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Optimal Relay Deployment in Suburban Macrocell of LTE-Advanced Network

Abduljalil Saif, Mahamod Ismail, Rosdiadee Nordin and Mohammed Fadhil
Department of Electrical, Electronic and System Engineering,
Universiti Kebangsaan Malaysia (UKM), Selangor, Malaysia

Abstract: Relaying is a promising technique introduced in LTE-advanced network for coverage extensions, throughput and data rate enhancement. However, the current relay deployment tends to be non-optimal in term of the number of relays and their position between evolved Node B (eNB) and User Equipment (UE). In this study, we propose optimal relay deployment by analyzing various scenario consisting up to 10 relays using two cooperative relaying strategies; Amplify And Forward (AAF) and Decode And Forward (DAF). The data is send over from eNB to UE using multi-hop communication over WINNER channel model in Suburban microcells of LTE-advanced networks environment. The optimal deployment is determined by evaluating the number of relays and their locations at targeted Symbol Error Rate (SER) or Signal-to-Noise Ratio (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 10 relays with relays located in the middle between eNB and UE.

Key words: AAF, DAF, WINNER, LTE-A, OFDM, MMSE, deploy relay

INTRODUCTION

Relay is one of the main characteristic being thought for IMT-advanced systems. The relay architectures described in 3GPP LTE-advanced and IEEE 802.16 m are examined only for non-mobile relay such as the relay station is linked to a designated BS and becomes a part of the static access network (Rani and Singla, 2016). In mobile communication, if UE is within the service coverage area of eNB then UE can communicate with eNB. In 4G and beyond 4G, the open issue is that to provide a continuous connection for the UEs which are not in the coverage area of eNB. One of the possible solutions is increasing the number of eNB. But the increase in number of eNB, increases the network cost. More number of eNB deployments will introduce intercell interference and spectrum allocation problems (Jishnu *et al*., 2016). To overcome this, we go for Multihop Relay (MHR) station based deployment schemes. The LTE-A and WiMAX suffers from white Gaussian noise, reduction in wireless service coverage, shadow fading, wireless interference and degradation in signal quality. One of the solution for above problem is MHR networks. MHR network addresses the coverage and throughput requirements of the cell edge users (Arthi *et al*., 2015). One of the important LTE-advanced benefits is the ability to take advantage of advanced topology networks, optimized heterogeneous networks with a mix of macros with low power nodes such as new relay nodes, femtocells and picocells (Pandey *et al*., 2014). The radio channel plays an important role in the evaluation of transceiver parameters such as modulation, coding, link adaptation, channel equalization, multi-user scheduling etc. The European Wireless World Initiative New Radio (WINNER) project radio frequencies are most likely between 2 and 6 Ghz (Zetterberg *et al*., 2005). This study was initiated from the necessity of modelling relay-enhanced LTE-advanced with the incorporation of WINNER channel. This study focuses on evaluating the performance of deploy relays nodes on suburban macro cells. For that the researchers explore the idea and theory of LTE-advanced and WINNER channel model to create a simulation model which is capable of evaluating the performance of relay deployment in an LTE-advanced utilizing the WINNER channel model. The contribution of this research is employing AAF and DAF with (different places and different number of relay) using WINNER channel model which consider as realty reference for channel model in suburban macro as this work will be as development for according work, so, the researchers can consider this work as reference for relay channel using WINNER channel model. The optimal deployment is determined 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 relay nodes have been considered in this model.

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

MATERIALS AND METHODS

Wireless channel models: A single path loss model was used for macro evolved Node B (eNB) to User Equipment (UE) connection which is based on the traditional formulae for NLOS propagation environment with minor correction to account for the contribution of LOS component. That assumption makes sense for homogeneous networks in which the site-to-site distance is constant and the topology of the entire cell grid is regular. However, using single path loss model may not be accurate enough in heterogeneous deployment as macro eNBs and Relay/Pico/femto/RRH have quite different transmit powers. The antenna gains, antenna heights and down-tilts are different too. Also, cell topology becomes more diversified in HetNet which demands more sophisticated channel models to represent the actual propagation environment. IMT-advanced channel model is geometry based stochastic channel model. It was proposed for the evaluations of radio interface technologies (Yuan, 2013). The framework of the primary module is based on WINNER II channel model. It is characterized by the bandwidth of 100 MHz with centre frequency between 2 and 6 GHz. WINNER channel model is a geometry based stochastic model. Geometry based modelling of the radio channel enables separation of propagation parameters and antennas. The channel parameters for individual snapshots are determined stochastically, based on statistical distributions extracted from channel measurement. Antenna geometries and field patterns can be defined properly by the user of the model. Channel realizations are generated with geometrical principle by summing contributions of rays (plane waves) with specific small scale parameters like delay, power, Angle of Arrival (AoA) and Angle of Departure (AoD). Superposition results to correlation between antenna elements and temporal fading with geometry dependent doppler spectrum. Transfer matrix of the channel is (Zetterberg *et al*., 2005):

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

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:

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

The channel from T_x antenna element s to R_x element u for cluster n is as follows:

$$H_{u,s,m}(t,\tau)(t,\tau)=\sum_{n=1}^{N}\begin{bmatrix}F_{rx,u,v}(\varphi m.n)\\ F_{rx,u,H}(\varphi m.n)\end{bmatrix}^{T}\begin{bmatrix}\alpha_{m,n,vv} & \alpha_{m,n,vH}\\ \alpha_{m,n,Hv} & \alpha_{m,n,HH}\end{bmatrix}\begin{bmatrix}F_{tx,s,v}(\varnothing m.n)\\ F_{tx,s,H}(\varnothing m.n)\end{bmatrix}\times e^{\left(j2\pi\lambda_0^{-1}\left(\overline{\phi_{m.n}}\cdot\overline{r_{tx,m}}\right)\right)}e^{\left(j2\pi\lambda_0^{-1}\left(\overline{\phi_{m.n}}\cdot\overline{r_{rx,m}}\right)\right)}\times e^{j2\pi v_{m,n}t\delta(\tau-\tau m,n)} \quad (3)$$

Where:

$F_{rx,u,v}$ and $F_{rx,u,H}$ = The antenna element u field patterns for vertical and horizontal polarizations, respectively
$\bullet_{m,n,vv}$ and $\bullet_{m,n,VH}$ = The complex gains of vertical-to-vertical and horizontal-to-vertical polarizations of ray m, n respectively
$\bullet_{0}$ = The wave length of carrier frequency
$\overline{\varnothing_{m,n}}$ = The AoD unit vector
$\overline{\varphi_{m,n}}$ = The AoA unit vector
$\overline{r_{rx,u}}$ and $\overline{r_{rx,s}}$ = The location vectors of element u and s respectively
$v_{m,n}$ = The Doppler frequency component of ray m, n. If the radio channel is modelled as dynamic, all the above mentioned small scale parameters are time variant t

Cooperative relaying techniques: We will discuss different cooperative protocols or transmissions techniques used in cooperative communication. cooperative communications protocols can be generally categorized into fixed relaying schemes and adaptive relaying schemes. In this study we describe both of these schemes and consider single relay as well as multi relay scenario.

Relay protocols: A cooperation strategy is modelled into two orthogonal phases, either in TDMA or FDMA, to avoid interference between the two phases: in phase 1 source sends (broadcast) information to destination and the information is also, received by the relay (due to broadcast) at the same time as it in phase 2 the relay can help the source by forwarding or retransmitting the information to the destination. Phase 1 below depicts a general relay channel where the source transmits with power P1 and the relay transmits with power P2. In this paper the researchers will consider the special case where the source and the relay transmit with in phase 2, the relay can help the source by forwarding or retransmitting the information to the destination as it shown in Fig. 1 (Khan *et al*., 2012).

As shown in Fig. 2 the source broadcasts its information to both the destination and the relay. The received signals Y_{sd} and Y_{sr} at the destination and the relay, respectively, can be written as:

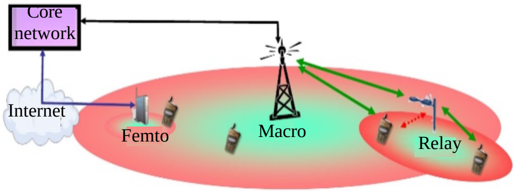

Fig. 1: Cooperative transmission

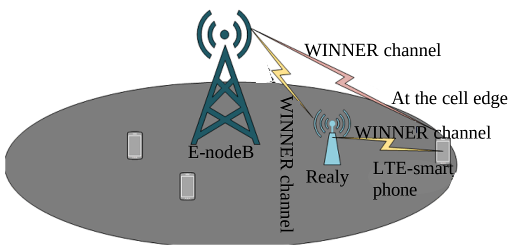

Fig. 2: Cooperation model

$$Y_{sd} = \sqrt{P}h_{sd}x+n_{sd}, Y_{sr} = \sqrt{P}h_{sr}x+n_{sr} \quad (4)$$

Where:

P = The transmitted power at the source

x = The transmitted information symbol and

n = The additive noise

In Eq. 4 the channel fades between the source, the relay and destination, respectively. Rayleigh flat fading channel can be mathematically modelled as complex gaussian random variable. Written as (z = x+j y) where real and imaginary parts are zero mean Independent and Identically Distributed (IID) Gaussian random variables. In phase 2 the relay forwards a processed version of the source's signal to the destination and this can be modelled as:

$$Y_{rd} = h_{rd}q(Y_{sr})+n_{rd} \quad (5)$$

Where the function q (·) depends on which processing is implemented at the relay node (Garg *et al*., 2013).

Cooperation relay strategies: In fixed relaying, the channel resources are divided between the source and the relay in a fixed (deterministic) manner. The processing at the relay differs according to the employed protocols. The most common techniques are the fixed AAF relaying protocol and the fixed relaying DAF.

