] > \gamma\}} \tag{13}$$

$$P_{c|w}[k+1] = \frac{\int_{-\infty}^{\gamma}\int_{\gamma}^{\infty} \mathrm{f}_{\mathrm{z}[\mathrm{k}+1]\mathrm{z}[\mathrm{k}]}(\mathrm{z}_1,\mathrm{z}_2)\mathrm{d}_{\mathrm{z}_1}\mathrm{d}_{\mathrm{z}_2}}{\int_{\gamma}^{\infty}\mathrm{f}_{\mathrm{z}[\mathrm{k}]}(\mathrm{z})\mathrm{d}_{\mathrm{z}}} \tag{14}$$

Where $\mathrm{f}_{\mathrm{z}[\mathrm{k}+1]\mathrm{z}[\mathrm{k}]}(\mathrm{z}_1,\mathrm{z}_2)$ is the joint probability density function of $z[k+1], z[k]$ [18].

$$\mathrm{f}_{\mathrm{z}[\mathrm{k}+1]\mathrm{z}[\mathrm{k}]}(\mathrm{z}_1,\mathrm{z}_2) = \frac{1}{2\pi\sigma_{z[k+1]}\sigma_{z[k]}\sqrt{1-\rho_{z[k+1]z[k]}^{2}}}$$

$$.exp\{\frac{-1}{2(1-\rho_{z[k+1]z\{k\}}^{2})}[\frac{(z_1-\overline{z[k+1]})^2}{\sigma_{z[k+1]}^{2}} - \frac{2\rho_{z[k+1]z\{k\}}(z_1-\overline{z[k+1]})(z_2-\overline{z[k]})}{\sigma_{z[k+1]}\sigma_{z[k]}} + \frac{(z_2-\overline{z[k]})^2}{\sigma_{z[k]}^{2}}]]\}$$

where $\rho_{z\{k+1]z[k]}$ is the correlation coefficient.

$$\rho_{z\{k+1]z[k]} = \frac{COV(z[k+1], z[k])}{\sigma_{z[k+1]}\sigma_{z[k]}}$$

Where *cov(z[k+1],z[k])* is the covariance between *z[k+1],z[k]*

Also $\int_{\gamma}^{\infty}\mathrm{f}_{\mathrm{z}[\mathrm{k}]}(\mathrm{z})\mathrm{d}_{\mathrm{z}} = Q(\frac{\gamma-\mu_{z[k]}}{\sigma_{z[k]}})$

Where $Q()$ is the complementary error function.

The probability of handoff from 3G to WLAN at instant *k+1* given that the MT is associated with the 3G at instant *k* ($P_{w|c}[k+1]$):

$$P_{w|c}[k+1] = \Pr\{\overline{\mathrm{Rss}}[\mathrm{k}+1] > \mathrm{MIT} \mid \overline{\mathrm{Rss}}[\mathrm{k}] < \mathrm{MIT}\} \tag{15}$$

BY conditional probability this equation can be written as

$$= \frac{\Pr\{\overline{\mathrm{Rss}}[\mathrm{k}+1] > \mathrm{MIT}, \overline{\mathrm{Rss}}[\mathrm{k}] < \mathrm{MIT}\}}{\Pr\{\overline{\mathrm{Rss}}[k] < MIT\}} \tag{16}$$

$$= \frac{\int_{MIT}^{\infty}\int_{-\infty}^{MIT}\mathrm{f}_{\overline{\mathrm{Rss}[\mathrm{k}+1]}\,\overline{\mathrm{Rss}[\mathrm{k}]}}(\overline{\mathrm{Rss}}_1, \overline{\mathrm{Rss}}_2)\mathrm{d}_{\overline{\mathrm{Rss}_1}}\,\mathrm{d}_{\overline{\mathrm{Rss}_2}}}{\int_{-\infty}^{MIT}\mathrm{f}_{\overline{\mathrm{Rss}[\mathrm{k}]}}(\overline{Rss})d_{\overline{Rss}}} \tag{17}$$

