Journal of Engineering and Applied Sciences 13 (16): 6883-6893, 2018
ISSN: 1816-949X

Optimal Deployment of Locations and Height Antenna for Relays on Macro Cell Environments for LTE-Advanced

Abduljalil Saif, Mahamod Ismail, Rosdiadee Nordin, Mohammed Fadhil and Nor Fadhilah Abdullah
Department of Electrical, Electronic and System Engineering,
Universiti Kebangsaan Malaysia (UKM), Bangi, Selangor, Malaysia

Abstract: Relay stations play an important role in throughput increase data rate and extending coverage for LTE-advanced. One solution to throughput increase data rate and extend the coverage is to use the fixed relays to transmit data between the eNB and UE through multi hop communication. In this study, we propose new study focusing on the optimal deployments different locations and height of antenna relays by analyzing various scenario consisting up to 10 relays using two cooperative relaying strategies AAF and DAF. The data is send over from eNB to UE using multi-hop communication over WINNER channel model in urban microcells of LTE-advanced networks environment. The optimal deployment is determined by evaluating the number of relays and their locations and height of antenna relay at targeted SER or SNR. Simulation results show that relay effectively boost the link performance in comparison with direct connection and also, AAF outperformed DAF. Moreover, the optimal deployment achieved using 2• 4 relays with relays located in the close from eNB, also, 4• 6 relays when relays located around the cel edge and 8• 10 relays when relays located in the cell edge to extend coverage, also, significant SNR gains by increase height antenna relays.

Key words: Relay deployment, height antenna, WINNER, OFDM, LTE-advanced, Malaysia

INTRODUCTION

One of the part of the (LTE-A) Long Term Evolution-Advanced recently (Kong *et al*., 2017). It is integral to have more attraction for the improvement of user data rates and extended coveragem, so, the improved spectrum efficiency can be achieved and increase data traffic demand can be met and moreover the improved service emergency can be modelled and the relay stations can be deployed (Abdalwahid, 2015). Network coverage issues can be arise because of the high level of diminution of the linkage of user terminal and the macro-cell. Due to this the increment in the density of current urban macro cell network with relay station having low power, there is expectation for enhancing the performance with lower cost in comparison of the big amount need to be invested for the deployment of latest macro site or acquire a low level frequency spectrum. Furthermore, due the cost limitations and non-feasibility of wired fibre access it is difficult to deploy small cell backhaul (Rodriguez *et al*., 2012). Even though, the wired backhauling provides an advantage of more capacity and sharing in the usage of radio resources, relay wireless backhauling which use LTE spectrum has a competitive advantage (Yuan, 2013). For reducing the overall path loss from UE to the eNB there is a two stage process of deployment relay stations. So, as to reduce the distance of evolved node B and user equipment. However when we consider the pass loss, it is linked with 3 kind of radio links which can be listed as direct link, relay link and access link which can be understand as (eNB-UE), (eNB-RS) and (RS-UE), respectively (Bulakci *et al*., 2011) (Fig. 1).

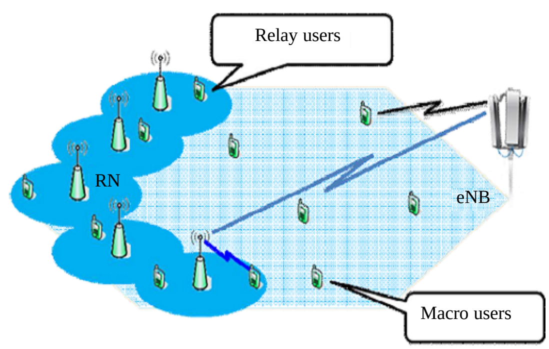

Fig. 1: Transmission links for relays at cell edge on urban macro cell network

Relay station deployment at the edge cell. Deploying relay station at edge cell. Relay users and macro users are served by RSs and eNB, respectively and the deployment

Corresponding Author: Abduljalil Saif, Department of Electrical, Electronic and System Engineering, Universiti Kebangsaan Malaysia (UKM), Bangi Selangor, Malaysia

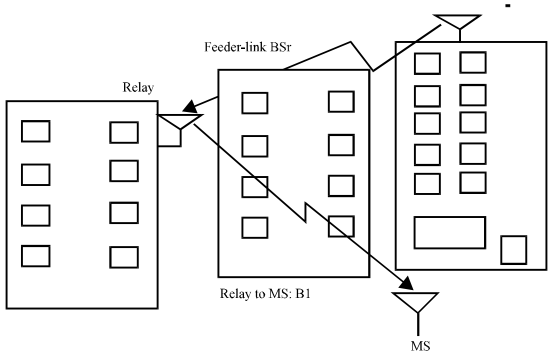

Fig. 2: Propagation in urban macro relaying scenario

which is proposed to cover the extended area which is the point the cell users and RSs connect, it this situation the RSs gets less path loss and benefits high resources. Nevertheless when this is the occurrence of propagation the position would be the roof-top through the street light pole. Figure 2, however, for the typical relay link there is the limitation of accuracy in statistical models. Moreover, there are some troubles relevant to the model building of the relay link which are mentioned by the users while they were using it or they are assumed regarding a planned station, its position and the factors related to its directions. To plan the relay site is a crucially important for boosting the performance and does not act as bottleneck for the link transmission. Due to the issue more empirical data is needed, so as to extrapolate and suggest an accurate model regarding the site planning.