Amplify and forward relaying protocol: In AAF relaying protocol which is often simply called an AAF protocol,

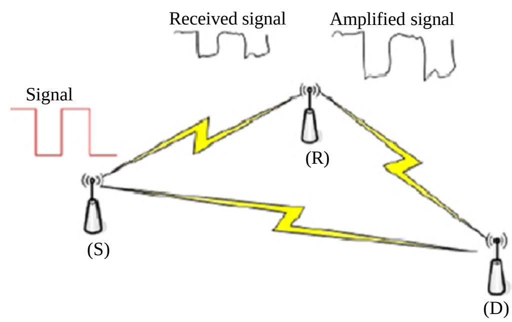

Fig. 3: Amplify and forward protocol

the relay scales received version transmits an amplified version of it to the destination. The amplify-and-forward scheme is presented in Fig. 3 (Khan *et al*., 2012).

The amplify-and-forward relay channel can be modelled as follows. The signal transmitted from the source x is received at both the relay and destination as:

$$Y_{sd} = \sqrt{P}h_{sd}x+n_{sd} \text{ and } Y_{sr} = \sqrt{P}h_{sr}x+n_{sr} \quad (6)$$

where h_{sd} and h_{sr} are the channel fades between the source and the relay and destination, respectively. The terms denote the additive white Gaussian noise with zero-mean and variance No. In this protocol, the relay amplifies the signal from the source and forwards it to the destination ideally to equalize the effect of the channel fade between the source and the relay. The relay does that by simply scaling the received signal by a factor that is inversely proportional to the received power which is denoted by:

$$\beta = \sqrt{\frac{P}{|h_{s,r}|^2 P+N_0}} \quad (7)$$

The signal transmitted from the relay is thus given by (• Y_{sr}) and has power P equal to the power of the signal transmitted from the source. In phase 2 the relay amplifies the received signal and forwards it to the destination with transmitted power P. The received signal at the destination in phase 2 according to Eq. 7 is given as:

$$Y_{rd} = \sqrt{\frac{P}{|h_{s,r}|^2 P+N_0}}h_{rd}Y_{sr}x+n_{rd} \quad (8)$$

Here, n_{rd} is the channel coefficient from relay to the destination and is an additive noise. More:

$$Y_{rd} = \sqrt{\frac{P}{|h_{s,r}|^2 P+N_0}}h_{rd}\sqrt{P}h_{sr}x+n'_{rd} \quad (9)$$

Specifically, the received signal Y_{rd} in this case is Eq. 9. Where:

$$n'_{rd} = \sqrt{\frac{P}{|h_{sr}|^2 P+N_0}} h_{rd} n_{sr} + n_{rd} \quad (10)$$

Assume that the noise terms are independent then the equivalent noise is a zero-mean, complex Gaussian random variable with variance:

$$n'_{rd} = \left(\frac{|h_{rd}|^2 P}{|h_{s,r}|^2 P+N_0} + 1 \right) \times N_0 \quad (11)$$

The destination receives two copies from the signal *x* through the source link and relay link there are different techniques to combine the two signals. The optimal technique that maximizes the overall signal-to-noise ratio is the Maximal Ratio Combiner (MRC). Note that MRC combining requires a coherent detector that has knowledge of all channel coefficients. With knowledge of the channel coefficients h_{sd}, h_{sr} and h_{rd} the output of the MRC detector at the destination can be written as:

$$Y = A\,Y_{sd} + B\,Y_{rd} \quad (12)$$

The combining factors A and B should be designed to maximize the combined SNR. An easier way to design them is resorting to signal space and detection theory principles. Since, the AWGN noise terms span the whole space to minimize the noise effects, the detector should project the received signals Y_{sd} and Y_{sr} to the desired signal spaces. Hence, Y_{sd} and Y_{sr} should be projected along the directions respectively, after normalizing the noise variance terms in both received signals. Therefore, A and B are given by Van Nguyen and Kim (2016):

$$A = \frac{\sqrt{p} h^*_{s,d}}{N_0},\; B = \frac{h^*_{s,d} \beta^* h^*_{s,r}}{\left(|h_{r,d}|^2 |\beta|^2 + 1 \right) N_0} \quad (13)$$

Decode and forward relaying protocol: Another processing possibility at the relay node is for the relay to decode the received signal, re-encode it and then retransmit it to the receiver. The decode-and-forward scheme is presented in Fig. 4. This kind of relaying is termed as a fixed Decode-And-Forward (DAF) scheme which is often simply called a DAF scheme without the confusion from the selective DAF relaying scheme. If the decoded signal at the relay is denoted by x' the transmitted signal from the relay can be denoted by x' given that x' has a unit variance (Khan *et al*., 2012).

