3GPP TSG RAN WG 1 ***TSGR1#20 R1-01-0576***
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Agenda Item: AH26: Tx Diversity (R5)

Source: Samsung and Seoul National University

Title: Performance results of basis selection transmit diversity for 4 antennas (update)

Document for: Discussion and approval

In this paper we provide further simulation results for various spatial correlated environments relative to the previous contribution R1-00-1073: *"Performance results of basis selection transmit diversity for 4 antennas",* which includes results of Macro cell, Micro cell in the Vehicular A channel and in the Pedestrian A channel [1].

The correlated channel model is same as described in R1-00-1180: "Channel model for Tx diversity simulation using correlated antennas" except AOD (angle of departure) is not fixed [2].

1 Introduction

History of >2 antenna Tx Diversity:

In TSG-RAN WG1#12, Seoul meeting, the usage of >2 transmit diversity and its preliminary simulation results was reported. This basis selection scheme is one of the methods to reduce feedback information by using the feature of a spatial basis vector [14(00)-882]. The simulation results of the advanced closed loop Tx diversity (**A-CLTD**) scheme showed excellent performance in correlated environment condition, i.e. micro and macro cellular [19(01)-0203].

Since it use spatial eigenbasis according to the dominant eigenvalue, this scheme effectively improves the performance of the channel estimation in both of the uplink and downlink beamforming case, as well as dramatically reduces the feedback information.

Update basis selection for correlated environments:

For the correlated channel, it use eigenbasis as spatial basis and table1 and table2 for feedback information multiplexing format according to the [19(01)-0203]. Therefore, no fast selection change is assumed.

Difference of basis selection and A-CLTD:

In A-CLTD, it is recommended to switch beams in order for beamforming the desired direction. Therefore, the weight vector is used as $\mathbf{w} = \mathbf{e}_1$ or $\mathbf{e}_2$ for this scheme. The performance of this scheme shows good in the correlated environment because of forming the beam toward the optimum direction.

However, in this **Basis Selection 4A2B/4A3B** scheme, 2bit-phase coherent combine was used for reducing the feedback information and for taking high resolution concurrently. Therefore, the weight vector is used as $\mathbf{w} = \mathbf{e}_1 + \mathbf{e}_2\exp(j\theta)$, where $\theta \in \{\pi/4, 3\pi/4, -\pi/4, -3\pi/4\}$ for 2 basis case and $\mathbf{w} = \mathbf{e}_1 + \mathbf{e}_2\exp(j\theta_1) + \mathbf{e}_3\exp(j\theta_2)$, where θ_1, $\theta_2 \in \{\pi/4, 3\pi/4, -\pi/4, -3\pi/4\}$ for 3 basis case. Nevertheless, the quality of this combination is poor in correlated environment.

Eigen basis selection

In this scheme, the pdf of eigenvalue is also considered, actually that is key idea of this scheme. For example, the beam switching is used in highly correlated environment but basis combining is used less correlated environments.

2 Simulation

2.1 Channel environments

The correlated channel mode is followed by R1-00-1180 : “Channel model for Tx diversity simulation using correlated antennas” but the AOD is not fixed.

2.2 Schemes for simulation

- Single antenna scheme: 1 antenna case
- R99 Mode2: Release 99 Mode 2
- **Nokia R2F2**: An extension of closed loop Tx diversity mode 1
- **A-CLTD**: advanced closed loop Tx diversity (beam switching)
  - $\mathbf{w} = \mathbf{e}_1$ or $\mathbf{e}_2$
- **Basis Selection 4A2B**: two basis in 4 antenna system (basis combine)
  - $\mathbf{w} = \mathbf{e}_1 + \mathbf{e}_2\exp(j\theta)$, where $\theta \in \{\pi/4, 3\pi/4, -\pi/4, -3\pi/4\}$
- **Basis Selection 4A3B**: three basis in 4 antenna system (basis combine)
  - $\mathbf{w} = \mathbf{e}_1 + \mathbf{e}_2\exp(j\theta_1) + \mathbf{e}_2\exp(j\theta_2)$, where $\theta_1, \theta_2 \in \{\pi/4, 3\pi/4, -\pi/4, -3\pi/4\}$
- **E-Basis Selection 4A2B**: same to the **Basis Selection 4A2B** except using the pdf of eigenvalue.
  - $\mathbf{w} = \mathbf{e}_1 + (\beta_2/\beta_1)\mathbf{e}_2\exp(j\theta)$, where $[\beta_1 \quad \beta_2] \propto \left[\sqrt{\lambda_1} \quad \sqrt{\lambda_2}\right]$
- **E-Basis Selection 4A3B**: same to the **Basis Selection 4A3B** except using the pdf of eigenvalue.
  - $\mathbf{w} = \mathbf{e}_1 + (\beta_2/\beta_1)\mathbf{e}_2\exp(j\theta_1) + (\beta_3/\beta_1)\mathbf{e}_2\exp(j\theta_2)$, where $[\beta_1 \quad \beta_2 \quad \beta_3] \propto \left[\sqrt{\lambda_1} \quad \sqrt{\lambda_2} \quad \sqrt{\lambda_3}\right]$

