Vector Channel Modeling

Why are Vector Channel Models Needed?

- Adaptive array modeling
- Algorithm evaluation
- Algorithm development
- Cell site planning
- Deployment and evaluation of location technologies

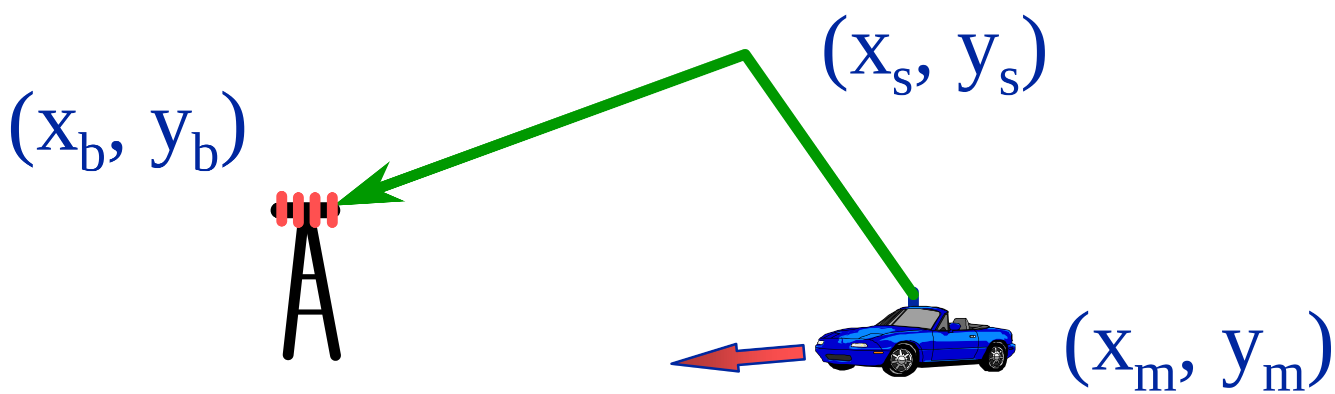
New Challenges In Describing the Model

- Spatial correlation
- Eigenvalue spread
- Angle spread
- Joint AOA-TOA statistics

Geometrical Models

- Location of each scatterer or scattering cluster is specified (e.g., uniform in circle about the mobile)
- Location determines signal properties

Channel Models - Geometrical Models



- AOA:

$$\theta = \text{atan}\left[(y_s - y_b) / (x_s - x_b)\right]$$

- TOA:

$$\tau = \left[\sqrt{(x_b - x_s)^2 + (y_b - y_s)^2} + \sqrt{(x_s - x_m)^2 + (y_s - y_m)^2}\right] / c$$

Evolution of Channel Models

- Single Element Receiver

Classical Models

Power level prediction, Doppler properties, Delay spread, Power-Delay profiles, etc.

- Multiple Element Receiver

New Challenges . . .

Spatial correlation, Eigenvalue spread, Angle spread, Joint AOA-TOA statistics, etc.