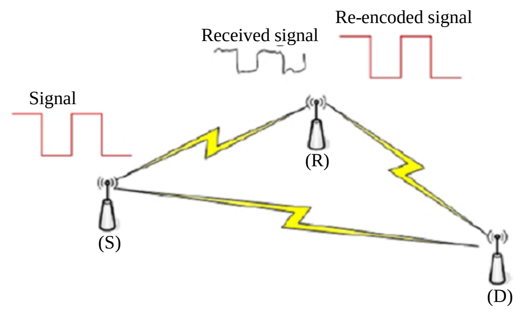

Fig. 4: Decode and forward protocol

Note that the decoded signal at the relay may be incorrect. If an incorrect signal is forwarded to the destination, the decoding at the destination is meaningless. It is clear that for such a scheme the diversity achieved is only one because the performance of the system is limited by the worst link from the source-relay and source-destination. Although, fixed DF relaying has the advantage over AF relaying in reducing the effects of additive noise at the relay, it entails the possibility of forwarding erroneously detected signals to the destination, causing error propagation that can diminish the performance of the system. The mutual information between the source and the destination is limited by the mutual information of the weakest link between the source-relay and the combined channel from the source-destination and relay-destination. The received signal at the destination in phase 2 in this case can be modelled as:

$$Y_{rd} = \sqrt{P} h_{rd} x + n_{rd} \quad (14)$$

With knowledge of the channel coefficients (between the source and the destination) and (between the relay and the destination), the destination detects the transmitted symbols by jointly combining the received signal Y_{sd} (Eq. 6) from the source and Y_{rd} (Eq. 14) from the relay. The combined signal at the MRC detector can be written as:

$$Y = A_2 Y_{sd} + B_2 Y_{rd} \quad (15)$$

In which the factors A_2 and B_2 are determined such that the SNR of the MRC output is maximized they can be specified as (Alexopoulos, 2008):

$$A_2 = \frac{\sqrt{p} h^*_{s,d}}{N_0},\; B_2 = \frac{\sqrt{p_2} h^*_{r,d}}{N_0} \quad (16)$$

Path loss models: The path loss model focuses on the study of the long term or large scale variations on the average received signal strength due to the variation of distance from the transmitter and the receiver. The path loss indicates how fast the received signal strength drops with respect to change in distance. The simplest path loss model is the free space path loss model where the average received signal strength is inversely proportional to the square of the distance for example the received signal strength is reduced by 4 times if we double the distance. But for terrestrial wireless communication the signal strength decreases more quickly. The path loss between transmitter and receiver is characterized by path loss exponent which depends on environment. For free space or rural area, its value is 2 for suburban it is from 2-3 for urban its value is about 4. The higher the path loss exponent is the faster the signal strength drops with increasing the distance. In some more composite environments such as irregular terrain the path loss exponent is not deterministic. So, some empirical models are used to model the path loss.

Path loss models for the various WINNER scenarios have been developed based on results of measurements carried out within WINNER as well as results from the open literature. These path loss models are typically of the following form:

$$PL = A\log_{10} d+B+C\log_{10}\frac{f_c}{5}+K \quad (17)$$

where d in [m] is the distance between the transmitter and the receiver, f_c in [GHz] is the system frequency, A the fitting parameter which includes the path-loss exponent. B is the intercept, it is a fixed quantity based on empirical observations. It is determined by the free space path loss to the reference distance and an environment dependent constant. C describes the path loss frequency dependence; K is an optional environment-specific term depending on the scenario. The models can be applied in the frequency range from 2-6 GHz and for different antenna heights. The processing of measuring the values from empirical observation of the variables A,B,C and K of Equation are described .The free-space path loss, PL_{free} can be written as follows:

$$PL_{free} = 20\log_{10} d+46.4+20\log_{10}\frac{f_c}{5} \quad (18)$$

The path loss models used in different scenarios of WINNER channel model are based on measured data obtained mainly at 2 and 5 GHz. These models have been extended to arbitrary frequencies in the range from 2-6 GHz with the aid of the path loss frequency dependencies and the path loss intercept we will focus on suburban macro cell scenario take in WINNER are briefly discussed.

Measurements for the suburban macro cell (C1) scenario were conducted at the centre-frequency 2.5 GHz. Measurements where the houses are lower than in the centre of the town with some parking lots, parks and trees along the streets in between the houses. The height of the houses varied typically from 3-6 stories. In this document only path-loss for the suburban macro is considered. All other channel parameters are documented in WIN1D54. The parameters proposed for WINNER 2 Model are not solely from those measurements but also, results from literature that has been used for model parameter design. Shadow fading standard is 6 dB. The path loss equation for this scenario is in Eq. 19:

$$\begin{aligned} PL_{los(suburban)} &= 40.0\log_{10}(d[m])+11.65- \\ &16.2\log_{10}(h_{BS}[m])-16.2\log_{10}(h_{RS}[m])- \\ &16.2\log_{10}(h_{MS}[m])+3.8\log_{10}(f[GHz]/5.0) \end{aligned} \quad (19)$$

Where:

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

30<d< 5 km; = h_{BS} 25 m; h_{RS} = 15 m; h_{MS} = 1.5 m, • = 6dB. In the formula it has been assumed that the effective antenna height is the real height because in suburban areas, it is assumed that the vehicle density is relatively small.

Design and evaluation of macro suburban simulation: We introduced the case design where we described the cases involved and general properties of the network and technologies being considered. In this study, the researchers therefore, discuss and evaluate the results which were performed for the different distributes for relays as well as scenarios with WINNER 2. The results of the performed simulations are presented here where interpretation and deductions of the results are also, discussed. We consider macro suburban scenarios for our simulation.

Simulation block diagram: Figure 5 shows adding Additive White Gaussian Noise (AWGN). After receiving the data at the receiver the cyclic prefix is removed and FFT applied again. Then, MMSE equalization is done. After that the hard detection is performed to evaluating the symbol error rate. This process is iterated for all the SNR of the given range for relaying this OFDM simulator has been design slightly differently.

