Source: **Motorola**
Title: **Far Scattering Cluster**
Document for: **Discussion**

1. SUMMARY

The Far-Scattering (FS) model as described in [1], is an important model for describing cases where a non-uniform environment produces a set of delayed paths with specific power and angle relationships. This case is often considered to represent a bad-urban environment [2]. It is likely that this case should also be used to model suburban areas, which often have late rays produced by buildings, terrain, or environment features.

- The Far-Scattering model is implemented with parameter value assumptions
- Examples are given for validation purposes.

2. FAR-SCATTERING MODEL FOR MACRO-CELLS

The Far-Scattering model is described here with parameters suited for implementing this model with the spatial channel model.

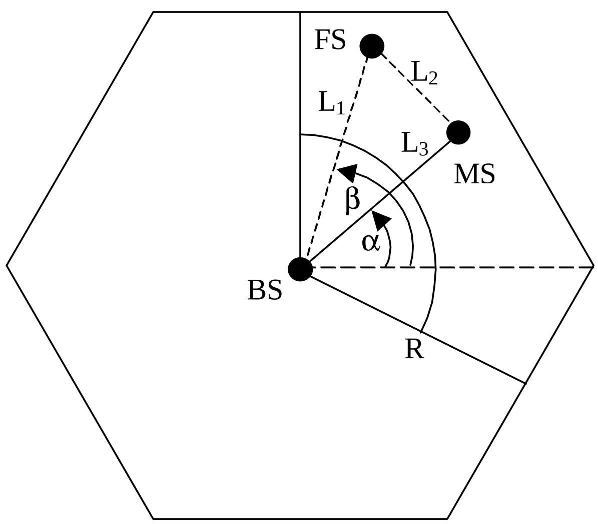

Figure 1, Far-Scattering Cluster Geometry

Figure 1 describes the geometry associated with the far-scattering model that was proposed in previous contributions.

R = Radius beyond which the far-scattering cluster may be located.
FS = Location of the far-scattering cluster
MS = Subscriber location
BS = Base station location
L1 = Distance between BS and FS
L2 = Distance between FS and MS
L3 = Distance between BS and MS
α = angle to the MS
β = angle to the FS

The geometry shown in Figure 1 is used to define several of the parameter values. Four paths are associated with L3 which is the line-of-sight path to the MS. The composite base angle spread associated with the NLOS propagation model will have an average AoD in the direction of α.

The path with the shortest delay cannot be less than the time required to travel the line-of-sight distance from the base to mobile. (The SCM does not define the first path at time $\tau = 0$ to be a LOS path, but this is assumed here as a reference unless an excess path delay is specified.)

The excess delay of the path to the far-scatterer will be the delta path delay between the far-scatterer path and the BS to MS path. $L_1 + L_2$ = path distance from BS to MS via the far-scatterer. The delta distance will be: Excess Distance = $L_1 + L_2 - L_3$. Therefore the excess delay is obtained by dividing the distance by C, the speed of light.

Excess Path Delay $\tau_{excess} = (L_1 + L_2 - L_3)/C$

The far-scatterer was suggested to be located geometrically in the cell beyond the minimum distance R=500m using a uniformly random location. This presents some problems however since the far-scatterer biases the geographic cell compared to other cells.

To address this concern, the far-scatterer must be located with respect to the mobile, such that other sectors, or other cells will have the correct probability of being affected by the far scatterer. To construct the model this way, a ring around the mobile is required.