The current research has a focus on performance of Relay link-based for measuring experimentation which was set in a real urban macro scenario. For this purpose a full fledge 4G Network was utilized and the objective is to demonstrate the deployment of sensitive relay in relation to the antenna height and relay type and to measure the average performance for several possible relay location. The different (Chu *et al*., 2011) from the outcome calculated by measurement with inclusion of both the receipt of strong signal as well as the Signal to Noise Ratio (SNR) which actually explains the impact of interference of the adjoining locations on the performance of the relay link. Then, the estimation of achievable data rates is done by using the measured valued of SNR over the multi-step transmission in consideration of different relay locations. We used 10 Relay Stations (RS) deployed in different locations from the Evolved Node B (eNB) and different environment of relays. Also, to analyse the effect of the height antenna relay in different heights, we used two protocol relays to Amplify And Forward (AAF) and Decode And Forward (DAF) and analysis for all the scenarios above under urban micro cell of Long-Term Evolution Advanced (LTE-A). The contribution of this study are to radio range extension, combat shadowing at high radio frequencies, reduce infrastructure deployment costs and admit rapid deployment, enhance capacity in cellular networks, higher bandwidth due to shorter hops and the relay-UE links can use unlicensed spectrum than the BS-UE links that should be licensed spectrum. As the main idea of this study was to explore the optimal relay deployment by analyzing various scenario consisting up to 10 relays using two cooperative relaying strategies AAF and DAF with using WINNER II channel in urban macro cell scenario in support for the LTE-advanced. The simulation results showed the optimal performance when deployed <6 relays if relays close from eNB, <8 relays if relays close from the cell edge and <10 relays if deployment relays in the cell edge. It is also, clearly noted that AAF is better than DAF at all different location of relay. The analysis shows optimal performance when increasing the antenna height relay. The more gain is achieved of different antenna height relay (5, 10, 15, 20, 25 m) sequentially of different locations relays actually results in the SNR vs BER curve. So, we employing AAF & DAF with different places, different antenna heights and different numbers of relay using WINNER channel model which consider as realty reference for channel model in urban macro cell environment. Alsol, increase signal to noise ratio by deploying relay nodes through 7 scenarios, one scenario without relay and others with one or more relays, Apply error correction technique, the convolutional code with Viterbi algorithm to eliminate noise effect or reduce symbol error rate. Optimal deployment relay by evaluating the number of relays and their locations by analysing the Symbol Error Rate (SER) for a certain range of Signal to Noise Ratio (SNR). For the simplicity of the simulation environment, a number of maximum ten relays nodes have been considered in this model.

MATERIALS AND METHODS

Relay deployment in LTE-advanced: After the modern technology regarding the wireless communication has become mature and there is an increase in the demand the more widespread coverage, the requirement of high data rate and throughput relay has been familiar among the users for the activities prior to standardization such as IEEE 802.16j standard is T-WINNER project which specifies relaying for the mobile WiMAX (802.16e) systems and LTE-advanced as a technology. The investigation capacity of relay is the main factor that can enhance the coverage and more flexible deployment options are available is cheap cost. In the recent past the

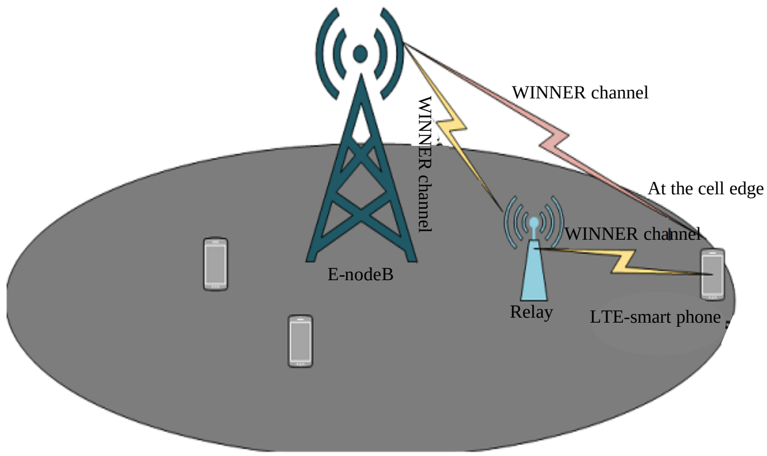

Fig. 3: Cooperative relaying

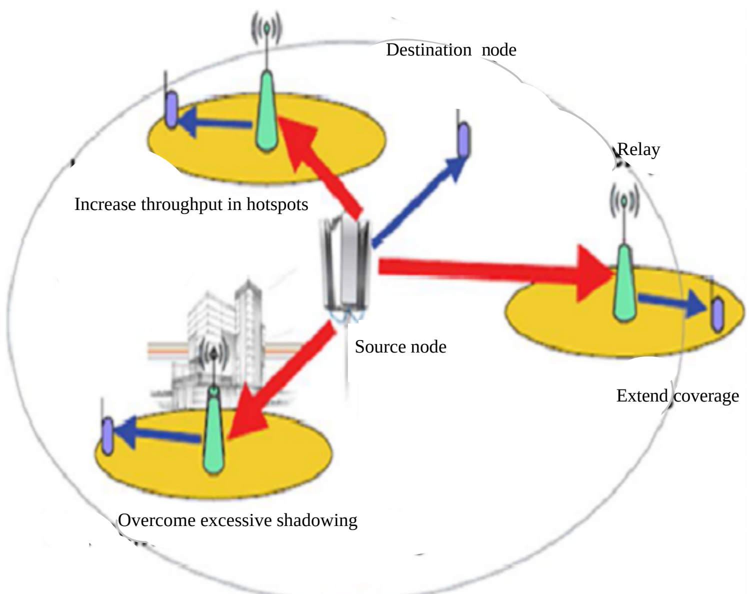

Fig. 4: Benefits of the multi-hop relaying

relay got acceptance to specify in-band relays which the type 1 of relays which is related to the scenario of coverage improvements. Accordingly, the RSs are sent at the cell edge to give scope. Two-bounce RS organization is delineated in Fig. 3. Note that since, in-band eNB to RSs are considered hand-off connection works in an indistinguishable transporter recurrence from the RS to UE is an entrance interface.

Cover and El Gamal planned limit hypotheses for a basic transfer channel. Numerous info various yield (MIMO) for transfer systems are considered and limit with regards to hand-off MIMO channels are contemplated. The transfer can be acknowledged either in a helpful or multi-jump of hand-off. The agreeable utilization of transfers makes virtual transmit decent variety and adventures the spatial division bringing about significant increment in the accessible limit (Abdallah *et al*., 2015).

Figure 3 illustrates a simple scenario where a message is transmitted by a source node to the destination node both through a cooperative relay and directly. The destination node then combines the signals received from the relay and the source node and can exploit the diversity gain. Also, multi-hop relaying the source node communicates with the destination node either directly or via. a relay as it can't receive both at the same time. In Fig. 4, the most typical benefits of the multi-hop relay is shown by Teyeb *et al*. (2009).

