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A MOBILITY AWARE HANDOVER SCHEME FOR 4G LTE SYSTEM

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Abstract
Reduction in cell size in an ultra-dense network faces the challenge of increase in frequency of handovers and signaling overhead (mobility management) as well as inter-cell interference. Such frequent handovers leads to increased packet loss and blocking rate if the handover latency is very high, which have adverse effect on connectivity and performance. However, most existing schemes have the common characteristics of increasing spectral and energy efficiency due to increase in the number of micro cell on a network, thus decreases the general network performance. In this study, an improved scheme was developed for fixed mobility management pattern (FMP). A comparison module was established and an identifier algorithm that uses the user equipment international mobile equipment identity (IMEI) as a decisive component of its cell selection camping process was designed. Network simulator (NS-3) was used to study the impact of macro cell and inter site distance (ISD) on user throughput and battery life usage using mobility pattern of 3km/h, with A3 event based measurement for ISD 50, 150, 300, 500, and 1000 respectively. The performance evaluation metrics used are; reference signal received power (RSRP), flow monitor and handover time. The FMP results were compared with micro cell performance in an ultra-dense network. The RSRP result from FMP was higher than that of micro cell at ISD 50 and 150 respectively (-71.36, -73.97 and 83.77, 85.13). The handover time for FMP was higher than that of micro cell except for ISD 50 which was 50s and 51s respectively. The flow monitor of FMP showed a packet loss ratio of 0.0001 compare to 0.21 of micro cell. The battery life usage shows that FMP used 5943±8.7mw compare to micro cell which used 1680.2±15.7 mw. These results showed that FMP is efficient in managing the frequency of handover and battery life consumption for better connectivity and performance.

Keywords: Handover, Mobility, LTE, Terminal, Call, Cell.

1.0 INTRODUCTION

The advancement in telecommunication and the ever-increasing communication tools such as mobile phones and geographical information system, incite individual search for the ease and unfailing information transmission and low communication cost. One of these developments is the concept of Long Term Evolution (LTE) system, Paging, Mobility Management Entity (MME) and Tracking Area List (TAL). As users increase day by day, users' satisfactions become a needful priority. Some of the problems associated with this development are congestion, inaccessibility of resources (resource wastage), degradation in quality of service, and over loading. These are the major challenges with LTE network which consists of Radio Access Network (RAN) and Core Network [1, 2].

LTE access network uses orthogonal frequency division modulation access in the downlink and Single Carrier Frequency Division Multiple Access (SC-FDMA) in the uplink which to provide an improved spectral efficiency also high data rates and low latency for users in high mobility scenarios [3]. Mobility Pattern, Tracking and Location update have been modelled with some algorithms to improve the movements of users and the tracking areas. The tracking areas consist of many cells, manageable by mobile terminals and deliver calls. Some of the models introduced are linear programming model, Poisson principle, Markov Chain rule, Tree algorithm and the use of linked lists.

Different measurements such as Reference Signal Received Power (RSRP), reference signal received quality (RSRQ), Received Signal Strength Indicator (RSSI), and Signal to Interference plus Noise Ratio (SINR) are used for LTE spectrum evaluation reports. Many critical decisions depend on these measurement values such as in handover decisions [4,5]. Due to degradation in the received signal power from a serving evolved node base station (eNB), a connected user equipment (UE) may need to switch to another eNB, which may happen due to user mobility. The process of a connected UE changing its association from one eNB to another is referred to as Handover (HO), this process is controlled by the eNB [6].

This paper aims at improving the radio resource allocation in Long Term Evolution Scheme, by analysing the behaviour of macro cell to determine the impact on user throughput at the point of handover. A pedestrian speed of 3 km/h was used as test sample, and users' records are kept for future resource allocation where user equipment is a paramount tool.

1.1 LITERATURE REVIEW

There are quite a number of works on the techniques of handover management in LTE. [7] studied the effect of mobility speed on the performance of three handover algorithms in Long Term Evolution (LTE) Networks. In [8], a vertical handover algorithm that anticipates the handover process in an efficient manner using PMIPv6 and IEEE 802.21 Media Independent Handover (MIH) standard was proposed.