2.3 Simulation parameters

Table 1 Basic simulation parameters

Bit Rate	*12.2 kbps*
Chip Rate	*3.84 Mcps*
Convolutional code rate	*1/3*
Carrier frequency	*2 GHz*
Power control rate	*1500 Hz*
PC error rate	*4 %*
PC Step Size	*1 dB total*
Channel model(s) and UE velocities	*Modified ITU Ped. A: 3, 10, 40, 120 km/h* *Modified ITU Veh. A: 3, 10, 40, 120 km/h*
CL feedback bit error rate	*4 %*
CL feedback delay	*1 slot*
TTI	*20 ms*
Target FER/BlkER	*1 %*
Geometry (G)	*0 dB*
Common Pilot	*-10 dB total*
Correlation between antennas	*Macro, Micro*
CL feedback rate	*1500 bps*

Table 2 Special simulation parameters

Comparing output	*Required Ec/Ior*
Modulation	*QPSK*
Physical channel rate	*30ksps*
Number of antennas	*Single Antenna: 1 EA* *R99 Mode 2: 2 EA* *Otherwise: 4 EA*
Total FSM bits	*Single Antenna: Not used* *R99 Mode2: 4bits*

	Nokia R2F2: 6bits *A-CLTD: 1bits* *Basis Selection 4A2B: 2bits* *Basis Selection 4A3B: 4bits* *E-Basis Selection 4A2B: 2bits* E-Basis Selection 4A3B: 4bits
Slot format	*#10 (6,2,0,24,8)*
Channel estimation	*Dedicated pilot (1slot)*
MPI modeling	*All noncoherent*

2.4 Simulation results

Same DOA

Vehicular A - Macro channel (Figure 1):
Both **A-CLTD** and **E-Basis Selection 4A2B** shows similar but best performance**.** Simulation shows that **E-Basis Selection 4A2B** offers at most 2.1dB gain at 120km/h, compared to **Nokia R2F2**.

Pedestrian A - Micro channel (Figure 2):
Both **Basis selection 4A2B** and **E-Basis selection 4A2B** shows similar but best performance**.** Simulation shows that **E-Basis Selection 4A2B** offers at most 3.1dB gain at 10km/h, compared to **Nokia R2F2**.

Different DOA environments

Vehicular A – Macro channel (Figure 3):
Both **A-CLTD** and **E-Basis selection 4A2B** shows similar but best performance**.** Simulation shows that **A-CLTD** offers at most 1.2dB gain at 40km/h, compared to **Nokia R2F2**.

Pedestrian A – Micro channel (Figure 4):
Both **Basis Selection 4A2B** and **E-Basis selection 4A2B** shows similar but best performance**.** Simulation shows that **E-Basis Selection 4A2B** offers at most 1.2dB gain at 40km/h, compared to **Nokia R2F2**.

Vehicular A – Micro channel (Figure 5):
Nokia R2F2 offers only 0.8 to 2.4dB but if **E-Basis Selection 4A3B** for 3 basis in 4 antennas is used, the gain could be reduced.

Pedestrian A – Macro channel (Figure 6):
This simulation shows the results of highly correlated environment in case of Pedestrian A.

3 Further study

More study is required in the Pedestrian A – Macro channel. If there is such kind of cell as like as 1 in figure 6, the antenna diversity is necessary. The comparison of **E-Basis Selection 4A3B** with **Nokia R2F2** is required in Vehicular A – Micro channel. The long-term parameter feedback is not considered but the effects of the feedback error need to be considered.