Where $f_{\overline{Rss}[k+1]\overline{Rss}[k]}(\overline{Rss_1}, \overline{Rss_2})$ is the joint probability density function of $\overline{Rss}[k+1], \overline{Rss}[k]$ [18].

$$f_{\overline{Rss}[k+1]\overline{Rss}[k]}(\overline{Rss_1}, \overline{Rss_2}) = \frac{1}{2\pi\sigma_{\overline{Rss}[k+1]}\sigma_{\overline{Rss}[k]}\sqrt{1-\rho_{\overline{Rss}[k+1]\overline{Rss}[k]}^2}}$$

$$.exp\{\frac{-1}{2(1-\rho_{\overline{Rss}[k+1]\overline{Rss}[k]}^2)}[\frac{(\overline{Rss_1}-\mu_{\overline{Rss}[k+1]})^2}{\sigma_{\overline{Rss}[k+1]}^2}$$

$$-\frac{2\rho_{\overline{Rss}[k+1]\overline{Rss}[k]}(\overline{Rss_1}-\mu_{\overline{Rss}[k+1]})(\overline{Rss_2}-\mu_{\overline{Rss}[k]})}{\sigma_{\overline{Rss}[k+1]}\sigma_{\overline{Rss}[k]}}+\frac{(\overline{Rss_2}-\mu_{\overline{Rss}[k]})^2}{\sigma_{\overline{Rss}[k]}^2}]\}$$

Where $\rho_{\overline{Rss}[k+1]\overline{Rss}[k]} = \dfrac{COV(\overline{Rss}[k+1], \overline{Rss}[k])}{\sigma_{\overline{Rss}[k+1]}\sigma_{\overline{Rss}[k]}}$

Also $\int_{-\infty}^{MIT} f_{\overline{Rss}[k]}(\overline{Rss})d_{\overline{Rss}} = Q(\dfrac{\mu_{\overline{Rss}[k]}-MIT}{\sigma_{\overline{Rss}[k]}})$

IV. PERFORMANCE METRICS

A. Number of handoffs

The number of handoffs has a great effect on the network performance, as it may degrade the overall performance. The number of handoffs (NHO) is defined as the sum of Moving In and Moving Out between WLAN and 3G network as the MT roams across the network boundary [11].

$$E\{N_{HO}\} = E\{N_{MO}\} + E\{N_{MI}\} \tag{18}$$

$$= \sum_{K=1}^{K\max}(P_{MO}[K] + P_{MI}[K]) \tag{19}$$

Where P_{MI}, P_{MO} represent probabilities of moving In and Out respectively and K_{Max} is the time index at which the MT reaches the WLAN edge.

$$P_{MO}[K+1] = P_{c|w}[K+1]\,P_w[K], \tag{20}$$

$$P_{MI}[K+1] = P_{w|c}[K+1]\,P_c[K] \tag{21}$$

Where $P_w[k]$ represents probability that MT is associated with the WLAN network at instant k and $P_c[k]$ represents probability that MT is associated with the 3G network at instant k.

$$P_w[k+1] = P_{w|c}[k+1]\,P_c[k] + (1 - P_{c|w}[k+1])\,P_w[k], \tag{22}$$

$$P_c[k+1] = P_{c|w}[k+1]\,P_w[k] + (1 - P_{w|c}[k+1])\,P_c[k] \tag{23}$$

In our model, the MT is assumed to be attached to the WLAN at the beginning; hence $P_w[0] = 1$ and $P_c[0] = 0$

B. Aggregated Throughput

Aggregated throughput is the sum of the available bandwidth in WLAN and 3G networks. Available bandwidth is the maximum bandwidth the path can provide without affecting other traffic in the path, i.e., the minimum unused link capacity along the path [13].The allocation of bandwidth to MT is controlled by the time interval up to which MT stays in WLAN or 3G networks. Also part of the bandwidth allocation criteria is the state of WLAN when MT is connected to.

There are two states for WLAN: WLAN Up and WLAN Down. When the received wireless signal is greater than sensitivity threshold α then it is denoted by WLAN Up state, otherwise it is denoted by WLAN Down state.

