Preliminary Discussion on Taped-Delay-Line Based MIMO Channel Model

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Purpose:
To discuss the probability assignment for RS above and below rooftop and the standard deviation of lognormal shadowing distribution

Introduction and Background

- Full Spatial Channel Models (SCM) is available for system level simulation
  - With narrow band limitation (max 5MHz)
  - Very complicated for generation and excessive run time is required
- Simplified Taped-Delay-Line MIMO channel model can be employed
  - For both link level and system simulations
- We discuss the MIMO channel generation method
  - Independent MIMO channel generation
  - Correlated MIMO channel generation

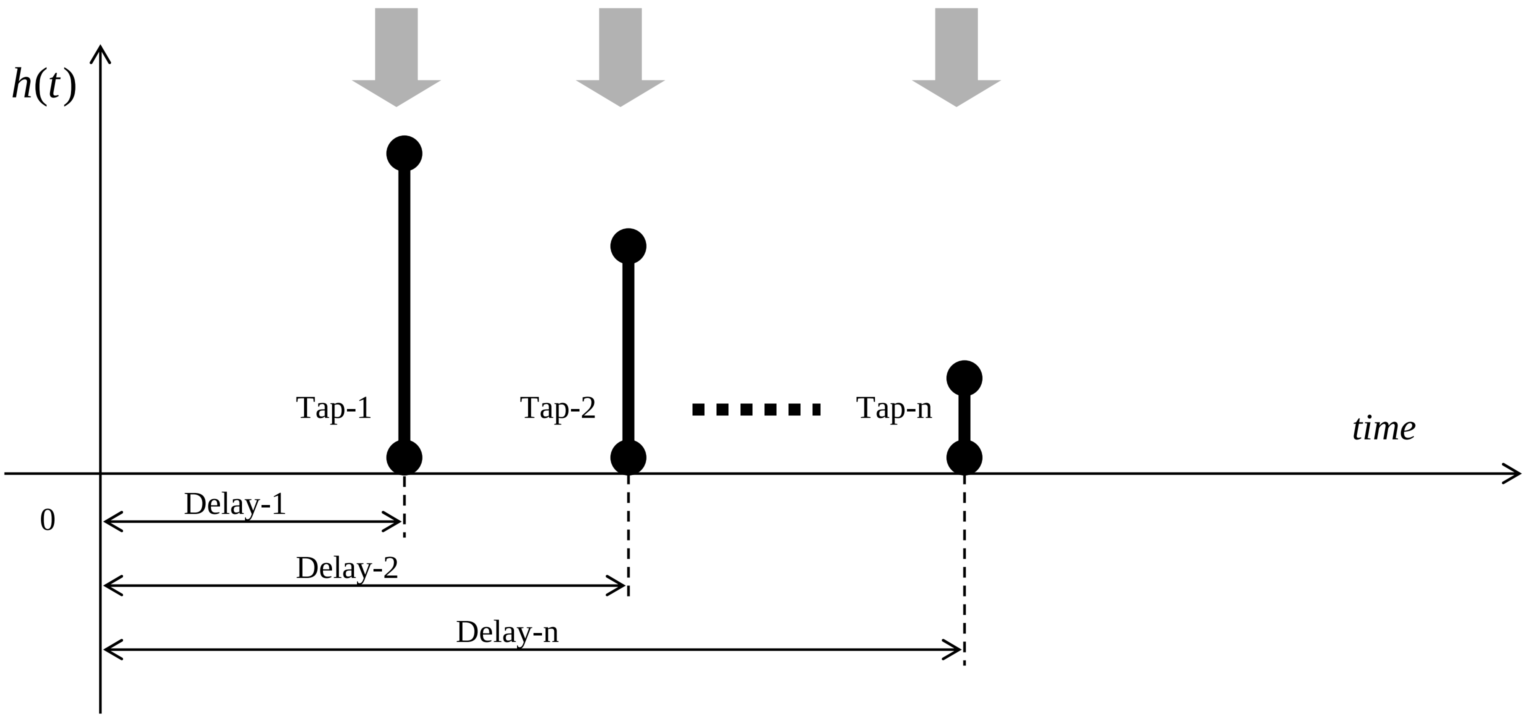
Methodology

- A tapped-delay-line based MIMO model is used for link level performance evaluation
  - It is a simplified MIMO propagation channel model
- The link level propagation aspects are captured by impulse response model
  - E.g. ITU channel model for narrow band (5MHz) channel
- The independent multiple Rayleigh faders are employed
  - Li-Hung model
- The MIMO-antenna /MIMO-channel correlation aspects are captured by correlation factor

Channel Model-Time Structure

- Tapped delay line model

$$H_1(t)=\begin{bmatrix} h_{1,1}(t) & h_{1,2}(t) \\ h_{2,1}(t) & h_{2,2}(t) \\ h_{3,1}(t) & h_{3,2}(t) \\ h_{4,1}(t) & h_{4,2}(t) \end{bmatrix} \quad H_2(t)=\begin{bmatrix} h_{1,1}(t) & h_{1,2}(t) \\ h_{2,1}(t) & h_{2,2}(t) \\ h_{3,1}(t) & h_{3,2}(t) \\ h_{4,1}(t) & h_{4,2}(t) \end{bmatrix} \quad H_n(t)=\begin{bmatrix} h_{1,1}(t) & h_{1,2}(t) \\ h_{2,1}(t) & h_{2,2}(t) \\ h_{3,1}(t) & h_{3,2}(t) \\ h_{4,1}(t) & h_{4,2}(t) \end{bmatrix}$$