4 Conclusion

We showed the simulation results of many diversity schemes in the correlated environments. Therefore, simulation shows that the beamswitching is best scheme in the macro cell and the basis combing is best scheme in the micro cell than any other scheme. The best scheme, **E-Basis Selection**, in both environments concurrently was also proposed.

References

[1] Samsung and Seoul National University, "Preliminary version of algorithm and Simulation results for Tx Diversity with more than 2 Tx Antennas", Tdoc R1-00-0882

[2] Samsung and Seoul National University, "Performance results of basis selection transmit diversity for 4 antennas", Tdoc R1-00-1073

[3] Siemens "Simulation parameters for Tx diversity simulation using correlated antennas", Tdoc R1-00-1180

[4] Siemens, "Description of the eigenbeamformer concept (update) and performance evaluation", Tdoc R1-01-0203

contact point

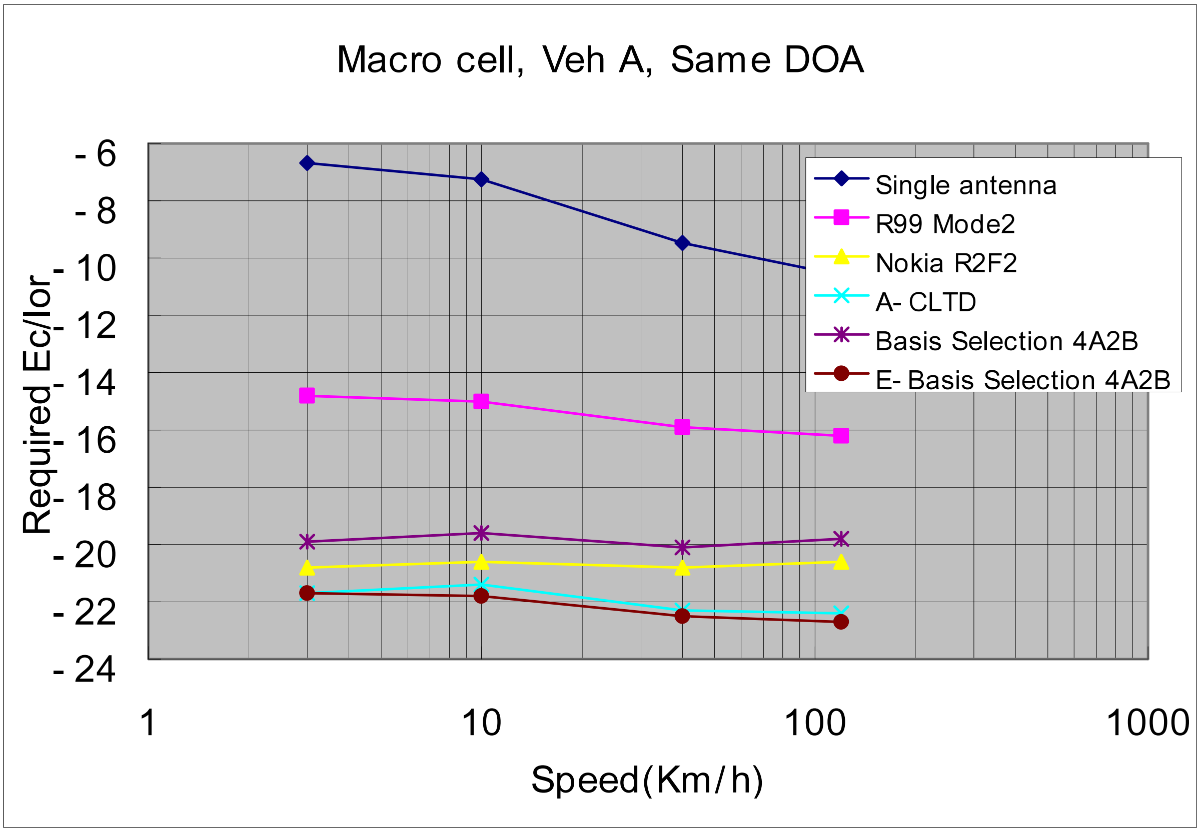

Figure 1. Same DOA: Vehicular A channel - Macro channel

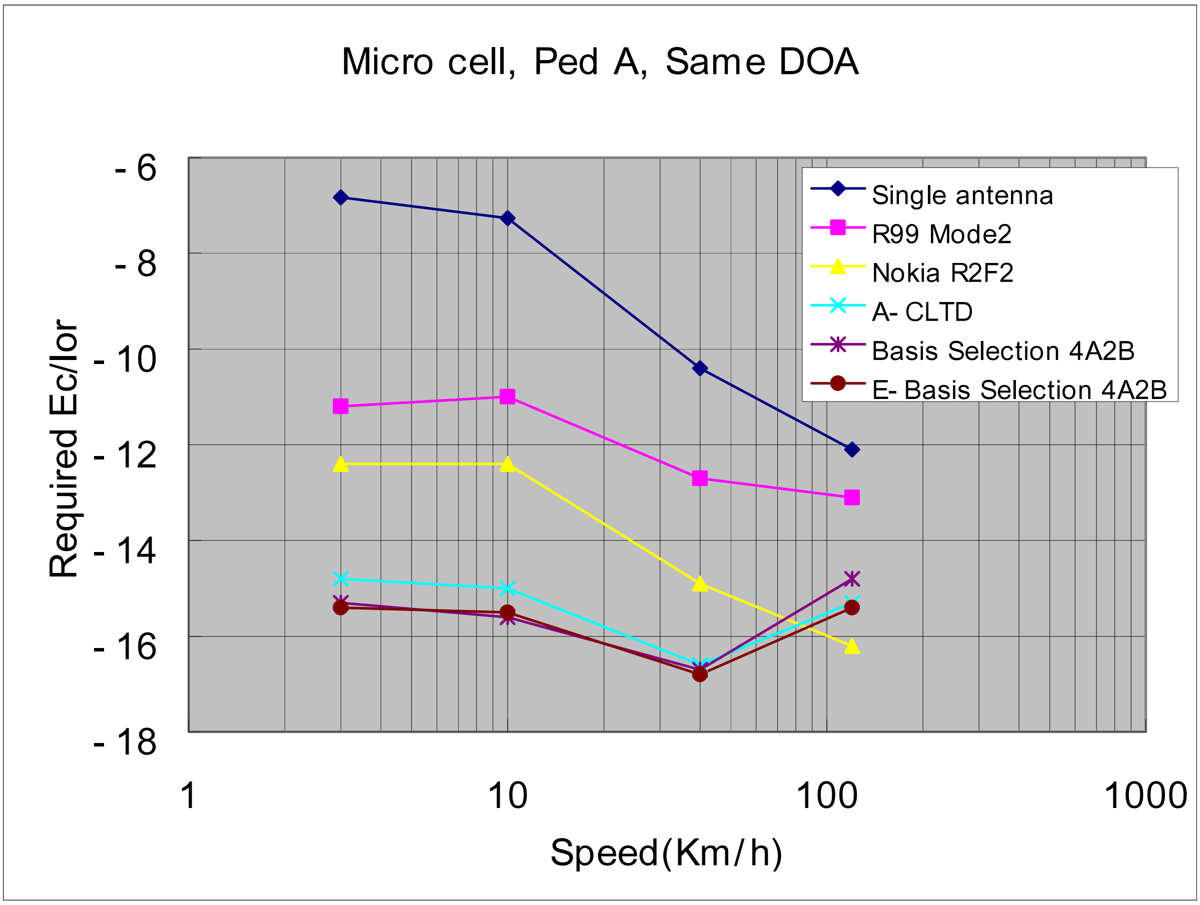

Figure 2. Same DOA: Pedestrian A - Micro channel

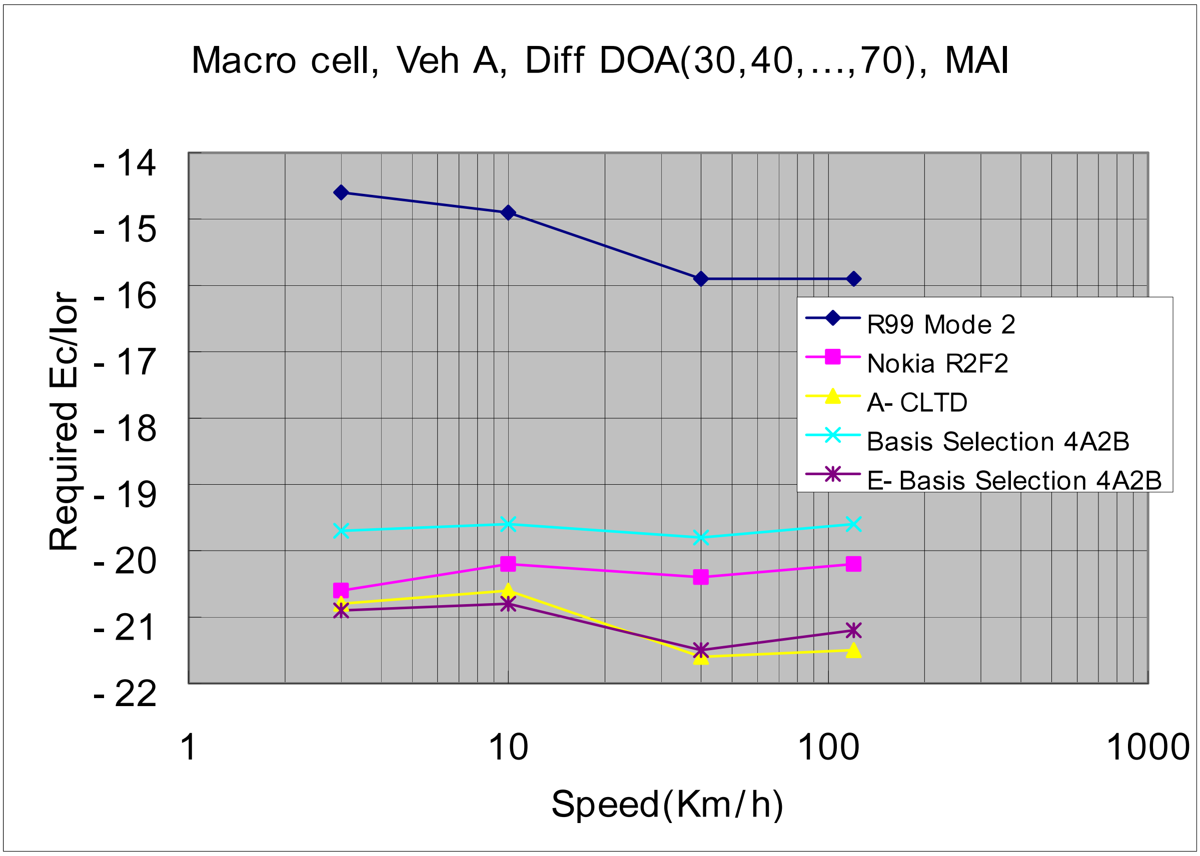

Figure 3. Diff DOA: Vehicular A – Macro channel