The probability that the WLAN is in the Up state at any time *k*:

$$P\,[K] = Pr\,\{RSS\,[K] > \alpha\}$$

$$= Q\,\left(\frac{\alpha - \mu[K]}{\sigma}\right) \qquad (24)$$

We assume that When RSS is lower than a certain interface sensitivity level *α*; the mobile terminal can not communicate with the AP.

The WLAN efficiency (ζ_{LT}) can be defined as the percentage of the WLAN up duration over the MT lifetime in the WLAN, it can be expressed as:

$$\zeta_{LT} = \sum_{K=Kstart}^{K\max} \overline{P_{MO}}[K] \frac{\sum_{h=1}^{K} P[h]}{K} \qquad (25)$$

Where $\overline{P_{MO}}$ is the calculated version of P_{MO},

K is the MT lifetime in the WLAN,

K_{Start} is the transition region starting point, where Transition region is the region between the point

when the RSS starts to oscillate around the interface sensitivity and the WLAN edge.

Then the MT aggregated throughput (*AT*) can be expressed as:

$$AT = \frac{\zeta_{LT}\, R_W\, (\overline{K_{MO}} - K_{start}) + R_C\, (K_{\max} - \overline{K_{MO}})}{K_{\max} - K_{start}} \qquad (26)$$

Where $\overline{K_{MO}}$ is the average time to MO,

R_W is the effective data rate in WLAN network,

R_C is the effective data rate in 3G network

C. Packet Delay

The delay for a successfully transmitted packet is defined as the time interval from the time the packet is at the head-of-line of the queue ready to be transmitted, until an acknowledgement for this packet is received [14].

A packet is considered excessively delayed if its head of line (HOL) delay exceeds θ_D .Where θ_D is the packet delay Threshold within existing hop as end-to-end delay for real-time application from the source to the destination.

The average probability of the packet delay (*D*) can be calculated as:

$$D = \frac{\sum_{K = Kstart}^{Kmo} P_D[K]}{(K_{MO} - K_{start} + 1)} \tag{27}$$

Where $P_D[K]$ is the probability that a packet will be excessively delayed, which is equal to the WLAN down states probability whose interval is equal to the delay threshold.

V. RESULTS

This part provides the performance results for the proposed ALIVE-HO algorithm. Numerical simulation using MATLAB is developed to simulate the operation of the algorithm. The simulation model assumes that the MT moving away from the WLAN access point in a straight line with a constant speed V. Also the model assumes that the MT is moving in urban area where the typical velocity for vehicular users around 50 km/hr (14 m/s) and the values of path loss exponent between 2.7 and 3.5.

The performance of the algorithm is studied for different path loss exponent values and different ASST values with respect to number of handoffs, aggregated throughput, and packet delay.

Table 1 shows the list of simulation parameter values. These parameters result in WLAN coverage of 100 meters approximately [11].

Table (1): Simulation Parameter Values

Parameter	Value	Parameter	Value
P_T	100 m Watt	T_S	0.01 sec
n	2.7,3,3.3	MOT_{WLAN}	-85 dBm
σ	7 dB	MIT_{WLAN}	-80 dBm
S	28.7 dB	$T_{handoff}$	1 sec
$D_{average}$	0.5 m	R_W	25 Mbps
D_{slope}	5 m	R_C	2.4 Mbps
α	-90 dBm	V	0.5 :1.5:14 m/s 1.8:5.4:50.4 Km/hr
ASST	-90dBm,-89dBm, -88dBm,-87dBm	θ_D	30 ms
R_{3G}	500m	R_{WLAN}	100m

A. Number of Handoffs

Figure 1 shows the relation between the number of handoffs and the speed of MT for path loss exponent (n) = 2.7 and for different ASST values (ASST = -90dBm,-89dBm, -88dBm,-87dBm).