The researchers in [9] presented a distributed mobility management solution with handover operations for software data network-enabled mobile networks to handle intra and inter handover procedures with data buffering and forwarding processes between base stations and mobility anchors. In [10], a two novel prediction scheme was developed. The first depends on scanning the quality of all signals among mobile station and all nearby stations in the surrounding area, while the second one is based on a multi-criteria prediction decision using both the signal-to-noise ratio SNR value and station's bandwidth.

In [11], a hybrid user mobility prediction approach for handover management in mobile networks was introduced. User mobility patterns were extracted using a mobility model based on statistical models and deep learning algorithms. Vector autoregression (VAR) model and a gated recurrent unit (GRU) were employed to predict the future trajectory of a user. However, these algorithms and models are not yet perfect to pave ways for user mobility pattern in the LTE system [12,13].

[14] discussed the technique for handover decision and the estimation scheme of mobility state to avoid service failure and unnecessary handovers in Heterogeneous Networks. The model uses the handovers' number and residence time to handle the speed of the user equipment. In [15], the use of fuzzy logic to optimize handover management decision in Heterogeneous Network where the fuzzy logic consisting of two inputs adapts handover management decision for both small and macro cells was developed.

In [16], multi-criteria decision-making process was introduced to select the Radio Access Technologies with a threshold approach to perform handover. In [17], context-aware radio access technology was deployed to examines user and network contexts in selecting the appropriate radio access technology for a service using two various scenarios through a smart city environment. However, the algorithms employed by the aforementioned papers were found to be inefficient in estimating optimal value for when handover decision should be taken. This may lead to frequent increase in handover which adversely affects network performance.

In [18], the authors proposed a mobility prediction model with the aim of reducing handover-related costs. In [19], the proposed Markov-based model predicts both user's path and destination. In [20], a mobility model was introduced to predict the next base station in an LTE network while [21] presented a mobility-aware proactive multi-cast technique to estimate user's next cells and staying durations. However, Markov models have been proven not to be able handle radical changes in user mobility pattern and when hidden states increase [22].

A single metric namely received signal strength (RSS) based conventional vertical handover scheme has been discussed [23]. This scheme compared the received signal strength of neighboring cells before handover is executed. If the RSS of the serving cell is lower or RSS of the target cell is higher than the predefined RSS threshold, handover decision is taken. The scheme is improved by adopting RSS threshold, bandwidth and signal to noise ratio were taken from target cell [24, 25] allowed handover decision to be taken based on SINR value of target cells instead of RSS value. However, this method could not provide for seamless connectivity of the mobile users because of the single handover metric and this can lead to increase in the probability of the handover ping-pong effect because of the higher number of unnecessary handovers of the users. Also, the authors didn't focus on load of the target cell signal interference from neighboring cells.

2.0 MATERRIALS AND METHODS

The scheme takes cognizance of the RSRP, RSRQ and SNR measurement at the serving and intended targeted cell. The cell with the best RSRP or RSRQ value is labelled the target cell and the scheme stores the UE unique identity. This is done in order to manage the frequency measurement process for UE with regular mobility pattern, meaning it does not necessarily have to do the cell selection process whenever it is in that zone. This in turn saves UE battery usage (the greater the measurement report, the higher the battery consumption).

The reporting condition can be event triggered or periodic. For event based triggers, there are some events from which one can choose the desired condition of HO Triggering. These events are listed in Table 1.

Table 1: Handover Triggering Events

Event	Triggering Condition
A1	Serving eNodeB power is greater than threshold
A2	Serving eNodeB power is lower than threshold
A3	Target eNodeB power is greater than serving one by certain threshold
A4	Target eNodeB power is greater than threshold
A5	Serving eNodeB power is less than threshold 1 and target eNodeB power is greater than threshold 2

(Source: [26])

For this work, A3 triggering event was selected using X2 interface. The UE makes periodic measurements of RSRP based on the signal received from the serving cell and from the strongest adjacent cells. Handover is triggered when the RSRP value from any neighboring cell is higher than the one from the serving cell by a number of dBs equal to HO hysteresis.

