CHANNEL MODEL

$$\underset{1\times2}{\vec{h}^{1\times2}_{ncs}} = \sum_{c=0}^{C}\sum_{s=1}^{S_c} \gamma_h I_h \sqrt{L_{T\text{-}RIS}}\, \underset{\sqrt{P_c}}{\beta_{cs}}\, a_n(\theta^{RIS}_{cs}, \phi^{RIS}_{cs})\, \underset{1\times2}{G^T_{e_t}(\theta^{cs}_{Tx})}\, \underset{2\times2}{\alpha_{cs}}\, \underset{2\times2}{\Theta_{ncs}}$$

★ $\gamma_h = \sqrt{\dfrac{1}{\sum_{c=1}^{C} S_c}}$: normalization constant (clustered channel models)

$\hookrightarrow$ 0 if LOS

3GPP v17.00

★ $I_h = \begin{cases} 0, & \text{if } c=0 \text{ and } I^{LOS}=0 \\ 1, & \text{else} \end{cases}$: control parameter

$\hookrightarrow I^{LOS} \in \{0,1\}$ with P_0 and P_1 $\hookrightarrow$ depends on env. and dist.

★ $L_{T\text{-}RIS} = \begin{cases} L^{LOS}_{T\text{-}RIS}, & \text{if } c=0 \text{ and } I^{LOS}=1 \\ L^{CS}_{T\text{-}RIS}, & \text{else} \end{cases}$: path loss coefficient

* $\beta_{cs} \sim \mathcal{CN}(0,1)$: fading parameter (or P_c)

↳ 1 if LOS

* $\underline{a_n(\theta_{cs}^{RIS}, \phi_{cs}^{RIS})}$: n^{th} element of array resp. vector → planar

→ θ_{01}^{RIS} : LOS angle from Tx-RIS (elevation)

→ θ_{cs}^{RIS} : randomly generated angles (elevation)

→ ϕ_{01}^{RIS} : LOS angle from Tx-RIS (azimuth)

→ ϕ_{cs}^{RIS} : randomly generated angles → $a_c \sim uni[1, d_{TX}^{RIS}]$ + Tx + RIS ⇓ cluster pozitions ⇓ bcs

$\phi_{TX}^{cs} \sim \mathcal{L}(\phi_{TX}^{c}, 5^\circ)$, $\theta_{TX}^{cs} \sim \mathcal{L}(\theta_{TX}^{cs}, 5^\circ)$

ϕ_{TX}^{c} ↓ uni$[-90^\circ, 90^\circ]$

θ_{TX}^{cs} ↓ uni$[-45^\circ, 45^\circ]$

* $G_{e_t}(\vartheta^{\epsilon}_{TX})$: Tx radiation pattern (assumed omni-directional)

* $\alpha_{cs} = \begin{bmatrix} \exp(j\Phi^{VV}_{cs}) & \sqrt{\kappa^{-1}_{cs}}\,\exp(j\Phi^{VH}_{cs}) \\ \sqrt{\kappa^{-1}_{cs}}\,\exp(j\Phi^{HV}_{cs}) & \exp(j\Phi^{HH}_{cs}) \end{bmatrix}$, $\kappa_{n,m} = 10^{X_{n,m}/10}$

$X_{n,m} \sim N(\mu_{XPR}, \sigma^2_{XPR})$

$\Phi^{pq} \sim \text{uni}[-\pi, \pi]$

→ polarization term , if $c=0 \Rightarrow \kappa_{n,m} = 0$

* Θ_{ncs} : 2x2 RIS response : $\begin{bmatrix} f^{VV} & f^{VH} \\ f^{HV} & f^{HH} \end{bmatrix}$

→ outdoor

$$\underbrace{\vec{g}_{nkl}}_{2\times 1} = \sum_{k=0}^{K}\sum_{l=1}^{L_k} \gamma_g I_g \sqrt{L_{RIS-R}}\, \underbrace{\beta_{kl}}_{\sqrt{P_c}}\, a_n(\phi_{kl}^{Rx}, \theta_{kl}^{Rx})\, \underbrace{\alpha_{kl}}_{2\times 2}\, \underbrace{b_{e_R}(\theta_{kl}^{Rx})}_{2\times 1}$$

→ all parameters are generated the same way with $\vec{h}_{ncs}$

→ indoor

↳ $g_{nkl} \rightarrow g_n$ (Pure LOS) ← RIS and Rx too close (valid assump.)

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excess phase

→ indoor (shared cluster model)

$$h_{SISO} = \sum_{c=0}^{C}\sum_{s=1}^{S_c} \gamma_h I_{h_{SISO}} \sqrt{L_{T-R}}\, \underbrace{\beta_{cs}}_{\frac{G}{\sqrt{P_c}}}\, \underbrace{b_{e_t}^{T}(\theta_{Tx}^{cs})}_{1\times 2}\, \underbrace{\alpha_{cs}}_{2\times 2}\, \underbrace{b_{e_R}(\theta_{cs}^{RX})}_{2\times 1}\, e^{j\Omega_e}$$

caused by the difference b_{cs}, $\tilde{b}_{cs}$

→ outdoor

$$h_{SISO} = \sum_{c=0}^{\bar{C}}\sum_{s=1}^{\bar{S}_c} \gamma_{h_{SISO}} I_{h_{SISO}} \sqrt{L_{T-R}}\, \bar{\beta}_{cs}\, b_{e_t}^{T}(\theta_{Tx}^{cs})\, \alpha_{cs}\, b_{e_R}(\theta_{cs}^{RX})$$