Winner channel models of LTE-advanced: IMT-advanced channel model is geometry based stochastic channel demonstrate. It was proposed for the assessments for radio interface advances. The structure of the essential module depends on WINNER II channel display. It is described by the transmission capacity of 100 MHz with focus recurrence in the vicinity of 2 and 6 GHz. Victor channel demonstrate is a geometry based stochastic model (Auer *et al*., 2007). Geometry based displaying of the radio channel empowers partition of spread parameters and reception apparatuses. The channel parameters for singular previews are resolved stochastically in light of factual circulations separated from channel estimation. Radio wire geometries and field examples can be characterized appropriately by the client of the model. Channel acknowledge are produced with geometrical guideline by summing commitments of beams (plane waves) with particular little scale parameters like postponement, power, AoA and AoD. Superposition results to relationship between's recieving wire components and fleeting blurring with geometry subordinate doppler range. Transfer matrix of the channel is:

$$H(t,\tau) = \sum_{m=1}^{m} H_m(t,\tau) \quad (1)$$

It is composed of antenna array response matrices f_{tx} for the transmitter, f_{rx} for the receiver and the propagation channel response matrix H_m for cluster m as follows:

$$H_{u,s,m}(t,\tau) = \iint F_{rx}(\varphi) h_m(t,\tau,\phi,\varphi) F_{tx}^{T}(\phi) d_{\phi} d. \quad (2)$$

The channel from T_x antenna element s to R_x element u for cluster n is as follows (Gawande and Ladhake, 2013):

$$Hu, s, m(t,\tau)(t,\tau) = \sum_{m=1}^{m} \begin{bmatrix} F_{rx,u,V}(\varphi_{m.n}) \\ F_{rx,u,H}(\varphi_{m.n}) \end{bmatrix}^{T} \begin{bmatrix} \alpha_{m,n,VV} & \alpha_{m,n,VH} \\ \alpha_{m,n,HV} & \alpha_{m,n,HH} \end{bmatrix} \begin{bmatrix} F_{tx,S,V}(\varnothing_{m.n}) \\ F_{tx,S,H}(\varnothing_{m.n}) \end{bmatrix} \times e^{\left(j2\pi\lambda_0^{-1}\left(\overline{\phi_{m,n}}\cdot\overline{r_{tx,u}}\right)\right)} e^{\left(j2\pi\lambda_0^{-1}\left(\overline{\phi_{m,n}}\cdot\overline{r_{tx,u}}\right)\right)} \times e^{j2\pi v_{m,n}t} \delta(\tau-\tau_{m,n}) \quad (3)$$

where $F_{rx,u,V}$ and $F_{rx,u,H}$ are the radio wire component u field designs for vertical and level polarizations respectively. • m, n, VV and • m, n, V H are the mind boggling additions of vertical-to-vertical and even to-vertical polarizations of beam m, n individually, $\bullet_0$ is the wave length of bearer recurrence, • m, n is AoD unit vector, • m, n is AoA unit vector, r rx, uand r rx, s are the area vectors of component u and s separately, v m, n is the Doppler recurrence part of beam m, n. In the event that, the radio channel is displayed as unique, all the previously mentioned little scale parameters are time variation t.

In OFDM framework plan, various parameters are utilized for example, subcarrier, protect time, image term, subcarrier dispersing, tweak write and blunder revising code. The selection of parameters relies upon bit rate, data transmission and deferral. FFT/IFFT which tweaks a square of info esteems onto various subcarriers. In the recipient, subcarriers are demodulated by FFT which perform switch operation of IFFT. The presentation of a Cyclic Prefix (CP) and a Cyclic Prefix evacuate (CPR) can likewise embed zero cushioning as a Guard Interval to decrease obstruction between the images. Additionally, the coding and interleaving and some progressive subcarriers in the OFDM framework may experience the ill effects of profound blurring in which the got SNR is beneath the required SNR level. There are two kinds of interleaving: piece interleaving and convolution interleaving. Bit-wise information image astute or OFDM image savvy interleaving can be utilized for square interleaving. Interleaving compose and measure must be dictated by the kind of FEC code, level of recurrence, time blurring and delay because of interleaving. Simple to Advanced Converter (ADC) computerized to simple converter (DAC) and radio recurrence (RF) are appeared by Gawande and Ladhake (2013). The signal received by relay station is given by:

$$y_{R,m} = \sum_{n=1}^{N} h_{RM,n} x_{BS,n} + n_{R,m} = h_{RM} x_{BS} + n_{R,m}$$

$$h_{RM} = \left[h_{RM,1m} h_{RM,3m,\cdots,h_{RM},Nm} \right]$$

where is the 1×NRM channel vector (where $h_{RM,Nm}$ corresponds to the complex-valued, channel gain between the nth eNB and the RS which takes into account path loss):

$$X_{BS} = \left[X_{BS,1} X_{BS,1} X_{BS,1}, \cdots, X_{BS,N} \right]$$

I is the N×1 vector of the transmitted signal ($X_{BS,n}$ is the signal transmitted by the nth eNB) and nRM, I is the additive white Gaussian noise observed at RS. The power of this noise term is • $\{|n_{RM,n}|^2\}$ = $\bullet^2_{RM,n}$. The signal received at the kth UE is a superposition of all the signals transmitted by eNBs and the RS which is given by:

$$y_{UE,k} = \sum_{n=1}^{N} h_{DL,nk} x_{BS,n} + h_{AL,mk} G y_{RN,m} + n_{UE,k}$$

$$y_{UE,k} = \sum_{n=1}^{N} \left(h_{DL,nk} + G h_{AL,mk} h_{RL,nm} \right) X_n + \left(G h_{AL,mk} n_{RN,m} + n_{UE,k} \right) k = 1, 2, \ldots, K$$

where, $h_{AL, mk}$ corresponds to the complex-valued, channel gain (which includes path loss, shadowing and rayleigh fading) between the RS and the kth UE, $n_{UE, k}$ is the additive white Gaussian noise with power equals to • $\{|n_{UE, k}|^2\}$ = • $^2_{UE, k}$. And Gis the amplification gain of RS which is defined as:

$$G = \sqrt{\frac{P_{RN,m}}{\sum_{n=1}^{N} p_{BS,n} |h_{RL,nm}|^2 + \sigma_{RN}^2}} > 1$$

$$P_{RN,m} = \varepsilon\{|Gy_{RN,m}|^2\} \text{and} P_{BS,n} = \varepsilon\{|X_{BS,n}|^2\}$$