A MIMO antenna and mobility speed of Pedestrian, Vichular_1, Vichular_2 (slow, fast and faster) were considered in this work. The scheme tends to measure and compute the difference in the RSRP value of serving cell, the target cell as well as the RSRQ and evaluate the relationship of both to user equipment battery consumption, store UE international mobile equipment identity (IMEI) for feature use.

The obtained values of both RSRP and RSRQ are also stored. This is to reduce the UE battery consumption; the greater the frequency of measurement performed by the UE the greater the consumption of battery. So for a device that has visited a tracking area in most recent time, the scheme suggests the last best useable cell be assigned to the device the next time it visits the same tracking area. The use of power budget (PBGT) and integrated algorithm was explored in this work. Power budget takes handover decision and integrated algorithm to compare the differences at the source and target cells. The UE Log database gets information about the UE IMEI from the MME, and also store information about the cell that best serve the UE from the comparison module. The comparison module compute RSRP and RSRQ value of the serving and target cell, compute the filtered differences and assign the best to the UE (see figure 1).

The transmission of the field strength or the power output in the cells areas are measured statistically for future use. During transmission, the comparison module takes the average number of transmission at every initiation, using the system metric equation. User equipment with the help of the eNBs determines the cell to monitor or move to by evaluating signal quality obtained from RSRP, SINR, RSSI and RSQR measurements. Other broadband systems use relatively similar metrics for that purpose. A resource block containing 84 resource elements, four (4) of which is dedicated to reference signal located in the 1st and 4th coordinate of the grid.

Reference Signal Received Power (RSRP): This is the average power received from a single reference signal (RS) in a resource element (RE) within the considered frequency bandwidth excluding all noise and interference from co-channel [26]. Knowledge of absolute RSRP enables the mobile to calculate downlink path loss. Equation (1) shows how RSRP is computed while equation (2) gives the formula to compute the path loss (PL).

$$\text{RSRP} = \frac{1}{4}\sum_{i}^{n} M_i \quad (1)$$

where:
M = resource element (RE)
i = 1,2,3….n

The UE is able to determine the linear Path Loss value by measuring the ratio of transmited power to the ratio of received power (See equation 2)

$$PL = \frac{Pt}{Pr} \quad (2)$$

where:
Pt = transmit power
Pr = receive power

Received Signal Strength Indicator (RSSI): Is the total power observed by the UE across the whole band, this includes the main signal and co-channel non-serving cell signal, adjacent channel interference and even the thermal noise within the specified band [4].

Signal to Interference and noise ratio (SINR): Is a measure of signal quality which specifies the relationship between Radio Frequency conditions and throughput as shown in equation (3):

$$\text{SINR} = \frac{S}{(I+N)} \tag{3}$$

where:
S = Signal power
I = Average interference
N = Thermal noise

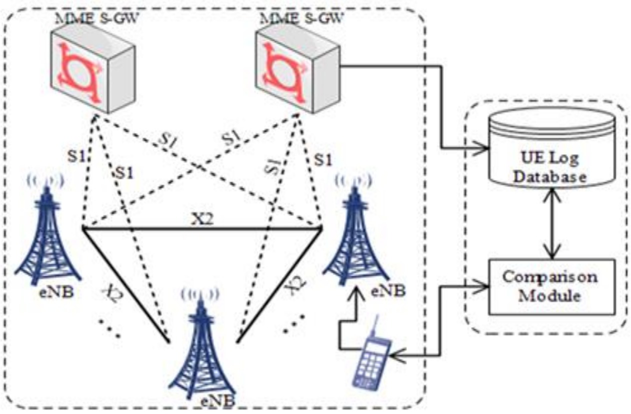

Figure 1: Fixed Mobility X2 Handover Architecture of the Proposed Model

Legend:
MME: Mobility Management Entity
eNB: Evolved Node base station
S-GW: Serving Gateway