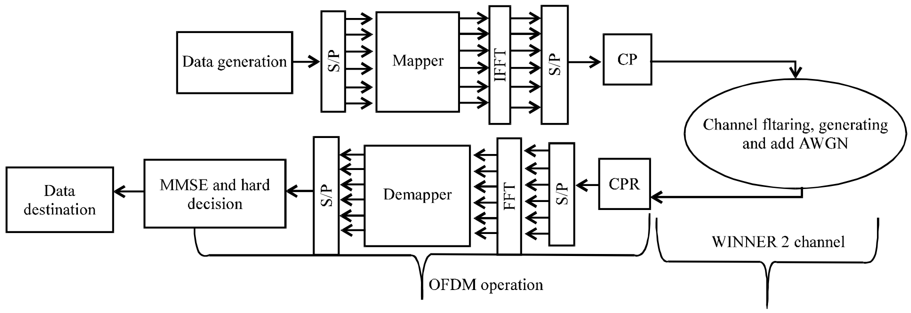

Fig. 5: OFDM operation and WINNER 2 channel

Table 1: System parameters

System parameters	Values
Channel bandwidth	20 (MHz)
Carrier frequency	2.5 (GHz)
Channel model used	WINNER 2
eNB height	25 (m)
eNB transmitted power	46 (dBm)
eNB elevation and antenna gain	14 (dBi)
eNB noise figure	5 (dB)
RN height	15 (m)
RN numbers	10
RN transmitted power	30 (dBm)
RN elevation and antenna gain	9 (dBi)
RN noise figure	7 (dB)
UE height	1.5 (m)
UE numbers	1 (single user)
E noise figure	7 (dB)
System bandwidth	20 (MHz)
Data modulation	QPSK
Cyclic prefix	64 samples
Transmitter IFFT size	1024
Sub carrier (tone) spacing	4.8828125 (kHz)
Number of iterations	10^5

Parameters of system: The simulation is performed in a network that is represented by a regular hexagonal cellular layout with eNB, RN and UE. Simulation setup follows the assumption of WINNER 2 and the down link is simulated. Multiplexing techniques Orthogonal Frequency Division Multiplexing (OFDM), full buffer down link, equalization Minimum Mean Square Error (MMSE) and detection hard decision are used. The parameters of system are summarized in Table 1.

Designing the environments: By default the WINNER channel model comes with no relay. As a standard LTE model, it consists of only eNBs and Ues which are distributed randomly. The locations of the eNB and the UE can be anywhere within the cell which means that the distance between eNB and UE will be set up randomly. If we introduce a relay node in between the eNB and UE, we have eleven the distance between eNB and UE. Otherwise there may some situation where the distance between eNB and UE is less than the distance between eNB and RN. If we put the relay node in between the eNB and UE, the environment will look like the Fig. 6.

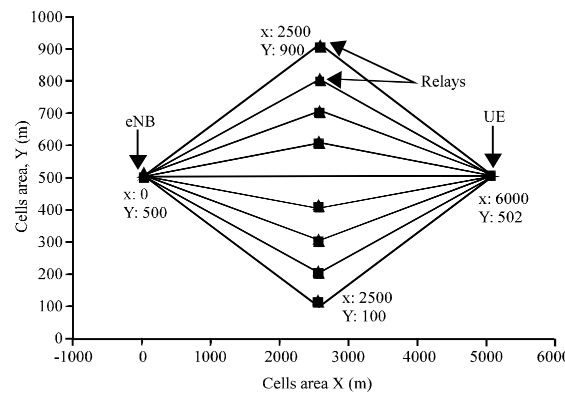

Fig. 6: Simulator environment in deploying 10 relays between eNB and UE

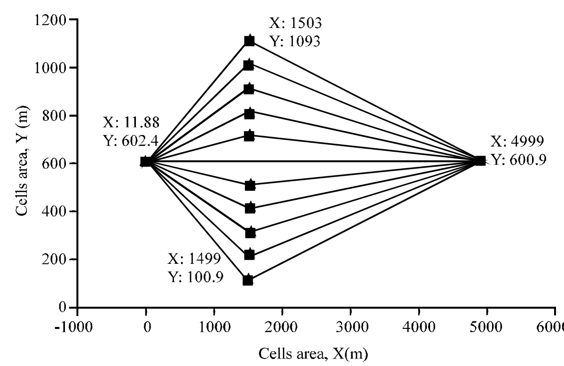

Fig. 7: Simulator environment in deploying 10 relays near from eNB

After that putting the relay node near the eNB can communicate with UE in eleven ways (Fig. 7). After that putting the relay node far from the eNB can communicate with UE in eleven ways (Fig. 8).