In Eq. 3 are the transmit power of the RS and the nth eNB, respectively. Equation 2 can be expressed as:

$$y_{UE,k} = (h_{DL,k} + Gh_{AL,mk} h_{RM}) X_{BS} + \tilde{n}$$

where X_{BS} is similar to the transmitted signal vector of Eq. 1 is the RM channel vector as in Eq. 1 h_{RM}:

$$h_{DL,k} = [h_{DL,1k} h_{DL,2k} h_{DL,3k}, ..., h_{DL,Nk}]$$

Is the 1 ×N DL channel vector ($h_{DL, Nk}$ corresponds to the complex-valued, channel gain which includes path loss, shadowing and rayleigh fading) between the nth eNB and the kth UE and:

$$\tilde{n} = Gh_{AL,mk} n_{RN,m} + n_{UE,k}$$

Is effective noise term. The power of the effective noise term is:

$$\varepsilon\{|\tilde{n}|^2\} = |G|^2 |\sigma_{RN,m}^2|^2 + \sigma_{UE,k}^2$$

For K UEs, we can represent the network MIMO channels in the downlink by a system of linear equations as:

$$\overbrace{\begin{bmatrix} y_{UE,1} \\ y_{UE,2} \\ \vdots \\ y_{UE,k} \end{bmatrix}}^{UE} = \overbrace{\begin{bmatrix} h_{DL,1} + Gh_{AL,m1} h_{RM} \\ h_{DL,2} + Gh_{AL,m2} h_{RM} \\ \vdots \\ h_{DL,k} + Gh_{AL,mk} h_{RM} \end{bmatrix}}^{H} \overbrace{\begin{bmatrix} X_{BS,1} \\ X_{BS,2} \\ \vdots \\ X_{BS,k} \end{bmatrix}}^{BS} + \overbrace{\begin{bmatrix} Gh_{AL,m1} n_{RN,m} + n_{UE,1} \\ Gh_{AL,m2} n_{RN,m} + n_{UE,2} \\ \vdots \\ Gh_{AL,mk} n_{RN,m} + n_{UE,k} \end{bmatrix}}^{\tilde{n}}$$

For multiuser transmission and reception, the transmitted signal vector in Eq. 5 is generated by a weighted linear combination of data symbols contained in a K×1 Vector :

$$d = [d_1 d_2, ..., d_k]^T$$

where d_k is the specific data symbol intended for the kth UE. Thus, the kth UE receives its own symbols as well as the other users symbols (Zetterberg *et al*., 2005; Renzo and Lu, 2015).

Path loss models: The path loss amongst transmitter and collector is portrayed by path loss example which relies upon condition. With the expectation of complimentary space or rustic region its esteem is 2 for rural from 2-3 for urban its esteem is around 4. The higher the way misfortune type is the quicker the flag quality drops with expanding the separation. In some more composite situations for example, sporadic territory, the way misfortune type is n't deterministic. So, some exact model is utilized to show the way misfortune (Chu *et al*., 2011). Way misfortune models for the different WINNER situations have been created in light of the consequences of estimations completed inside WINNER and in addition, comes about because of the open writing. These way misfortune models are ordinarily of the accompanying structure:

$$PL = A\log_{10} d + B + C\log_{10} \frac{f_c}{5} + K \quad (4)$$

where d in m is the separation between the transmitter and the beneficiary, f_c in GHz is the framework recurrence, A the fitting parameter which incorporates the way misfortune type. B is the catch, it is a settled amount in light of experimental perceptions. It is controlled by the free space way misfortune to the reference remove and a domain subordinate consistent. C portrays the way misfortune recurrence reliance, K is a discretionary domain particular term relies upon the situation. The models can be connected in the recurrence run from 2-6 GHz and for various recieving wire statures. The handling of measuring the qualities from experimental perception of the factors A, B, C and K of equation are depicted by Conrat *et al*. (2014). The free-space way misfortune (PL)_free can be composed as takes after:

$$PL_{free} = 20\log_{10} d + 46.4 + 20\log_{10} \frac{f_c}{5} \quad (5)$$

The data used in measuring was mainly obtained at 2 and 6 GHz and was used in the scenarios of WINNER channel model using the path loss models. The extension of the model was done on the arbitrary frequencies ranging from 2-6 GHz along with the help of dependencies of path loss frequencies and the intercept of the path loss. The focus will be on sub-urban marco cell scenario take in WINNEER are shortly mentioned in the following. The measurements were conducted for several scenarios such as 1-C3 the sub-urban marco cell, urban macro cell and bad urban macro cell scenarios, respectively at the frequency of 2.5 GHz. In the areas where the building are taller and their height is more than the center of town, having parking lots, parks and tress along the streets between the buildings. There is a typical variation in the building heights. The parameters which were basically related to the WINNER II model are not merely from these measurements but they are also the outcome of literature existing and discussing the design of model parameter. Hence, the scenario is presented in the given Eq. 6-8:

$$PL_{BS\text{-}RS(urban)} = 40.0\log_{10}(d_{BS\text{-}RS})+13.47-14\log_{10}(h_{BS}[m])-14\log_{10}(h_{MS}[m])+6\log_{10}(f_c[GHz]/5.0) \quad (6)$$

$$PL_{RS\text{-}MS(urban)} = 40.0\log_{10}(h_{RS}[m])+13.47-14\log_{10}(h_{RS}[m])-14\log_{10}(h_{MS}[m])+6\log_{10}(f_c[GHz]/5.0) \quad (7)$$

$$h_{BS} = 32\text{ m};\ h_{RS} = 20\text{ m};\ h_{MS} = 1.5\text{ m}, \sigma_{urban} = 6_{dB};\ 50\text{ m}<d<6\text{ km};\ d_{BP} = 4h_{BS}\times h_{RS}\times h_{MS}\times(f/c) \quad (8)$$

Where:

h_{BS} = The height of the eNB
h_{RS} = The height of the Relay Station
h_{MS} = The height of the Mobile Station
d = The distance between transmitter and the receiver
c = the velocity of light in vacuum
fc = The carrier frequency
• = Shadow fading standard deviation

where h_{BS}, h_{RS} and h_{MS} are the actual antenna heights. It the present formulation there is an assumption that the ideal optimally effective height of an antenna is real height the cause of this is the presence of the scenario of macro cell in urban area. Moreover, there is another assumption that the destiny of the vehicle is relatively small. Shadow fading standard is 8dB (Yuan, 2012).