Reference Signal Received Quality (RSRQ): Measures overall signal received in OFDM symbol as shown in equations (4) and (5).

$$\text{RSRQ} = \frac{RSRP}{RSSI/\text{NRB}} \tag{4}$$

where:
N is the number of resource block

$$\Delta(C_A - C_B)t = [(RSRP)_{CA} - (RSRP)_{CB}]t \tag{5}$$

where:
Δ = change in serving cell A and target cell B
Cell A = C_A, Cell B = C_B and t = time
$[(RSRP)_{CA}$ and $(RSRP)_{CB}]t$ represent the RSRP received from the target cell and serving cell at time t, respectively.

$\Delta\,(C_A - C_B)t$ is the RSRP difference of a user at serving cell C_A at time t.

Once the filtered difference has been computed, the handover decision is made if equation (6) is satisfied:

$$F\,(C_A - C_B)t > F\,\Delta Threshold \tag{6}$$

$F\,\Delta Threshold$ is a constant value equivalent to handover margin (HOM). If the filtered RSRP difference between any of target cell and serving cell is greater than this threshold, the handover decision is triggered immediately [27].

Since RSSI does not depend on the measured cell as it is simply the total received signal power. Thus, the ratios of RSRQs only depend on the ratio of the RSRPs. In contrast, ratio of RSRQs may be used to trigger inter – frequency handover where it can be used to direct UEs to a less loaded layer.

Time-to-Trigger: The time to trigger values for LTE networks are specified by 3GPP which are, (0, 0.04, 0.064, 0.08, 0.1, 0.128, 0.16, 0.256, 0.32, 0.48, 0.512, 0.64, 1.024, 1.280, 2.560, 5.120) in (s).

Handover margin is between the range of 0 and 10 dB (3GPP). The flow monitor output is analysed using equations (7)- (11) as used by [28].

These show the latency, throughput and packet loss accordingly.

$$\text{Mean delay: delay} = \frac{\text{delay sum}}{\text{rxPackets}} \tag{7}$$

$$\text{Mean jitter: jitter} = \frac{\text{jitter sum}}{\text{rxPackets} - 1} \tag{8}$$

Mean transmitted packet size (byte):

$$Stx = \frac{txBytes}{txPackets} \tag{9}$$

Mean received packets size (byte):

$$Srx = \frac{rxBytes}{rxPackets} \tag{10}$$

$$\text{Packet loss ratio: q} = \frac{\text{lostPackets}}{\text{rxPackets+lostPackets}} \tag{11}$$

The process of selecting a serving cell by user equipment in terms of available resources; the UE informs the serving eNB if there is need for handover to occur, that is, the need for the user equipment to camp on another cell with better RSRP value. The UE periodically listens to broadcast of the neighbouring cell, with the help of its serving cell, to measure the signal strength of other cells around. Once it finds a cell with better strength than its current cell, it sends a measurement report to its serving cell to confirm the intended targeted cell has the required resources for the UE to function and then initiate a handover process.

The UE detaches from the previous cell once all its packets have been forwarded. This is done with the help of the serving gateway which serves as a mobility anchor between the serving and target cell. Algorithm 1 determines the best signal strength useful for the users at the serving and target cell while algorithm 2 keeps details of UE IMEI that have successfully been handed over to a cell with the best RSRP on the network.

NS3 simulation software was used to set up a realistic multi-cell LTE network to study the effect of mobility speed on the performance of macro cell using power based handover algorithms in Long Term Evolution (LTE) Network. Mobility models were used to vary the location of the user equipment, hence triggering handover events across the network. LTE has LENA module within the simulator which provides X2-handover measures based on the measurement performed by UE. The UE moves between eNodes, while the RSRP and RSRQ is measured and sent back to the serving eNodeB.