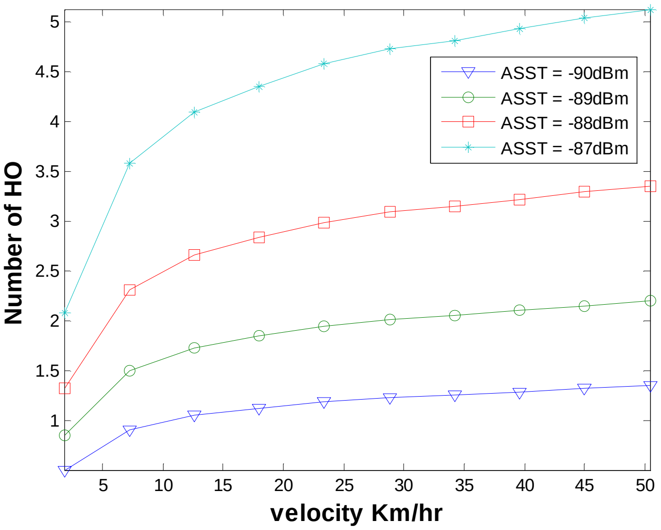

Fig. (1): Number of handoffs (n = 2.7, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

The figure shows that the number of handoffs increases when the ASST is increased, as increasing ASST allows MT to remain in the WLAN for a shorter duration.

Figure 2 shows the relation between the number of handoffs and the speed of MT for path loss exponent (n) = 3 and for different ASST values (ASST = -90dBm,-89dBm, -88dBm,-87dBm).

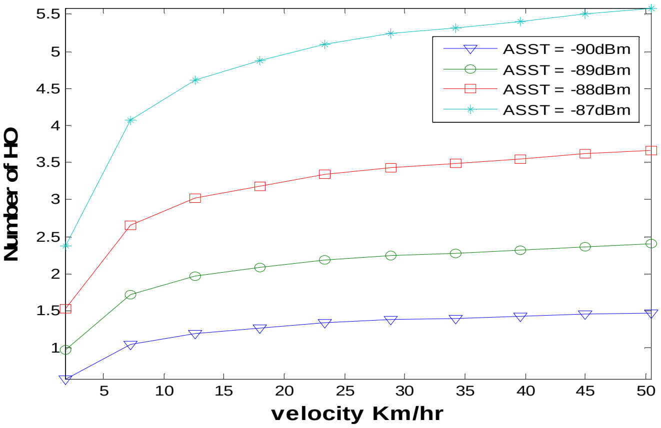

Fig. (2): Number of handoffs (n = 3, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

The obtained results from figure 2 is the same as figure 1 but the number of handoffs increased in figure 2 compared to figure 1 .The path loss exponent is increased from n = 2.7 to n = 3, as increasing path loss exponent reduces MT lifetime in WLAN , therefore increasing number of handoffs.

Figure 3 shows the relation between the number of handoffs and the speed of MT for path loss exponent (n) = 3.3 and for different ASST values (ASST = -90dBm,-89dBm, -88dBm,-87dBm).

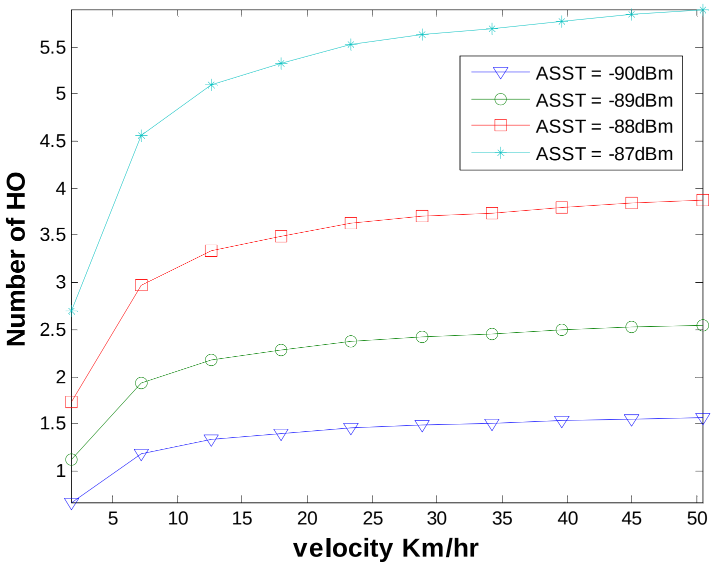

Fig. (3): Number of handoffs (n = 3.3, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

The obtained results from figure 3 is the same as figures 1,2 but the number of handoffs increased in figure 3 compared to figures 1,2 as the path loss exponent (n) = 3.3 .