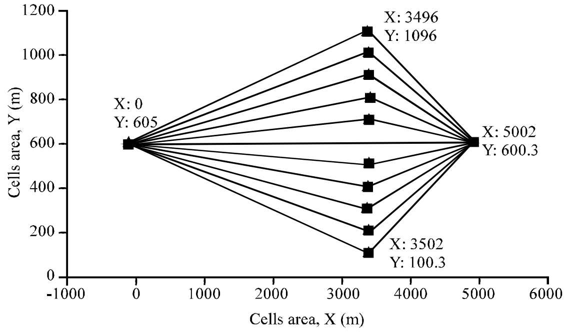

Fig. 8: Simulator environment in deploying 10 relays far from eNB

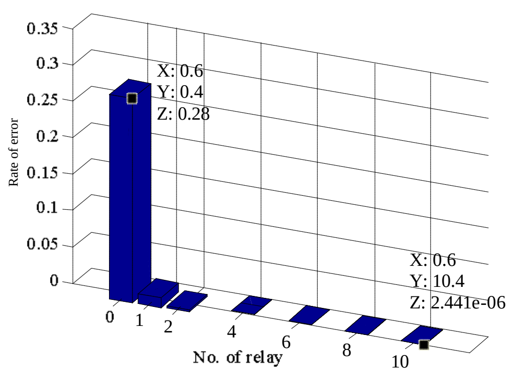

Fig. 9: Illustrates the effect of employing relay on SER

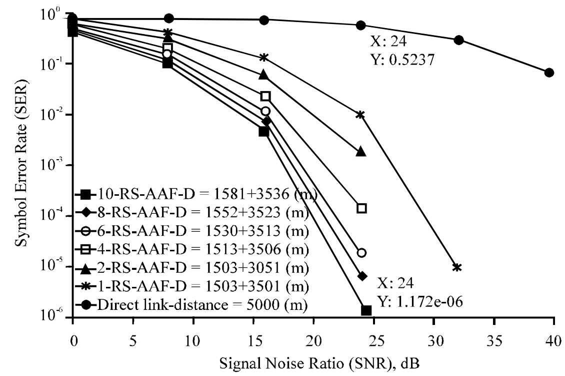

Fig. 10: Deploying relays near from eNB with AAF is used for C1 scenario

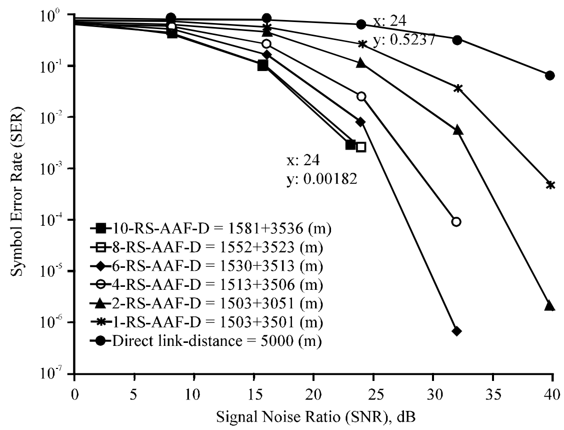

Fig. 11: Deploying relays near from eNB with DAF is used for C1 scenario

RESULTS AND DISCUSSION

Simulation result of C1-suburban macro-cell scenario: In this simulation, we will show and discuss simulation results of both direct signal and deploying relays to cooperative communications. The focus is on the Symbol Error Rate (SER) performance analysis of both AAF and DAF protocol for LTE-advanced technology in environment the micro urban cell.

Figure 9 shows the effect of deploy relays between eNB and UE on enhancing the result of the signal in the destination. It also, shows the effect of deploy relays cooperates to give the best performance than that of single relay cooperation and direct signal. In this case there is a round 28.1, 28, 27.9, 27.8, 27.1 and 26.4% SER improvement achieved with 10, 8, 6, 4, 2, 1 relay on sequent and the deploying of ten relay show the best performance.

Figure 1-10 show direct and relayed signal when relay applied in DAF technique. In this case ten relays are used although significant gain is not achieved as compared to AAF but fixed DAF relaying has the advantage over AAF relaying in reducing the effects of additive noise at the relay, it involves the possibility of forwarding erroneously detected signals to the destination if decoded wrongly causing error propagation that can reduce the performance of the system. So, we will discuss the effect of deploy relays on performance when the relays are put close, medium and far from the eNB.

Also, the graph below shows relays and direct signal when relay operates in both AAF and DAF techniques. These curves are plotted against BER and SNR when ten relay are used and compared the result between two techniques. Though, multi relay somehow improves the results DAF but still significant gain is not achieved as compared to AAF because DAF has the responsibility of reducing the effects of additive noise at the relay and reducing error propagation. SER improvement is achieved and clearly the same gain is achieved from other deployed relays scheme of AAF when compared to the deployed relays scheme of DAF.