These measurement reports lead to handover request whenever the measurement report of a neighbour eNodeB is considered better than the current serving eNodeB. The inter-site distance between UE, serving eNodeB and neighbour eNodeB are 50, 150, 300, 500, 800 and 1000m respectively and the duration of simulation is about 100 second. The flow monitor is also taken care of during simulation to check throughput and packet loss.

Algorithm 1: Handover Algorithm

Let UE = User Equipment, MME = Mobile Mobility Entity M*i* = estimated received power,

i= lower bound, n = upper bound, RSRPs = Reference Signal Receive Power of Serving cell,
RSRPt = Reference Signal Receive Power of target cell, RSRPval = Δ in RSRPs and RSRPt;

Input: UE, MME,*i*, n, M*i*,
Output: RSRPs, RSRPt, RSRPval;

1. Reg UE, MME;
2. Measurement set:
   Set
   $\text{RSRP} = \frac{1}{4}\sum_{i}^{n} M_i$
   $\text{RSRQ} = \text{N x } \frac{RSRP}{\text{RSSI}}$;
3. UE gives measurement report
4. Measurement update expired
5. Compute RSRPs;
6. Compute RSRPt;
7. If RSRPt > RSRPs
8. Set RSRPt = RSRPval;
   else
9. Go to 2;
10. Set RSRPs = RSRPval;
11. Set SINR =$[S\ /\ (I + N)]$;
12. Compute SINR;
13. Return RSRPs, RSRPt, RSRQt, RSRPval, SINR;

Algorithm 2: UE IMEI Identifier Algorithm

Let UE = User equipment, MR = Module Recognizer, IMEI = International Mobile Equipment Identifier, Registered UE = RU;
Input: UE, IMEI;
Output: registered UE;

1. **While** (true): Data ← Incoming Connection Listener();
2. If(empty (data)) continue;
3. UE ← Retrieve Connection details (data);
4. Pre-process (UE);
5. MR ← Get Module Recognizer (UE);
6. If (is True (MR));
7. UE → resources ← Auto Assigned Radio Resources (UE);
8. **end while**;
9. **return** ru;

The simulation parameters used is as shown in table 2. The performance metrics used are Battery consumption, Handover time, flow monitor, SINR and RSRP, where the values were varied in order to see the improved quality of service. For the simulation, sectors of macro-cell were created. Since macro-cells have sectored radio output, the parabolic antennas were used for radio transmission. This gives almost 110-115 degrees radio signal dispersion. There are three important aspects in creating any e-nodeB in a simulator:

i. Assign a realistic propagation model to the cell.
ii. The inter-cell interference should be accounted for.
iii. Fading and shadowing effect must be considered and imitated by software models.

Currently LTE-Sim supports two algorithms namely:

i. Position-based (If $d2 > d1$, then choose eNB2 to be the new serving eNB)
ii. Power-based (If $RSRP2 > RSRP1$, choose eNB2 to be the new serving eNB) [29].

Table 2: Handover Simulation Parameters

S/N	Parameter	Value
1	ISD (m)	50, 150, 300, 500, 800, 1000
2	eNodeB Tx power (dBm)	43.01
3	eNodeB Noise Figure (dB)	5
4	UE Tx power (dBm)	23
5	UE Noise Figure (dB)	6
6	UE Antenna Height (m)	1.5
7	UE Speed (kmph)	3, 20, 60
8	UE mobility	Straight line at constant speed
9	Thermal Noise (dBm/Hz)	-107
10	Frequency Band (MHz)	1800
11	Downlink Freq. (MHz)	2640
12	Uplink Freq. (MHz)	2540
13	DL EARFCN	1876
14	UL EARFCN	19876
15	System Bandwidth (MHz)	20
16	Antenna Mode	MIMO
17	Antenna pattern	Sectorized
18	Antenna Gain (dBi)	0
19	Duplexing Mode	FDD
20	Tx Time Interval (ms)	1
21	Path Loss Model	-142
22	Serving cell Threshold	-142
23	Neighbor cell offset (dB)	4
24	Hysteresis (dB)	1
25	Time-to-Trigger (ms)	320
26	HO Triggering event	A3 event