B. Aggregated Throughput

Figure 4 shows the relation between the aggregated throughput and the speed of MT for path loss exponent (n) = 2.7 and for different ASST values (ASST = -90dBm,-89dBm, -88dBm,-87dBm).

The figure shows that the aggregated throughput decreases when the ASST is increased, as increasing ASST allows MT to remain in the WLAN for a shorter duration.

Figure 5 shows the relation between the aggregated throughput and the speed of MT for path loss exponent (n) = 3 and for different ASST values (ASST = -90dBm,-89dBm, -88dBm,-87dBm).

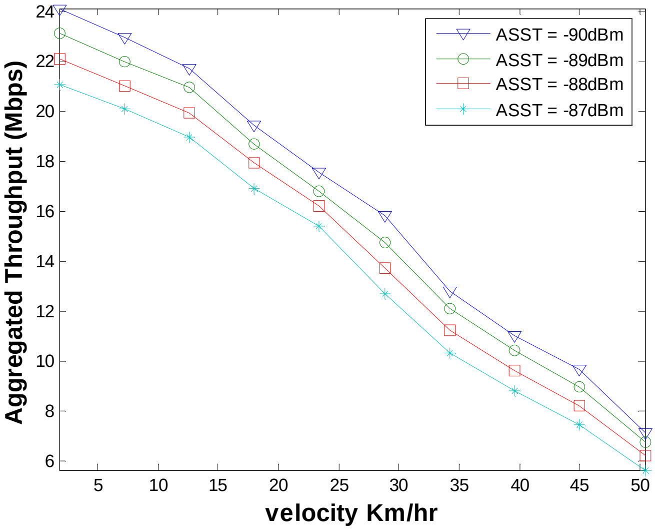

Fig. (4): Aggregated throughput (n = 2.7, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

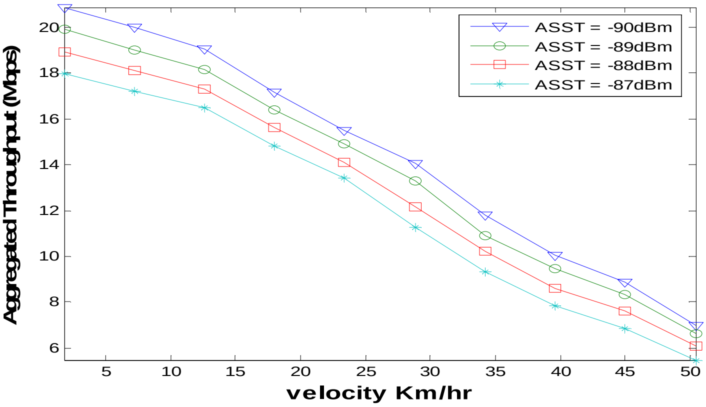

Fig. (5): Aggregated throughput (n = 3, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

The obtained results from figure 5 is the same as figure 4 but the aggregated throughput decreased in figure 5 compared to figure 4 .The path loss exponent is increased from n = 2.7 to n = 3, as increasing path loss exponent reduces MT lifetime in WLAN , therefore decreasing aggregated throughput.

Figure 6 shows the relation between the aggregated throughput and the speed of MT for path loss exponent (n) = 3.3 and for different ASST values (ASST = -90dBm, -89dBm, -88dBm,-87dBm).

The obtained results from figure 6 is the same as figures 4, 5 but the aggregated throughput decreased in figure 6 compared to figures 4, 5 as the path loss exponent (n) = 3.3.