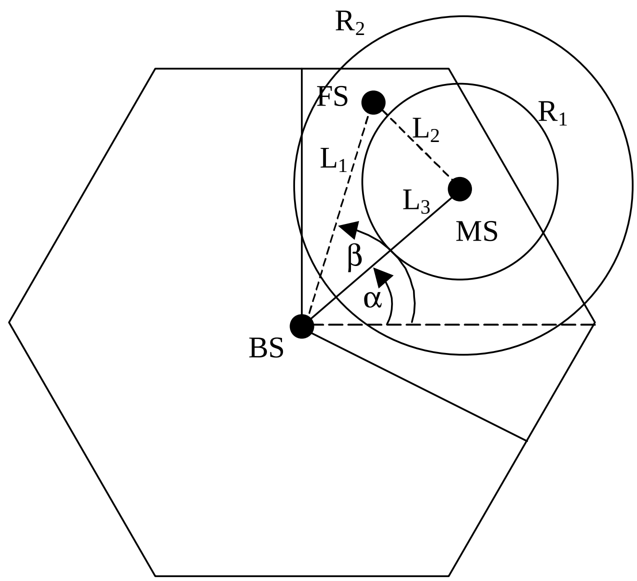

Figure 2, Locating the Far Scattering Cluster

Figure 2 illustrates the concept of locating the FS cluster relative to the mobile using a minimum radius R1 = 500m, and a maximum radius R2 = 1000m.

The shadow fading has been described to be common among all paths of the same cluster, and independent between clusters. The site-to-site correlation of 50% applies to this situation since the environmental characteristics near the mobile are common to both paths.

The procedure in detail is:

1. Drop MS within test cell as usual.

2. Drop FS relative to the MS with a random angle, and minimum radius R1 = 500m, and maximum radius R2 = 1000m.

3. Generate 6 delays

$\tau_1, \tau_2, \tau_3, \tau_4, \tau_5, \tau_6$

4. Sort $\tau_1,\ldots,\tau_4$ into increasing delays,

5. Subtract shortest delay of $\tau_1,\ldots,\tau_4$ from each of $\tau_1,\ldots,\tau_4$

6. Sort τ_5, τ_6 into increasing delays,

7. Subtract shortest delay of τ_5, τ_6 from each of τ_5, τ_6

8. Assign Powers to paths corresponding to all 6 delays:

$P_n' = e^{\frac{(1-r_{DS})\cdot\tau_n}{r_{DS}\cdot\sigma_{DS}}} \cdot 10^{-\xi_n}$, $n = 1,\ldots,6$ where ξ_n $(n = 1,\ldots,6)$ are i.i.d. Gaussian random variables with variance $\sigma^2_{RND} = (3\text{ dB})^2$.

9. Calculate excess path delay τ_{excess} and add to τ_5 and τ_6.

10. Attenuate P_5 and P_6 by 1dB/uS of excess delay with a 10dB maximum attenuation.

11. Include proper shadow fading deltas between clusters.

12. Normalize powers of the 6 paths to unity power.

In the following plots, simulation results are shown to illustrate the behavior of the far scattering cluster when it is added to the standard SCM model.

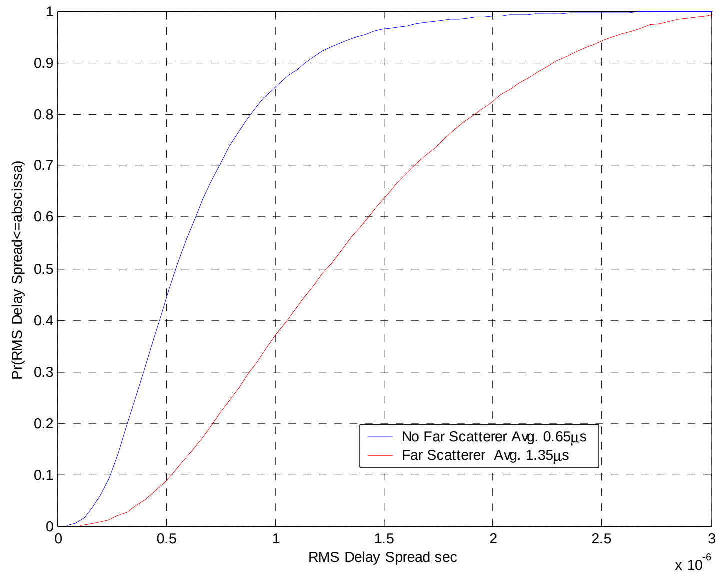

Figure 3, Delay Spread with a Far-Scattering Cluster

Figure 3 describes the distribution of simulated delay spread. When the Far Scatterer is added to the model with its extra path length, the delay spread is increased accordingly. The average value increases from the 0.65uS for the No-FS case to 1.35uS for the FS case.