3.0 RESULTS AND DISCUSSION

As shown in figure 2, X2- handover is done in three modes. The first mode is handover preparation, the second is handover execution and the last is handover completion. The simulation velocity was increased as follows: 50, 150, 300, 500, 800 and 1000 (m) while the speed of the UE was at 3, 20 and 60 Km/h. There are eleven nodes in all; node 0 is the Serving Gateway/Packet Data Network Gateway, node 1 is the remote host, node 2 is the serving eNodeB, node 3 is the target eNodeB, nodes 5 represent the UE while nodes 6- 11 represent other nodes on the network.

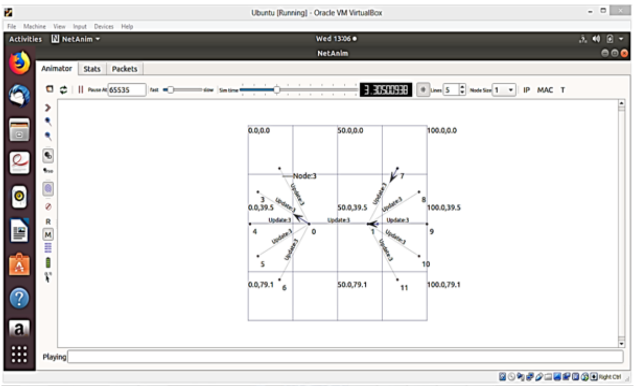

Figure 2: Handover illustration with NetAnim

An important aspect of macro-cell creation is the transmission power, which plays a major role in coverage and directivity. There are three important factors that need to be taken into consideration when configuring the transmitter power: a. Coverage b. Signal Directivity c. UE battery drainage.

Inter-site distance determines the interference and coverage areas of a particular radio environment. As the inter-site distance becomes very large handover would be impossible because the UE would experience a radio drop in blind radio coverage before re-connection. The bandwidth of the UE is 25 which specify the number of Resource Blocks. The area margin factor determines how much the coverage extends outside the designated enode-b area.

Table 3 shows the handover time for both micro and fixed mobility pattern (macro cell) scenarios, having satisfied the handover condition. The result shows the impact of Inter Site Distance (ISD) on the achievable spectral efficiencies and data rates at the point of handover as shown in figures 3 - 5.

The RSRP values at 50, 150 and 300 for FMP performed better than that of micro cell, while micro cell at 500, 800 and 1000 (m) were slightly higher. As shown in Table 4, SINR of FMP is lower than that of microcell; this reduces overlapping and Ping-Pong effect in FMP. The interference and noise experience by micro cell tends to be more compare to FMP as cell are densely located to each other. This poses a challenge of high frequency of handover, increased signalling and high measurement overhead as control signals are from spatially close small cells.

Table 5 shows the result of the flow monitor, showing the transmitted and received data and the packet loss accordingly. The result shows that FMP has a packet loss of 1 at ISD 150 and 500 respectively. This implies that the packet loss ratio of FMP is 0.0001 which is still reasonable in as much as we are able to reduce the overhead signalling and battery consumption level. As shown in figure 3, the difference in the data rate of microcell and FMP is relatively small, although microcell has a higher data rate. Therefore, the areas where users can transmit and receive at higher data rate are larger in small cells than macro cell. On the other hand, micro cell consumes more of UE battery life and generate more signal overhead.

Figure 4 shows the comparison of macro and micro cells in terms of handover time. Both FMP and micro cell have a slight difference in handover time. FMP shows higher values at 50, 150 and 300 ISD. The handover time for micro cell is observed to reduce with respect to distance as cells are closely located which resulted in the increase of handover frequency. This in turn increases the number of service interruption as each handover occurrence bring about a certain level of service interruption and the possibility of Ping-Pong effect cannot be overemphasis.