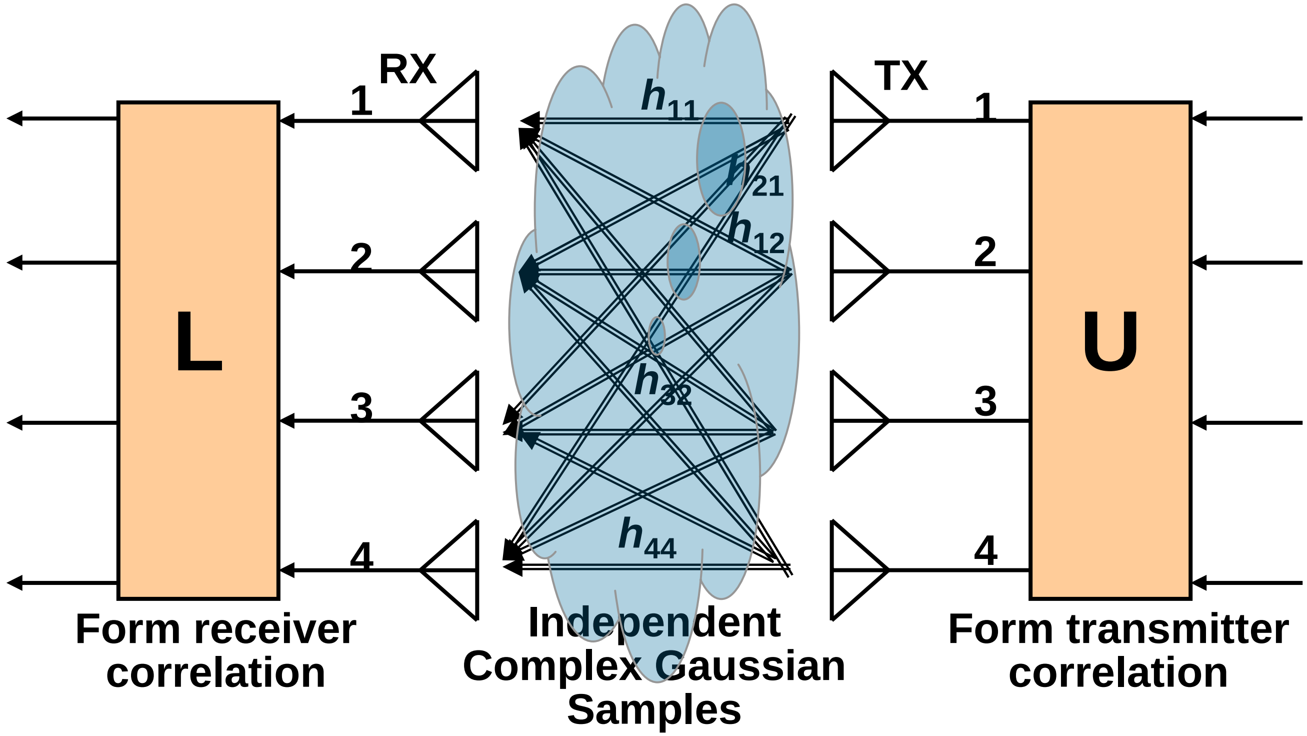
ITU Channel Model Parameters (Examples)

- 3 ITU channel models

Tap	OIP-A		OIP-B		V-A		Doppler spectrum
	Relative Delay (ns)	Average Power (dB)	Relative Delay (ns)	Average Power (dB)	Relative Delay (ns)	Average Power (dB)	
1	0	0	0	0	0	0	Classic
2	110	-9.7	200	-0.9	310	-1.0	Classic
3	190	-19.2	800	-4.9	710	-9.0	Classic
4	410	-22.8	1200	-8.0	1090	-10.0	Classic
5	-	-	2300	-7.8	1730	-15.0	Classic
6	-	-	3700	-23.9	2510	-20.0	Classic

- Need to improve ITU model to wider bandwidth channel (more than 6 taps)

Correlated MIMO Channel Model –(1)



$$R_R = LL^H \quad \text{(L is lower triangular Cholesky RX correlation)}$$

$$R_T = UU^H \quad \text{(U is upper triangular Cholesky TX correlation)}$$

* We assume the receive antennas are uncorrelated

Correlated MIMO Channel Model –(2)

$$R = \begin{pmatrix} 1 & \rho & \rho^2 & \rho^3 \\ \rho & 1 & \rho & \rho^2 \\ \rho^2 & \rho & 1 & \rho \\ \rho^3 & \rho^2 & \rho & 1 \end{pmatrix}$$

ρ	# of transmit antennas				
	2	3	4	6	8
Low	0.2	0.2	0.2	0.5	0.5
High	0.7	0.7	0.7	0.85	0.85

Generation of Correlated MIMO Channel Model

- **STEP-1:** Specify the number of transmit antennas N_T and the number of receive antennas N_R.
- **STEP-2:** Select a tapped delay line model for the channel dispersion, where this is applied to all of the $N_T x N_R$ MIMO path.
- **STEP-3:** Apply an iindependent complex Gaussian sample to each tap on each MIMO path to form H. The H is constructed in such a way that the correlation between any pair of fading taps will be zero. Consequently, the correlation matrix for every tap position will simply be an identity matrix
- **STEP-4:** Specify a correlation matrix for each tap position.
- **STEP-5:** Perform a Cholesky factorization of the correlation matrix *R*, such that *R* can be represented as $R = UU^{H}$.
- **STEP-6:** The uncorrelated taps at a given delay position can then be correlated by multiplying the uncorrelated H by the transform matrix $H_C = HU$.

Summary and Discussion

- Simplified MIMO channel model is discussed
  - Based on Taped-delay-line model
- Channel model extension to for wideband is required
- Channel model and associated correlation factors are required for the MMR links
  - BS-RS, RS-RS, BS-MS, RS-MS