Table 1: The parameters of system

Parameters	Values
Carrier frequency	2.5 (GHz)
Bandwidth	10 (MHz)
Data modulation	QPSk
PRB bandwidth	180 (kHz)
Sub carrier (tone) spacing	4.88 (kHz)
Channel model used	WINNER II
Transmitter IFFT size	2048
Cyclic prefix	64
eNB transmit power	46 dBm
eNB elevation gain	14 dBi
eNB noise figure	5 dB
eNB antenna pattern (horizontal)	A (•) = -min [12(• /• 3 dB) 2, Am] • 3 dB = 70° and Am = 25 dB
eNB height	32m
Relay site planning	Considered via higher probability of LOS and 5 dB bonus on NLOS
RS Transmit power	30 dBm
RS numbers	10
RS-UE elevation gain	9 dBi
Relay link antenna pattern (horizontal)	A (•) = • min [12(• /• 3 dB) 2, Am] • 3 dB = 70° and Am = 20 dB
RS access link antenna pattern	Omni-directional
RS height	20 m
RS noise figure	7 dB
UE maximum transmit power	23 dB m
UE maximum antenna gain	0 dBi
UE noise figure	7 dB
UE height	1.5 m
Shadow fading	Log-normal
Standard deviation (•)	8 dB on the direct link; 8 dB on the access link; 6 dB on the relay link
Detection	Hard decision
De-correlation distance	50 m
Correlation factor	0.5 between sites; 1.0 between sectors
Number of iterations	10^5
Equalization	MMSE

Simulation scenarios: The network simulation is done by a regular hexagonal cellular layout with eNB, RS and UE. The assumption followed for simulation is WINNER II and the down link is simulated and equalization Minimum Mean Square Error (MMSE), multiplexing techniques Orthogonal Frequency Division Multiplexing (OFDM) are used. The parameters of system are presented in summarized form as under (Table 1).

The installation sites of the eNB and the UE can be anywhere within urban macro cell and the distance between eNB and UE will follow WINNER II. The relay stations are installed between eNB and UE, put the relay stations at different heights for relay antenna (5, 10, 15, 20, 25 m) and have different roads between eNB and UE with different environments. On the other hand there are some situation where the distance between eNB and UE is less than the distance between eNB and RS. If we put the Relay stations in between the eNB and UE, it will be set up randomly.

RESULTS AND DISCUSSION

The data was simulated using MATLAB program and WINNER MATLAB coded source to insert different

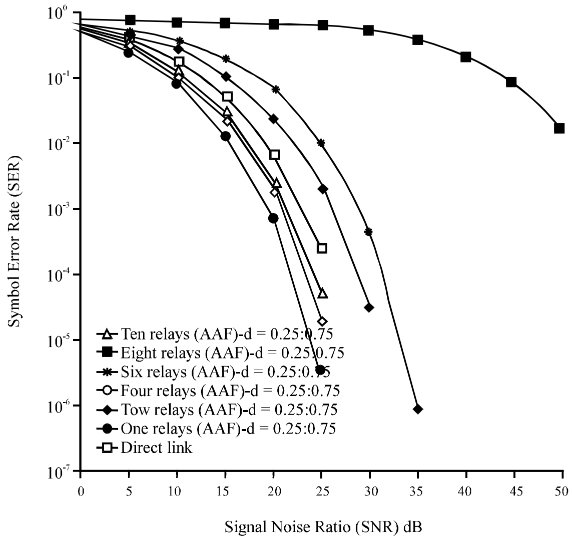

Fig. 5: Distributing relays around eNB with using AAF; Deploy relays close from eNB in urban microcell environment, d = 6 km

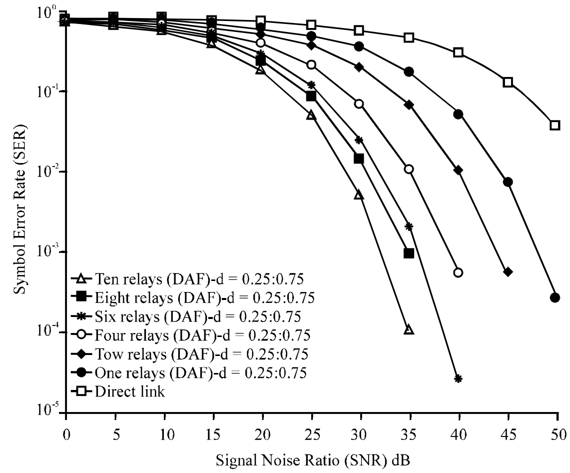

Fig. 6: Distributing relays around eNB with using DAF; Deploy relays close from eNB in urban microcell environment, d = 6 km

propagation environments. The study shows and later interpret results calculated by simulations of both direct signal and deployment of relays to cooperative diversity networks. The Symbol Error Rate is taken (SER) against the Single Noise Ratio (SNR) to show optimal performance analysis of both AAF&DAF protocol for LTE-advanced technology in urban macro cell environment by use different number of relays on different locations and different height antenna of relays.

Optimal deployment of number of relays at different locations: There are 7 scenarios in the first simulation, one without relay and six with different number of relays (1, 2, 4, 6, 8 and 10 relays) it studies the optimal deployment of cooperative relay number in the network performance using AAF and DAF protocol.

The effect deployment of number of relays between eNB and UE on enhancing the results of the signal in the destination clearly. Obviously increasing the number of relays scattered between the eNB and UE operating on the further improvement in performance. But note that the benefit rate improvement at least a certain number of relays which would lead to the futility of increasing the number of relays scattered and this depends on the relay site and the scenarios used.