Table 3: RSRP *(dBm)* at Handover for micro cell and Fixed Mobility Pattern macro cell

ISD *(m)*	**Micro cell**		**FMP macro cell**	
	Serving cell	***Target cell***	***Serving cell***	***Target cell***
50	-73.97	-73.83	-71.62	-71.36
150	-85.39	-85.13	-83.93	-83.77
300	-93.48	-93.25	-93.52	-93.14
500	-95.32	-95.11	-96.81	-96.68
800	-99.21	-99.03	-100.63	-100.51
1000	-101.68	-101.47	-103.27	-103.24

Table 4: SINR at Handover for micro cell and Fixed Mobility Pattern macro cell

ISD *(m)*	**Micro cell**		**FMP macro cell**	
	Serving cell	***Target cell***	***Serving cell***	***Target cell***
50	8353750	8836530	7532191	7946820
150	3844440	4014373	2749315	3596200
300	1182600	1256910	1097534	1158329
500	720105	742961	556841	566974
800	341616	384516	247150	252683
1000	215437	252336	140483	142320

Table 5: Packets Transmitted vs Loss Packets for Macro Cell

ISD (m)	**Tx Bytes**	**Rx Bytes**	**Tx Packets**	**Rx Packets**	**Loss Packets**
50	10514740	10514740	9995	9995	0
150	10514740	10513688	9995	9994	1
300	10514740	10514740	9995	9995	0
500	10514740	10513688	9995	9994	1
800	369	369	2	2	0
1000	189	189	2	2	0

Table 6: Handover Time for Microcell and Fixed Mobility Pattern Deployment

ISD *(m)*	**FMP macro cell Time *(s)***	**Micro cell Time *(s)***
50	50	51
150	59	55
300	65	61
500	79	71
800	86	78
1000	92	88

In figure 5, micro cell is observed to have a high spectral efficiency which is good for the network. This is as a result of decoupling of the signal and control panel but this does leave us with the challenge of high frequency of handover which could also bring about ping pong effect and high number of service interruption. This also brings about high signalling overhead.

By LTE power model, FMP uses a minimal percentage of battery life compared to micro cell. This is due to increase in the number of measurement report which will have effect on the DRX state, as microcell has the possibility of being active most time to allow for paging and resource allocation. While FMP is likely to activate the RRC_IDLE most time as cells are not closely located.

Table 6 shows the handover time for both micro cell and FMP, giving the time the serving cell executes handover to the target cell. The result shows the effect of ISD on spectral efficiency and data rate at handover as described in figure 6. At handover, RSRP value of the serving cell at each ISD is lower than that of the target cell which justifies the need for handover. The RSRP value of the macro cell was observed to outperform the micro cell deployment at 50, 150 and 300 (m), while there was a slight difference at 500, 800 and 1000 (m) respectively. The handover time for microcells were significantly shorter than those of FMP scenarios, which implies an increase in the number of handover in small cells and poses a problem of increase in the number of interruption experience by the user equipment.

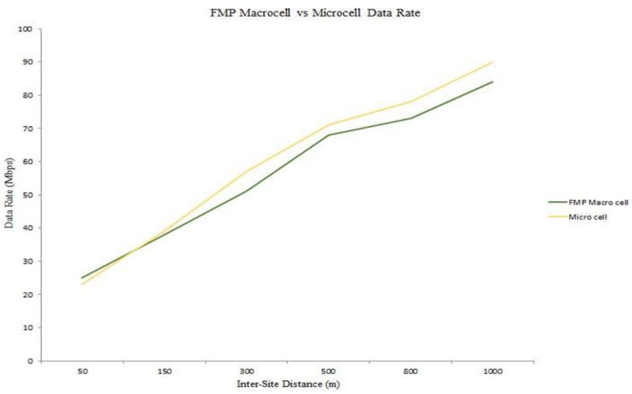

Figure 3: Data rate for FMP and Microcell

Micro cell tends to use up more battery life of user equipment compare to FMP as the number of measurement is on the increase and hardly get into DRX_IDLE mode. The difference in performance between the serving and target cells at the point of handover were higher in micro cell than that of FMP. It shows that the FMP cells are more stable in handling control signals than micro cells. The handover condition in micro cell is achieved much faster, thus leading to an increase in the frequency of handover.