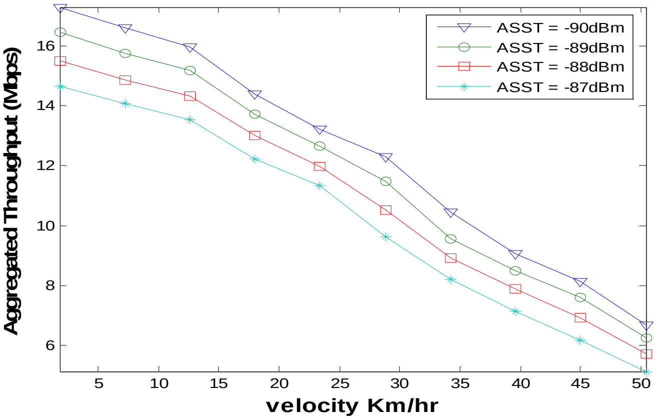

Fig. (6): Aggregated throughput (n = 3.3, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

C. Packet Delay

Figure 7 shows the relation between the packet delay and the speed of MT for path loss exponent (n) = 2.7 and for different ASST values (ASST = -90dBm,-89dBm,-88dBm,-87dBm).

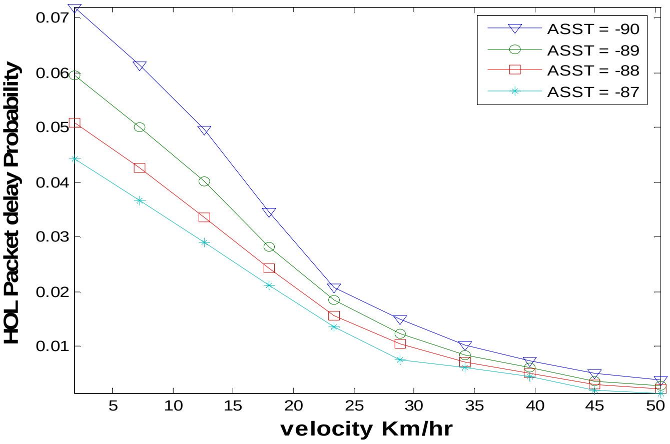

Fig. (7): HOL packet delay probability (n = 2.7, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

The figure shows that the packet delay probability decreases when the ASST is increased, as increasing ASST allows MT to remain in the WLAN for a shorter duration.

Figure 8 shows the relation between the packet delay and the speed of MT for path loss exponent (n) = 3 and for different ASST values (ASST = -90dBm,-89dBm, -88dBm,-87dBm).

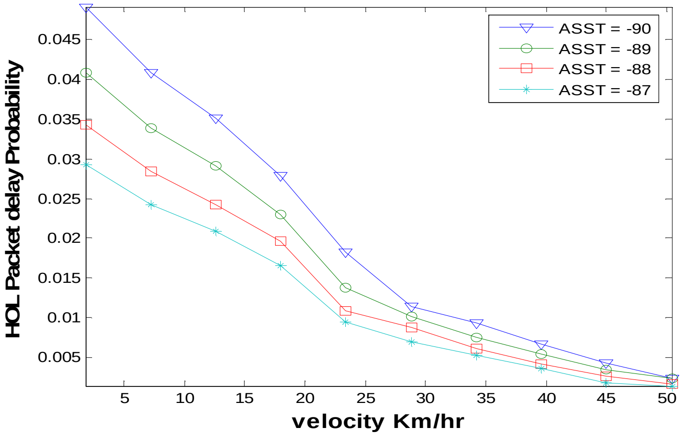

Fig. (8): HOL packet delay probability (n = 3, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

The obtained results from figure 8 is the same as figure 7 but the packet delay probability decreased in figure 8 compared to figure 7 .The path loss exponent is increased from n = 2.7 to n = 3, as increasing path loss exponent reduces MT lifetime in WLAN , therefore decreasing packet delay probability .