The environment related to urban macro cell of Fig. 5 showed deploying relays used AAF technique around the eNB that the less Bit Error Rate (BER) appears with higher Signal to Noise Ratio (SNR) in all relay scenarios. Moreover it is also noticeable that, without relay scenario exhibits the worst BER, next come with one cooperation relay scenario, then, two, four, six, eidht and ten cooperative relays are deployed the results becomes

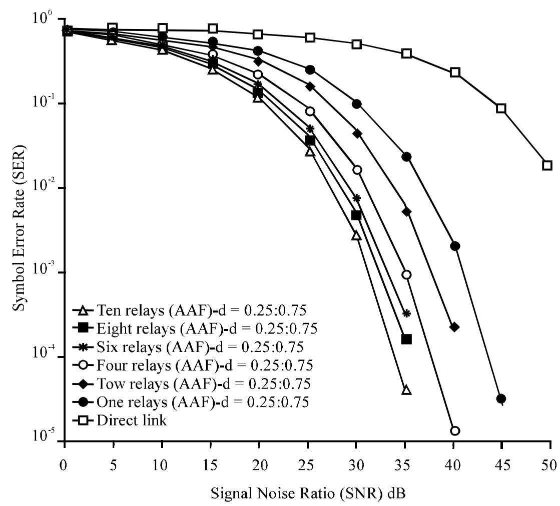

Fig. 7: Distributing relays around cell edge with using AAF; Deploy relays close from eNB in urban microcell environment, d = 6 km

even better when increase number deployment of relays, the average reduction in BER of six previous scenario over without relay scenarios is 78, 82, 85.7, 87.7, 88.3 and 89.6%, respectively. Furthermore, Fig. 6 depicts deploying relays used DAF technique around eNB with the average reduction in BER of six previous scenarios over without relay scenarios is 43, 53, 63, 68, 69 and 71%, respectively. It is very clear that in this section can used 2• 4 relays to enhanced the performance also, to keep the cost with reduced infrastructure deployment with in six relays.

Figure 7 shows deploying relays utilized AAF technique around the cell edge, scenario of without relay has highest BER through varying values of SNR, then

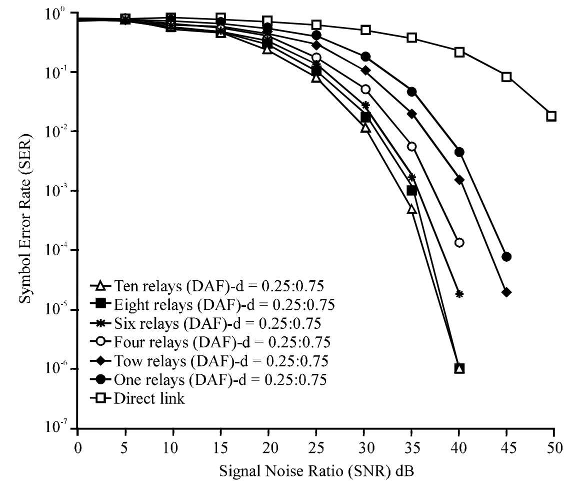

Fig. 8: Distributing relays around cell edge with using DAF; Deploy relays close from eNB in urban microcell environment, d = 6 km

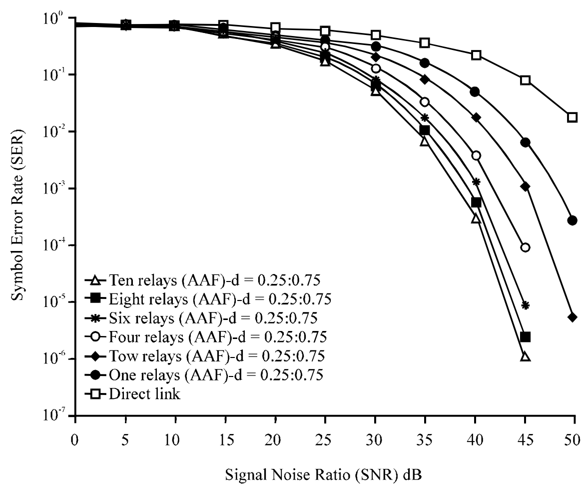

Fig. 9: Distribute relays Far from eNB at cell edge with AAF is used; Deploy relays close from eNB in urban microcell environment, d = 6 km

cooperative with one scenario, then cooperative with two relay scenarios and so on with four, six, eight and lastly cooperative with ten relay scenarios. The mean decrease in BER of cooperative relays scenarios over without relay scenarios as follow: with one relay scenario is more than 57% with two relay scenarios is 63% with four relay is 68.5% with six relay is 72% with eight relay is 73% and with ten relay is 74.5%. Aso, in Fig. 8 when used DAF technique the average reduction in BER of six previous cooperative relay scenarios is 49, 54, 60, 63.6, 65 and 66.5%, respectively. It's clear that by comparing AAF with DAF, the BER in the former achieved with less SNR than that of the later in the sex scenarios. In this study, we

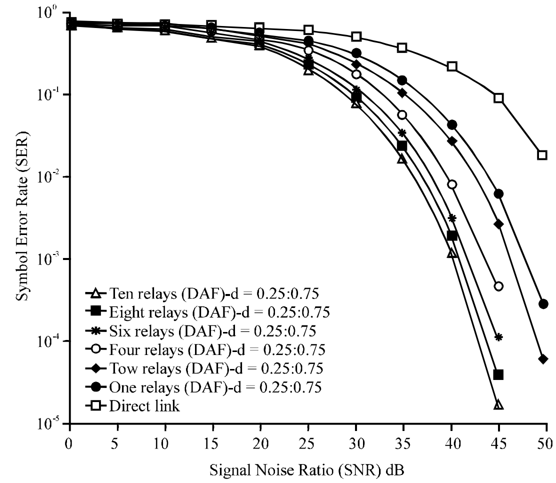

Fig. 10: Distributing relays Far from eNB at cell edge with using DAF; Deploy relays close from eNB in urban microcell environment, d = 6 km

can used 4~6 relays to get best gain of reduced in SER and solve the problem of signals in the cell edge with reduce infrastructure deployment costs and admit rapid deployment.

When the deployment relays in the cell edge the average reduction in BER of six cooperative relays scenarios over without relay scenario showed in Fig. 9 and 10 are 38, 47, 55, 58, 61 and 62%, respectively with used AAF technique. Also, average reduction in BER of pervious scenario when used DAF technique are 38, 43, 50, 54, 57 and 58% respectively. it's clear that all the relay scenarios perform much better than the without relay scenario and increasing the number of cooperative relays enhance SNR vs. BER. Clearly to get on the reduced in BER with 8~10 relays deployed in cell edge to extension coverage and enhanced throughput of the signals.

In this case, ten relays DAF are used though the sufficient success has not been achieved yet however the fixed DAF has more advantages than AAF relay specially in the case of decreasing the effect of additive noise. Involving the possible existence of forwarding wrongly recognized signals to the desired destination and if it is decoded erroneously hence, it causes propagation of error resulting in the reduction of the performance of the system.