Figure 11 shows the improvement with deploy relays scheme than direct scheme. When ten relays are used in

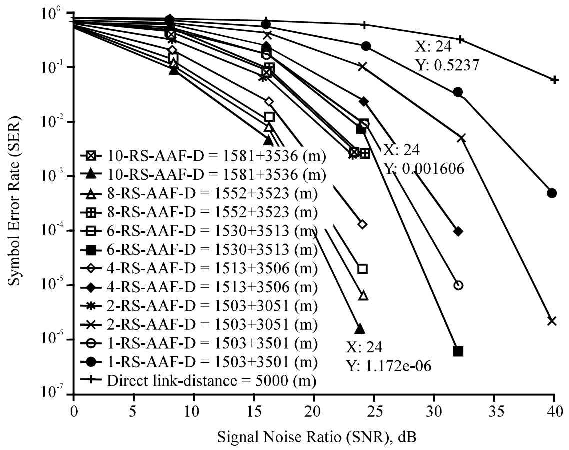

Fig. 12: Deploying relays near from eNB with AAF vs. DAF is used for C1 scenario

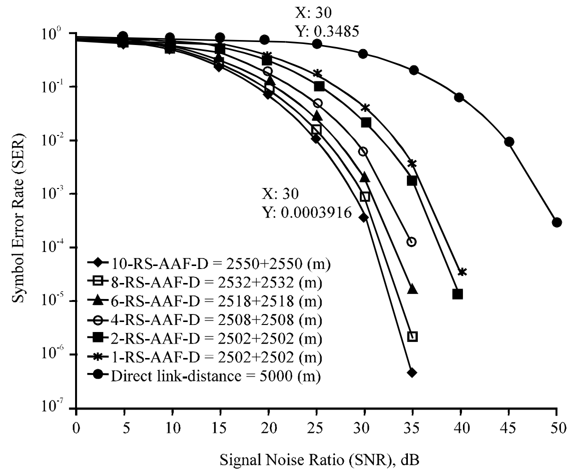

Fig. 14: Deploying relays between eNB and UE with DAF is used for C1 scenario

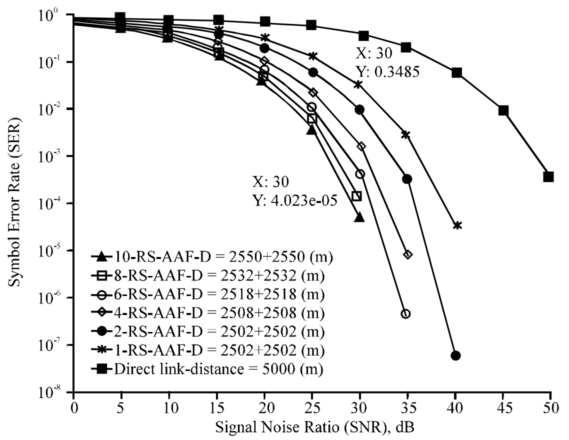

Fig. 13: Deploying relays between eNB and UE with AAF is used for C1 scenario

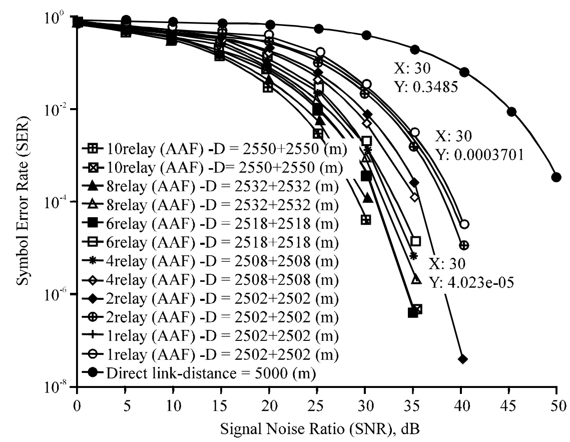

Fig. 15: Deploying relays between eNB and UE with AAF vs. DAF is used for C1 scenario

AAF technique close from eNB, it clearly demonstrates that a more gain is achieved of ten relays as compared to direct signal there is a 52.369% SER improvement achieved.

Figure 12 shows the improvement with deploy relays scheme than with direct scheme when ten relay are used in DAF technique close from eNB. It clearly demonstrates tha t a more gain is achieved of ten relayscompared to direct signal as there is a 52.188% SER improvement achieved. And clearly the same gain is achieved of eight Relays compared to ten Relay, so when deploying relays close from the eNB no need to deploy relay more than eight.

Figure 13 shows the comparison between AAF and DAF scheme when the relays are put close from eNB. The best performance of deploy relays Scheme with AAF is clearly better than DAF. When relays are used in AAF technique close from eNB. It clearly demonstrates that a more gain is achieved of ten Relays as compared to DAF there is a 0.1605%.

Figure 14 shows the improvement with deploy 10-relay scheme than the others. These curves are plotted against SER and SNR when ten relay are used and operated in AAF technique. This graph clearly demonstrates that a more gain is achieved with the cooperation of ten relays as compared to direct signal as there is a 34.846% SER improvement achieved with the cooperative of ten relay operating in AAF technique when positioning the relay between the eNB and UE.