Geometrical vs. Statistical Models

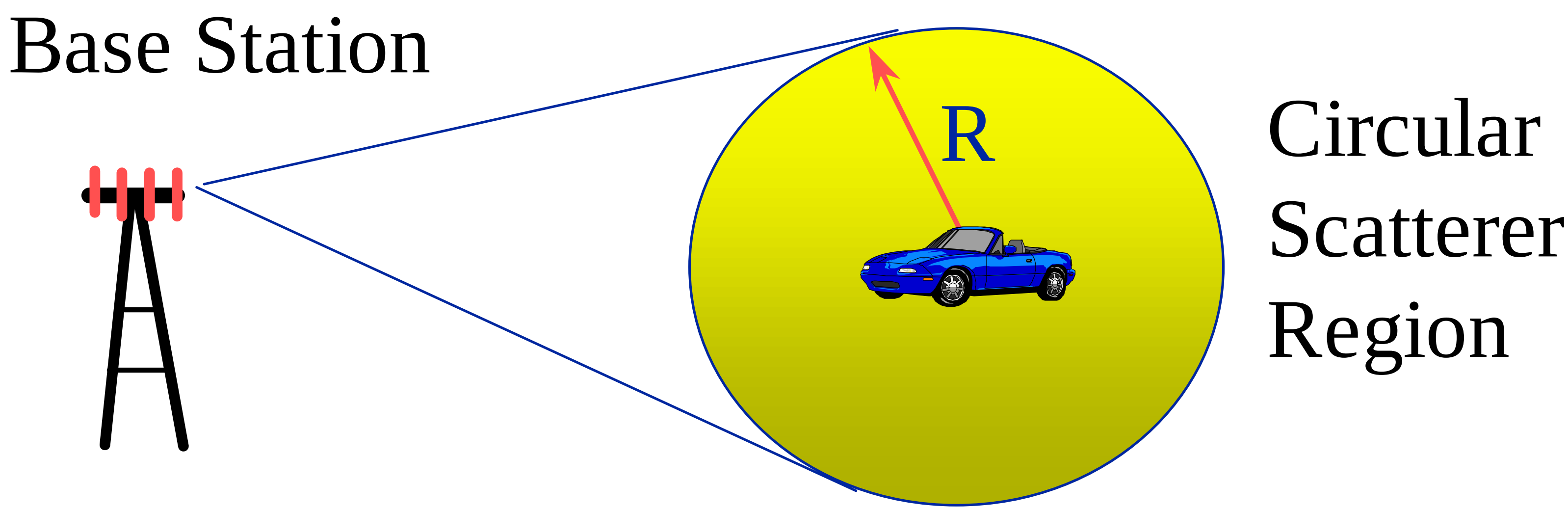
Geometrical Models

- Location of each scatterer or scattering cluster is specified (e.g., uniform in circle about the mobile)
- Location determines signal properties

Statistical Models

- Signal properties are found from some statistical distribution directly (e.g., Gaussian angle of arrival)
- The location of each scatterer is not specified

Circular Model (Macrocell)*

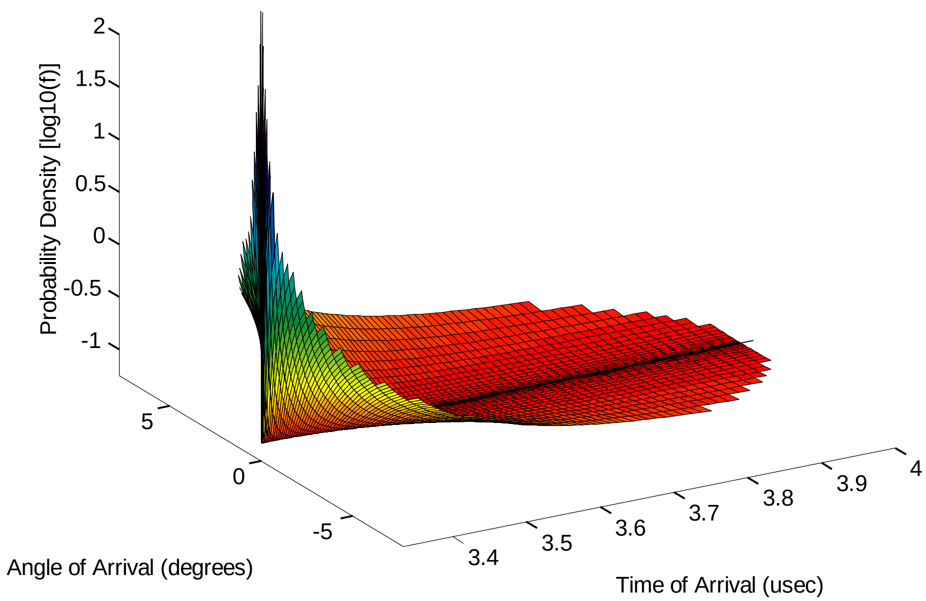


- Models macrocell environments
- Scatterers are uniformly distributed in a circular region about the mobile
- Approximate radius, 30 m < R < 200 m

Spatial Channel Models

Joint TOA-AOA (Circular BS View)

$$f_{\tau,\phi_b}(\tau,\phi_b)=\begin{cases}\dfrac{(D^2-\tau^2c^2)(D^2c+\tau^2c^3-2\tau c^2D\cos(\phi_b))}{4\pi R_m^2(D\cos(\phi_b)-\tau c)^3} & : \dfrac{D^2-2\tau cD\cos(\phi_b)+\tau^2c^2}{\tau c-D\cos(\phi_b)}\le 2R_m\\ 0 & : else.\end{cases}$$



$D = 1km$
$R_m = 100m$