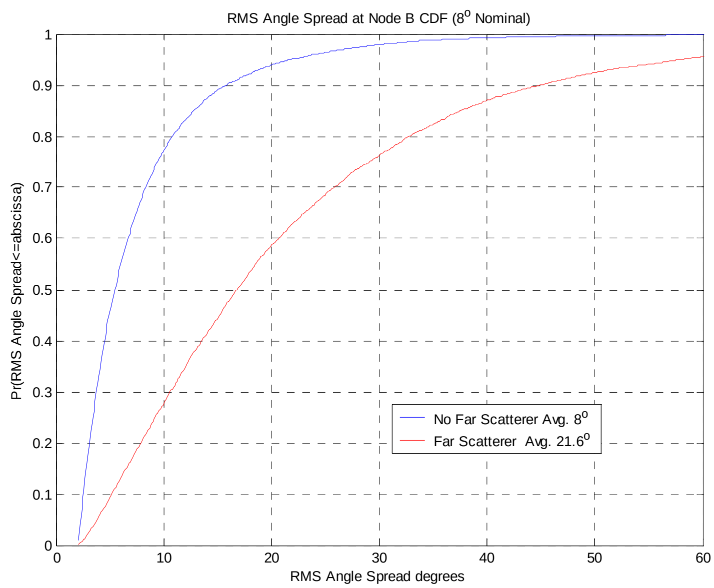

Figure 4, Composite Base Angle Spread with a Far Scattering Cluster (8° nominal)

Figure 4 describes the composite base angle spread when the FS cluster is added for the case when the AS = 8°. There is an increase in angle spread caused by the relative angle difference and the powers associated with the signals arriving from the later cluster.

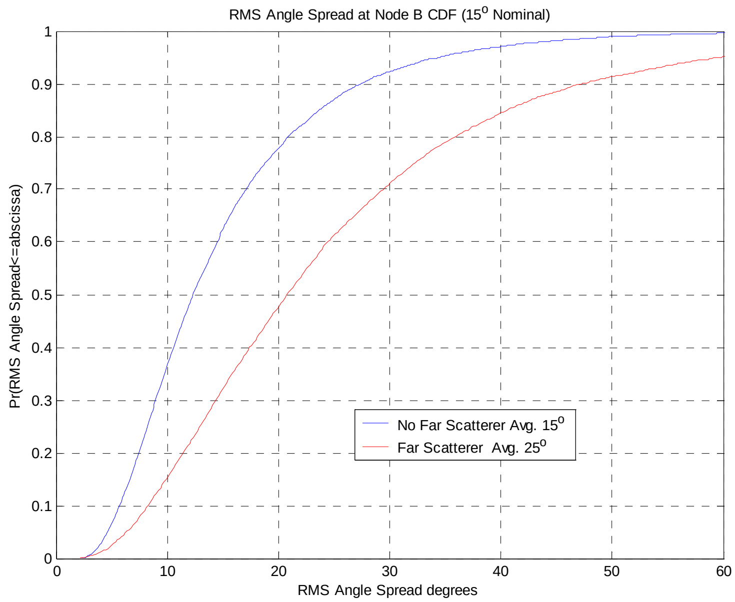

Figure 5, Composite Base Angle Spread with a Far Scattering Cluster (15º nominal)

Figure 6 describes the composite base angle spread when the FS cluster is added to the model for the case when the AS = 15º. There is an increase in angle spread caused by the relative angle difference and the powers associated with the signals arriving from the later cluster.

3. CONCLUSION

Details are given to describe the Far Scatterer operation. There are a number of assumptions and parameters that were not well described in previous documents, and these are examined in this contribution.

The FS cluster needs to be specified with respect to the mobile location so that the geographic sector is not biased, thus allowing different sectors or different cells to have a statistically fair chance to be the best server.

The concept of using a doughnut shape around the mobile to locate the FS cluster was shown. The inner radius is 500m, and the outer radius is 1000m.

4. REFERENCES

[1] Mitsubishi Electric Research Lab, SCM-072, “Open Questions on the MIMO Channel Model”, Quebec City, October 22 nd , 2002.

[2] L. M. Correia, Wireless Flexible Personalized Communications, COST 259: European Co-operation in Mobile Radio Research, Chichester: John Wiley & Sons, 2001.