Figure 15 shows the improvement with deploy relays cooperative than direct scheme without cooperative. This graph clearly demonstrates that a more gain is achieved at ten relays compared to direct signal. There is a 34.81%

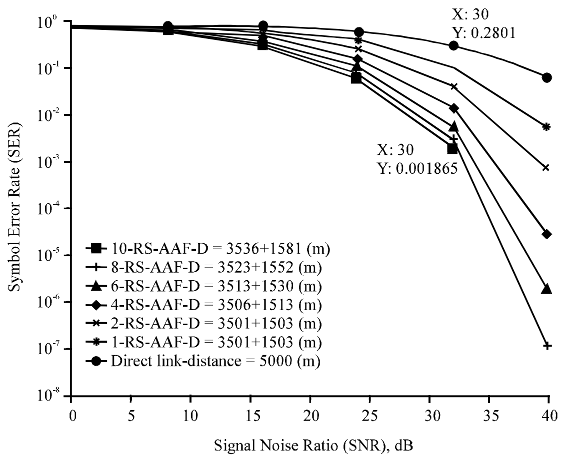

Fig. 16: Deploying relays far from eNB with AAF is used for C1 scenario

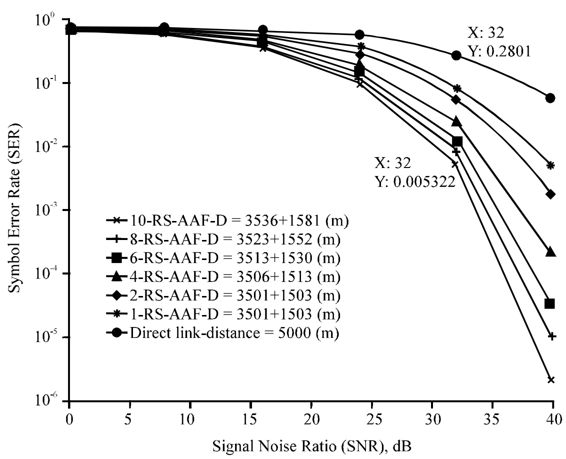

Fig. 17: Deploying relays far from eNB with DAF is used for C1 scenario

SER improvement achieved with the cooperative of ten relay operating in DAF technique when the relay is put between the eNB and UE.

Figure 16 shows the comparison between AAF and DAF scheme when the relays is put between eNB and UE. The best performance of deploy relays scheme with AAF is shown clearly than DAF. When relays are used in AAF technique between eNB and UE they clearly demonstrate that a more gain is achieved of ten relays as compared to DAF. Clearly find gain is achieved of other deployed Relays scheme of AAF compared to deployed relays scheme of DAF.

Figure 17 shows the improvement with deploy 10-relay scheme than all the other schemes and clearly a more gain is achieved with the cooperation of ten relays compared to direct signal which reaches to 27.82% SER improvement in AAF technique when deploy relays near UE.

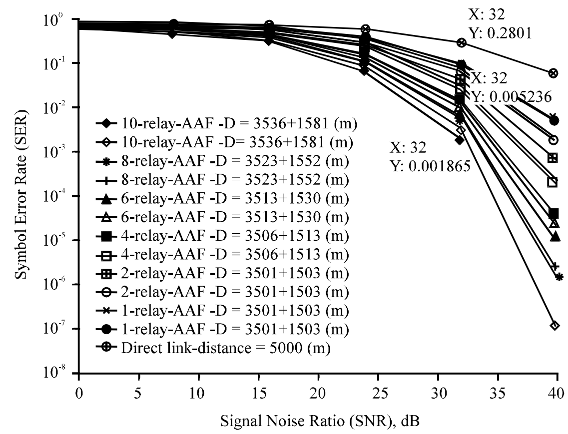

Fig. 18: Deploying relays far from eNB with AAF vs. DAF is used for C1 scenario

Figure 18 shows the improvement with deploy relays schemes than direct scheme and clearly a more gain is achieved with the cooperation of ten, eight and six Relays compared to direct signal reaching to 27.478% SER improvement in DAF technique when deploy relays are close from UE. So when deployed relays close from the UE, it just distributes no more than six or eight relays.

Figure 18 shows the comparison between AAF and DAF scheme when the relays put close from UE. The best performance of deploy relays scheme with AAF is shown clearly than DAF. When relays are used in AAF technique close from UE, it clearly demonstrates that a more gain is achieved of ten relays as compared to DAF as there is a 0.3371% SER improvement achieved. Clearly, find gain is achieved of other deployed relays scheme of AAF compared to deployed relays scheme of DAF.

CONCLUSION

In Long Term Evolution-Advanced (LTE-A) systems, the transmission quality, signal strength and coverage area are affected by white Gaussian noise, shadowing, wireless interference etc. This effect can be decreased by using more number of evolved eNB but problem is that eNBs are expensive and it will increase network cost. Relay Stations RS are less expensive than eNBs, hence we go for RS deployment instead of eNBs. The main idea of this study was to explore the feasibility of optimal deploying relays support for the LTE-advanced channel model used to create several scenarios where relays is involved as a medium of transmitting signal to the UE. The researchers built a simulator to support relay nodes from the WINNER 2 Model to simulate the results and evaluate the performance of the network by performing the SNR vs. SER in relay environments. Both the non-cooperative and cooperative environment is simulated. So, a total of seven different environments for suburban macro cell scenarios are considered. The simulation results showed optimal of deploying 10 relays environment are better than the others deploying environments even when deploying direct link environment. The analysis shows that the addition of different relays in cooperative environment actually results in a lower symbol error rate in the SNR vs SER curve.

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