Figure 11-13 show comparison between AAF and DAF scheme when the Relays put in different locations between eNB and UE. The best performance of all environments of distributed relays scheme is shown clearly with AAF than DAF. When relays are used in AAF technique close from eNB, it clearly demonstrates that a more gain is achieved of distributed relays as

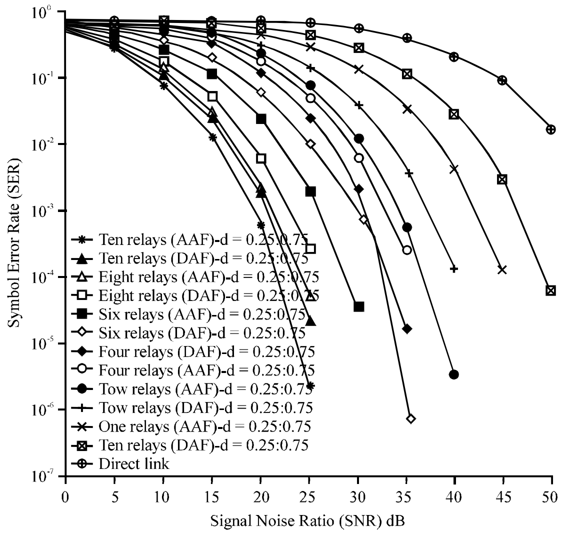

Fig. 11: Comparing AAF vs. DAF when relays are distributed near eNB; Deploy relays close from eNB in urban microcell environment, d = 6 km

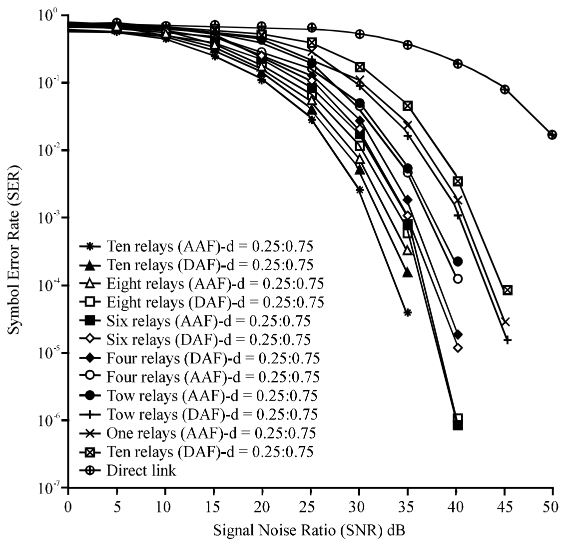

Fig. 12: Comparing AAF vs. DAF when Relays are distributed middle from eNB; deploy relays close from eNB in urban microcell environment, d = 6 km

compared to DAF (Fig. 14). Clearly, find gain is achieved of other deployed Relays scheme of AAF compared to deployed Relays scheme of DAF when Relays are distributed around and at cell edge or far from the eNB.

Relay comparison with different antenna height: In this study, the results of analyzing the impact of transceiver Height Antenna for Relays (HAR) in a LTE-Advanced

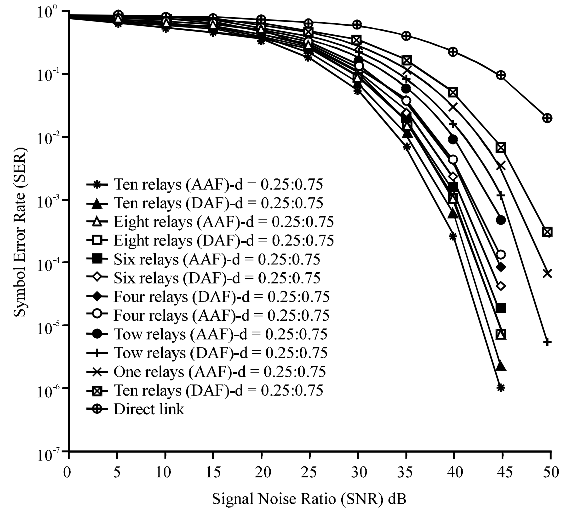

Fig. 13: Comparing AAF vs. DAF when relays are distributed Far from eNB; Deploy relays close from eNB in urban microcell environment, d = 6 km

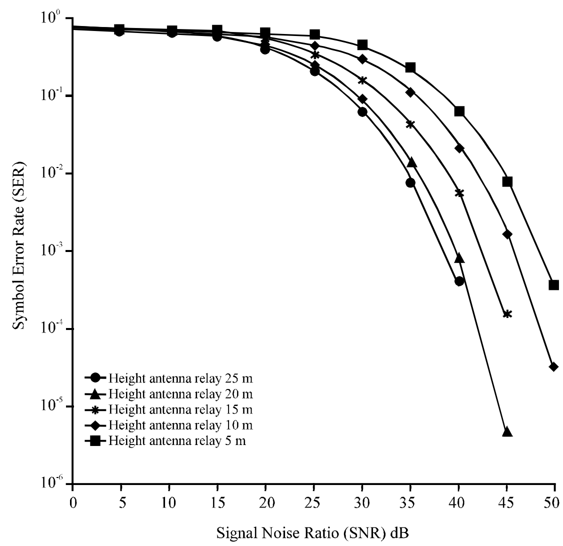

Fig. 14: Comparison of different antenna height relays for DAF technique; Deploy relays close from eNB in urban microcell environment, d = 6 km

relaying in urban macro cell scenario will be shown. A multi-antenna height of the relays (5, 10, 15, 20, 25 m) measurement c ampaign was performed in an urban macro-cellular environment. The analysis results show that relay antenna height has improved the performance when increasing the antenna height relay. In order to evaluate this dependence on the antenna height more thoroughly, additional measurements and analysis have to be performed when the WINNER models for relaying scenarios were used.