Figure 9 shows the relation between the packet delay and the speed of MT for path loss exponent (n) = 3.3 and for different ASST values (ASST = -90dBm,-89dBm, -88dBm,-87dBm).

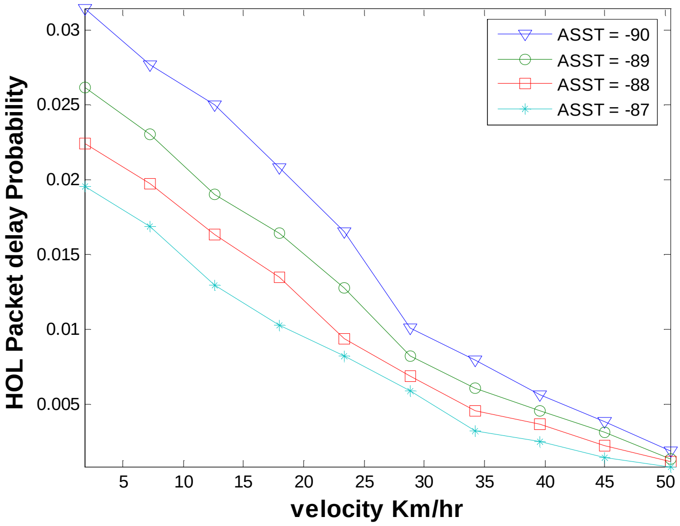

Fig. (9): HOL packet delay probability (n = 3.3, ASST = -90dBm,-89dBm,-88dBm,-87dBm)

The obtained results from figure 9 is the same as figures 7,8 but the packet delay probability decreased in figure 9 compared to figures 7,8 as the path loss exponent (n) = 3.3 .

VI. CONCLUSION

There is a growing trend in mobile communications towards overlay networks and mobile devices with the capability of using different access technologies. In this scenario the mobile device must choose the right access technology. In the short term, the combination of WLAN and 3G (UMTS) technologies is of the most importance. We introduced ALIVE-HO algorithm and the analytical model to evaluate performance of it. The performance is evaluated based on number of handoffs, aggregated throughput, and packet delay for a MT moving in urban area. The present work is done for different channel conditions as well as different mobility schemes. As the ASST value increases, the number of handoffs increases, the aggregated throughput decreases, and the packet delay probability decreases also as the path loss exponent value increases the number of handoffs increases, the aggregated throughput decreases, and the packet delay probability decreases. By optimally tuning ASST value which depends on the type of application, quality of service parameters and the system requirements, we can optimize system performance.

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أداء خوارزم المناقلة (تسليم السلطة) الرأسية المعتمد على العمر الزمنى التكيفى (ALIVE-HO) فى الشبكات الغير متجانس

تجمع الشبكات اللاسلكية الغير متجانسة بين الشبكات اللاسلكية الحالية. و يجب على هذا المزيج الفعال من الشبكات اللاسلكيه المختلفة أن يكمل كل منهما الآخر وأن يوفر معدل بيانات ذو سرعة عالية ونطاق تغطية واسع وأن يضمن جودة الخدمة. تلعب المناقلة السلسة بين الشبكات اللاسلكيه المختلفة دورا حيويا فى الجيل القادم للشبكات اللاسلكيه و يعتبر من أعظم تحديات المناقلة السلسة خلق بروتوكول للمناقلة الرأسية. فى هذة الورقة البحثية تم دراسة أداء عملية المناقلة الرأسية عن طريق الدمج بين شبكة الجيل الثالث والشبكة المحلية اللاسلكية ودراسة تأثير حد قوة الإشارة و أس فقدان المسار على خوارزم المناقلة الرأسية المعتمد على العمر الزمنى

التكيفى من حيث عدد مرات المناقلة الرأسية، السرعة المجمعة، واحتمالية تأخير الحزم. وبناء على ذلك يمكن تحسين أداء عملية المناقلة الرأسية فى الشبكات اللاسلكية والمتنقلة. وقد تم العمل فى هذا البحث مع أحوال مختلفة للقناة وكذلك خطط مختلفة للتنقل.