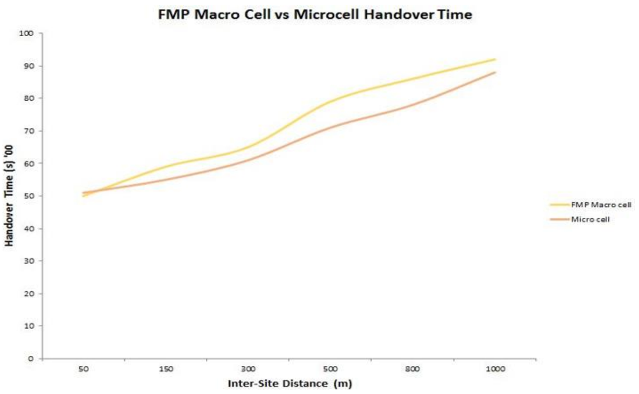

Figure 4: Handover time for FMP and Microcell

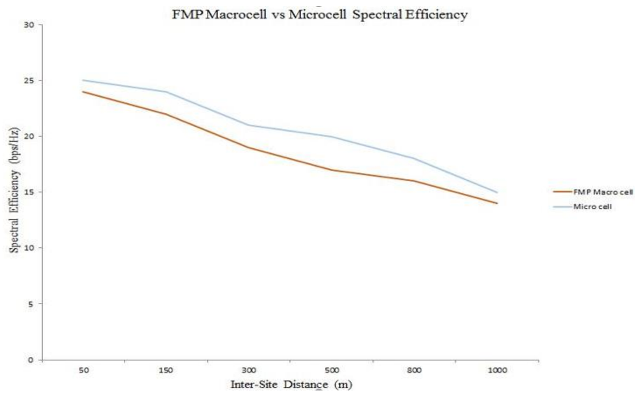

Figure 5: Spectral Efficiency for FMP and Microcell

The required handover time for macro cells is more than that of small cells at different ISD for FMP cell and micro cell respectively. Very short handover time will lead to increased number of handover and significantly high measurements overheads, thereby leading to poor spectrum management. This is not too appropriate for this generation mobile network.

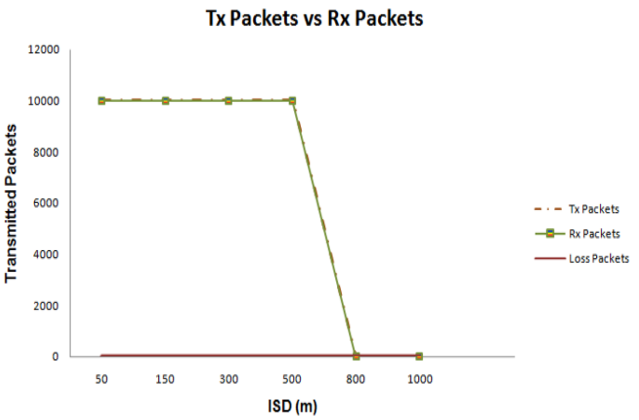

Figure 6: System Throughput

The scenario considered for this research work is a Multiple-Input Multiple-Out (MIMO) system which did not put into consideration the impact of interference from a SISO system all of which can have impact on the result obtained.

4.0 CONCLUSION

Fixed mobility pattern (FMP) has the potential to conserve user equipment battery life as the number of measurement report is on the minimal. This in turn reduce the battery life level consumption and improve quality of service since the number of interruption is reduced and also the DRX is more in an RRC_IDLE state. The simulation result shows that the FMP has reduced the number of handovers, signaling measurements number, packet delay ratio, and packet loss ratio. The handover time is longer, thus it reduces signalling and high measurement overheads that would be incurred if the control signals are from densely close small cells. FMP leverages on the RCC_IDLE state as the UE with lower packet arrival rate, can effectively save more power when entering RRC IDLE state, and there is a trade-off between the power consumption and the transmission delay.

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