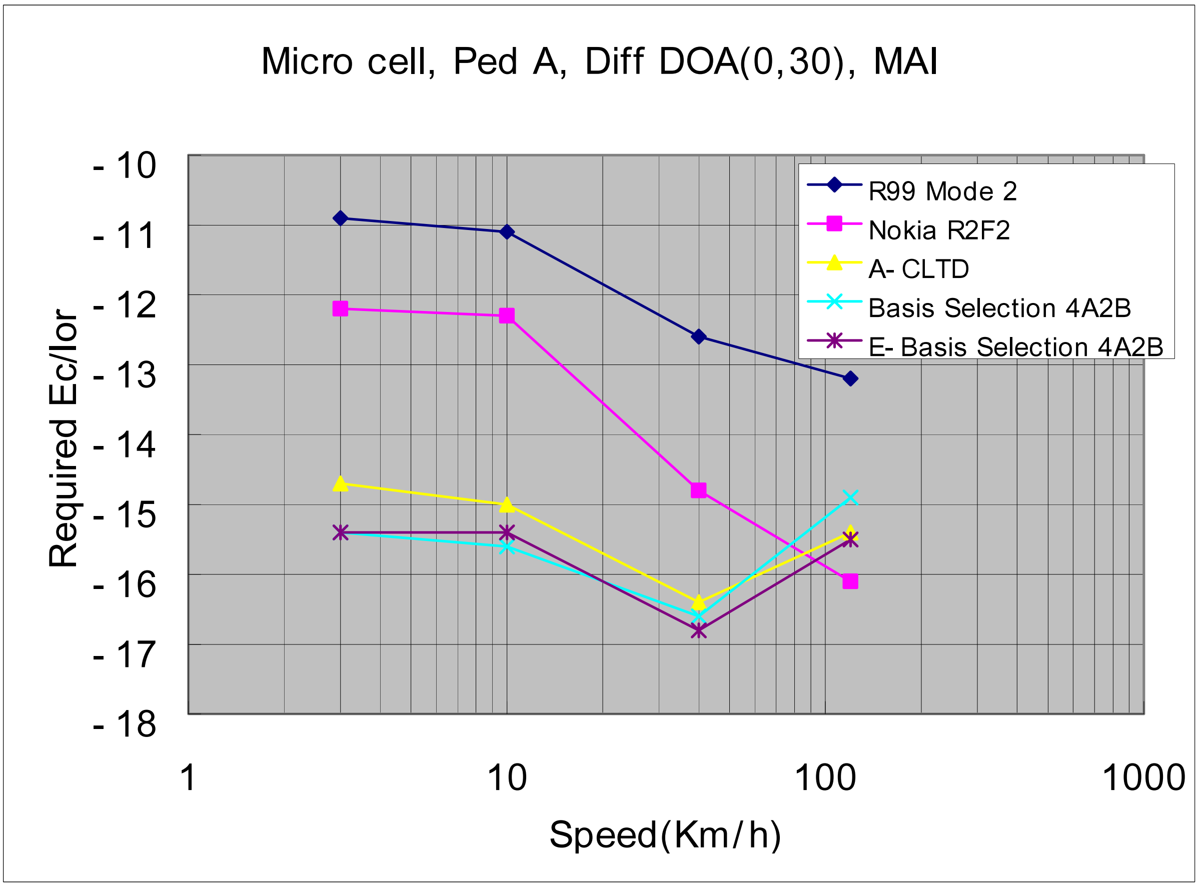

Figure 4. Diff DOA: Pedestrian A – Micro channel

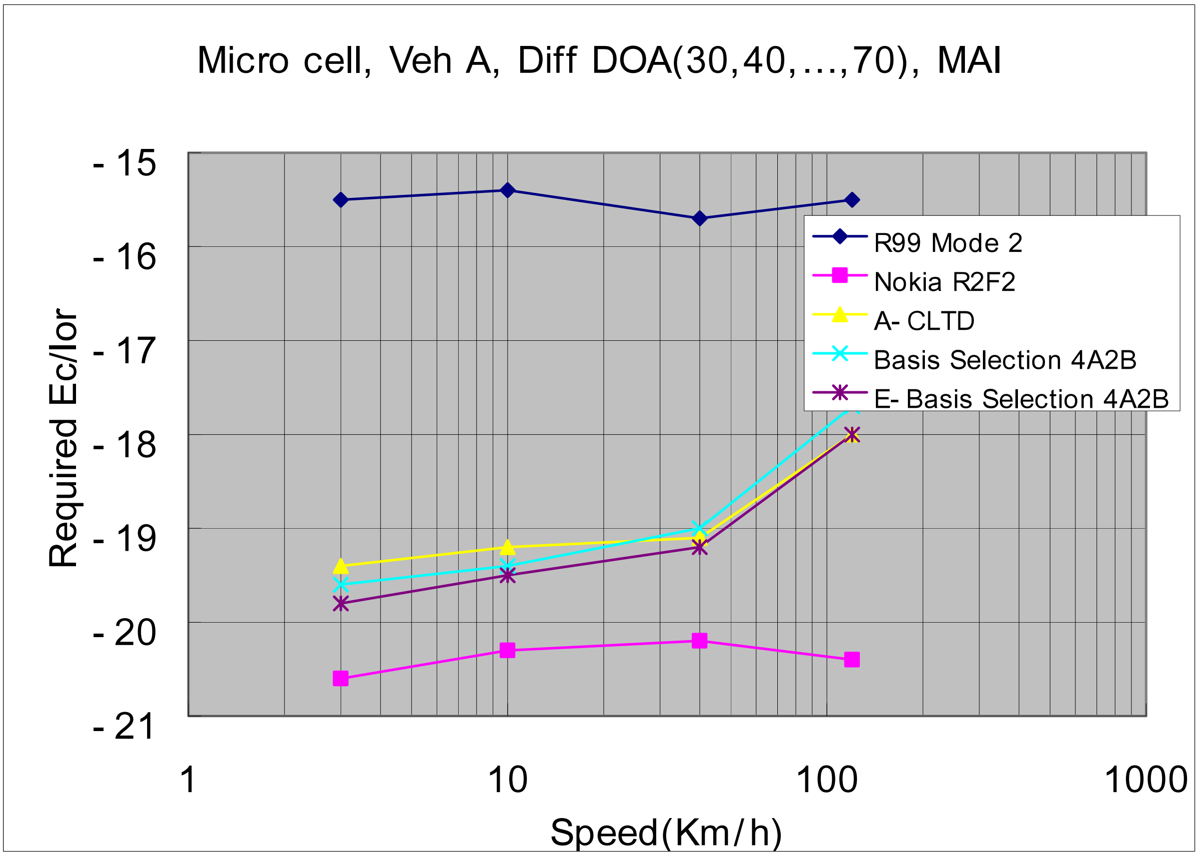

Figure 5. Diff DOA: Vehicular A – Micro channel

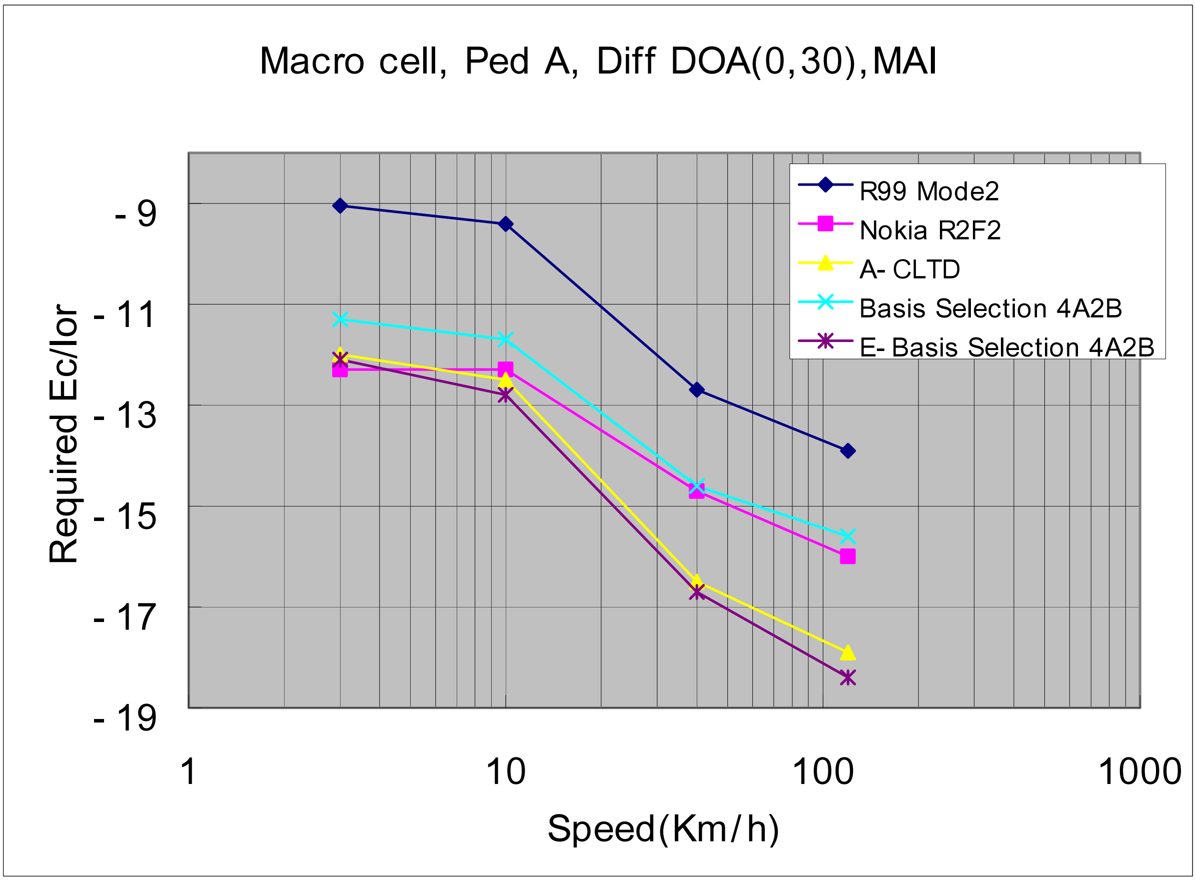

Figure 6. Diff DOA: Pedestrian A – Macro channel