Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Independent Rayleigh Faders Generator**
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Re:	IEEE 802.16m-07/080r3– Call for Comments on Draft 802.16m Evaluation Methodology Document
Abstract	This document contains proposed text for the draft evaluation methodology for IEEE 802.16m technical proposals.
Purpose	For discussion and approval by TGm
Notice	
Release	
Patent Policy	

Independent Rayleigh Faders Generator

References:

[1] Wu, Z., "Model of Independent Rayleigh Faders", *Electronics Letter*, 22nd, July 2004, Vol. 40, No. 15, pp. 949-951.

[2] Jakes, W.C., Microwave Mobile Communications", Wiley, New York, 1974.

[3] Li, Y., and Huang, X., "The Simulation of Independent Rayleigh Faders," *IEEE Trans. Commun.,* 2002, 50, pp. 1503-1514.

[4] Dent P., Bottomley, G.E., and Croft,T.," Jakes Fading Model Revised," *Electronics Letter*, 24th, June, 1993, Vol. 29, No. 13, pp. 1162-1163.

Discussion

The ITU channel model is adopted as the baseline link channel model for the 802.16m system. This model is structured with tapped-delay-line (TDL) with properly defined multi-antenna correlation properties. This TDL model defines the number of communication paths, the time delay relative to the first tap, average power relative to the strongest tap and the Doppler spectrum of each tap. The Doppler spectrum has the classical Jakes spectrum as [2]:

$$S(f) = \begin{cases} \dfrac{1}{\pi f_d} \dfrac{1}{\sqrt{1-(f-f_d)^2}}, & |f| < f_d \\ 0, & otherwise \end{cases} \qquad (1)$$

where f_d is the Doppler frequency shift depending on the subscriber speed and the carrier frequency.

Many Rayleigh fading models have been developed in the realization of the Doppler spectrum (1) with certain number of equal-strength rays arriving at the moving vehicle with uniform distributed arriving angles. But the generated multiple fading waveforms are not uncorrelated [3, 4] but even they are uncorrelated their computations are rather complicated [4].

Lately Wu [1] proposed a Rayleigh fading model that the multiple fading waveform are independent and their computations are in the order of Jakes and Li and Huang's model [3]. The proposed model to generate M-independent Rayleigh fading waveforms has the following form:

$$T_k(t) = \sqrt{1/N_0} \sum_{n=1}^{N_0-1} (A_{k,1}(n) + jA_{k,2}(n)) \left[\cos(\omega_M \cos\alpha_{n,k} t + \theta_n)\right], \quad k = 0,1,2\cdots,M-1 \qquad (2)$$

where

$\omega_M = \frac{v_m}{\lambda}$ is the maximum Doppler frequency shift for a mobile station moving with maximum velocity v_m and λ is the wavelength corresponding to the frequency used to transmit the signal.

$N_0 = \frac{N}{8} = 4$, with usually N is selected as 32,

$\{\theta_n\}$: independent random phase sequences, each is uniformly distributed in $[0,2\pi]$,

$n = 0, 1, 2, \ldots N_0 - 1$

$\{A_{k,p}\}$: different orthogonal weighting functions such as the Walsh-Hadamard sequences.

Or specifically, $A_{kp}(n)$ is the kpth orthogonal sequences in n (± 1 values), which satisfies

$$\frac{1}{N_0}\sum_{n=0}^{N_0-1} A_{kp}^*(n) A_{lq}(n) = \begin{cases} 1, & k = l, \quad p = q \\ 0, & otherwise \end{cases}$$

$k = 0, 1, 2, \ldots M-1$, $p = 1, 2$

$$\alpha_{n,k} = 2\pi\frac{n}{N} + 2\pi\frac{k}{MN}, \quad n = 0,1,2,\ldots N_0-1, \quad k = 0,1,2,\ldots M-1$$

Equation (1) can be implemented in the following functional block diagram,

$$w_{n,k} = w_m \cos\alpha_{n,k} \quad , n = 0,1,\cdots,N_0-1 \quad , k = 0,1,2,\cdots,M-1$$

$$\alpha_{n,k} = \frac{2\pi n}{N} + \frac{2\pi k}{MN} \quad , n = 0,1,\cdots,N_0-1 \quad , k = 0,1,2,\cdots,M-1$$