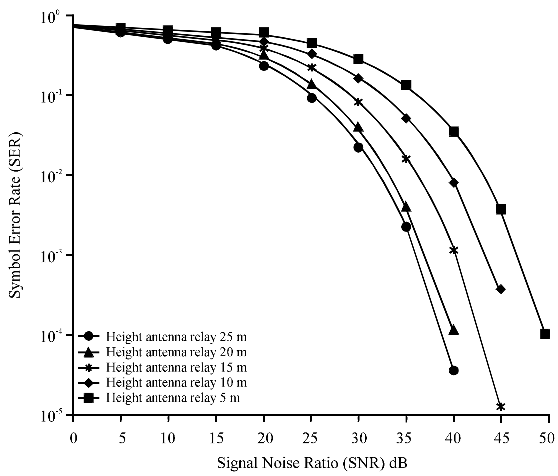

Fig. 15: Comparison of different antenna height relays for AAF technique; Deploy relays close from eNB in urban microcell environment, d = 6 km

Figure 14 and 15 showed deploying relays used DAF and AAF technique around the cell edge, scenario of Height Antenna for Relays (HAR) 5 m has highest BER through varying values of SNR, then HAR 10 m scenario, then HAR15 m scenarios, then HAR 20 m scenarios and lastly cooperative with HAR 25 m scenarios has lowest BER at all values of SNR. The average reduction in BER of DAF technique in Fig. 14 of HAR 20 m scenarios over HAR 25 m scenarios is more than 3%, HAR 15 m scenarios over HAR 25 m scenarios is 17%, HAR 10 m scenarios over HAR 25 m is 33% and HAR 5 m scenarios over HAR 25 m scenarios is 55.5%. Also in Fig. 15, when used AAF technique the average reduction in BER of four previous HAR scenarios is 5, 18, 51 and 67%, respectively. Clearly the increase HAR produced the reduction in BER and the optimal HAR with 20 and 25 m. To comparing AAF with DAF, the BER of AAF in the former achieved with less SNR than that of DAF in the four scenarios.

CONCLUSION

The main purpose for the deployment LTE-advanced with relay in a macro cell design is to decrease the cost of multi-antenna support and flexibility of bandwith which gives the support to the high peak rates, through put as well as increasing the coverage area. Moreover, the better user experience is achieved by lower latencies The main idea of this study was to explore the optimal relay deployment by analyzing various scenario consisting up to 10 relays using two cooperative relaying strategies AAF and DAF with using WINNER II channel in urban macro cell scenario in support for the LTE-advanced. The simulation results showed the optimal performance when deployed <6 relays if relays close from eNB, <8 relays if relays close from the cell edge and <10 relays if deployment relays in the cell edge. It is also clearly noted that AAF is better than DAF at all different location of relay. The analysis shows optimal performance when increasing the antenna height relay. The more gain is achieved of different antenna height relay (5, 10, 15, 20, 25 m) sequentially of different locations Relays actually results in the SNR vs BER curve.

ACKNOWLEDGEMENT

This research was supported by the Universiti Kebangsaan Malaysia (UKM) through research grant GUP-2016-005 which was used to conduct this research.

REFERENCES

Abdallah, A., D. Serhal and K. Fakih, 2015. Relaying techniques for LTE-Advanced. Proceedings of the 21th European Wireless Conference on European Wireless, May 20-22, 2015, Budapest University of Technology and Economics, Budapest, Hungary, pp: 1-6.

Abdalwahid, M.B., 2015. Performance evaluation of relayed enhanced long term evolution advanced network using decode and forward protocol. Ph.D Thesis, Sudan University of Science and Technology, Khartoum, Sudan.

Auer, G., D. Klaus, K. Kari, K. Ole and O. Magnus *et al*., 2007. Final CG metropolitan area description for integration into overall system concept and assessment of key technologies. Master Thesis, TUI Group, Hanover, Germany.

Bulakci, O., S. Redana, B. Raaf and J. Hamalainen, 2011. Impact of power control optimization on the system performance of relay based LTE-Advanced heterogeneous networks. J. Commun. Networks, 13: 345-359.

Chu, Q.H., J.M. Conrat and J.C. Cousin, 2011. Propagation path loss models for LTE-Advanced urban relaying systems. Proceedings of the 2011 IEEE International Symposium on Antennas and Propagation (APSURSI), July 3-8, 2011, IEEE, Spokane, Washington, USA., ISBN:978-1-4244-9563-4, pp: 2797-2800.

Conrat, J.M., Q.H. Chu, I. Maaz and J.C. Cousin, 2014. Path loss model comparison for LTE-Advanced relay backhaul link in urban environment. Proceedings of the 2014 8th European International Conference on Antennas and Propagation (EuCAP), April 6-11, 2014, IEEE, The Hague, Netherlands, ISBN:978-8- 8907-0184-9, pp: 3472-3476.

Gawande, P.D. and S.A. Ladhake, 2013. BER performance of OFDM system with cyclic prefix and zero padding. Intl. J. Ad. Eng. Technol., 6: 316-324.

Kong, Q., R. Lu, S. Chen and H. Zhu, 2017. Achieve secure handover session key management via mobile relay in LTE-Advanced networks. IEEE. Internet Things J., 4: 29-39.

Renzo, M.D. and W. Lu, 2015. End-to-end error probability and diversity analysis of AF-based dual-hop cooperative relaying in a Poisson field of interferers at the destination. IEEE. Trans. Wirel. Commun., 14: 15-32.

Rodriguez, I., C. Coletti and T.B. Sorensen, 2012. Evaluation of potential relay locations in a urban Macro-cell scenario with applicability to LTE-A. Proceedings of the 2012 IEEE 75th International Conference on Vehicular Technology (VTC Spring), May 6-9, 2012, IEEE, Yokohama, Japan, ISBN:978-1-4673-0990-5, pp: 1-5.

Teyeb, O., V. Van Phan, B. Raaf and S. Redana, 2009. Dynamic relaying in 3GPP LTE-Advanced networks. EURASIP. J. Wirel. Commun. Networking, Vol. 2009, 10.1155/2009/731317

Yuan, Y., 2012. LTE-Advanced Relay Technology and Standardization. Springer, Berlin, Germany, ISBN:978-3-642-29676-5, Pages: 185.

Yuan, Y., 2013. LTE-A Relay Scenarios and Evaluation Methodology. In: LTE-Advanced Relay Technology and Standardization, Yuan, Y. (Ed.). Springer, Berlin, Germany, ISBN:978-3-642-29675-8, pp: 9-38.

Zetterberg, M.B., K. Yu, N. Jalden T. Rautiainen and K. Kalliola *et al.*, 2005. IST-2003-507581 WINNER D5.4v.1.4 final report on link level and system level channel models. TUI Group, Hanover, Germany. https://www.researchgate.net/profile/Pekka_Kyoesti/publication/229031750_IST-2003-507581_WINNER_D5_4_v_14_Final_Report_on_Link_Level_and_System_Level_Channel_Models/links/0912f508908ed00431000000/IST-2003-507581-WINNER-D5-4-v-