Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	Link Adaptation with the Feedback of Rician Channel k-factor
Date Submitted	**2008-07-07**
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Re:	Call for Contributions of IEEE 802.16m_08/024 on the topic of "Link Adaptation Schemes"
Abstract	The Rician k-factor is an indicator for channel status and should be used as one of parameters for link adaptation. This contribution proposes a Link Adaptation with Rician Channel k-factor feedback for 802.16m systems.
Purpose	Discussion and approval by the task group.
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Link Adaptation with the Feedback of Rician Channel k-factor

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Introduction

In a typical wireless communication environment, a transmitter and receiver are surrounded by objects which reflect and scatter the transmitted energy, causing several waves to arrive at the receiver via different routes. This is multipath propagation. When the direct wave from the transmitter to receiver is blocked by buildings, walls, and etc, the propagation is termed as non-line-of-sight (NLOS) propagation. On the contrary, if there is a direct path between transmitter and receiver, then it is called line-of-sight (LOS) propagation. In the LOS situation, the received signal is composed of a random multipath component, which amplitude is described by the Rayleigh distribution plus a coherent LOS component that has essentially constant power. The power of this component is usually greater than the total multipath power. The theoretical distribution which applies in this case is Rician distribution with k-factor indicating the strength of LOS component. Therefore, the Rician k-factor is an indicator for channel status and should be used as one of parameters for link adaptation.

Proposed Link Adaptation with Rician k-factor

This contribution demonstrates the performance of MIMO techniques over channels with different Rician k-factors. The Frequency Pilot Time Correlation (FPTC) [1] is used to estimate the channel impulse response then feedback to the transmitter. Table 1 shows the system configurations. Define Ricean k-factor as the ratio of direct-path power and diffuse power, Figures 1, 2, and 3 are the BER performance in different Ricean channels for QPSK, 16QAM, and 64QAM, respectively. At BER performance of 10^{-3} for SISO case with Rician k-factor of 5, the SNR requirements for QPSK, 16QAM, and 64QAM are 17.5dB, 22.5dB, and 28dB respectively. High Rician k-factor (above 15) means better the channel condition. If user would like to increase the data rate, VBLAST will be our suggestion. Figures 4, 5, and 6 depict the BER performance of VBLAST in different Ricean channels for QPSK, 16QAM, and 64QAM, respectively. The BER will be improved about 5.5dB if 2x1 STBC is used, and the data rate will be increased about 79% for QPSK modulation if 2x2 VBLAST is used. Therefore, Table 2 summarizes the link adaptation based on the estimated k-factor.

Table 1. System Configurations

Parameters	Values
Bandwidth	20 MHz
FFT size (NFFT)	2048
Useful symbol time (Tb)	91.4286 μs
Guard time (Tg)	22.8571 μs
OFDMA symbol time (Ts)	114.2857 μs
Subcarrier frequency pacing (□f)	10.9375 kHz
Sampling Frequency (Fs)	22.4 MHz
Sample time (1/Fs)	44.643 ns
Length of CP (1/4)	512

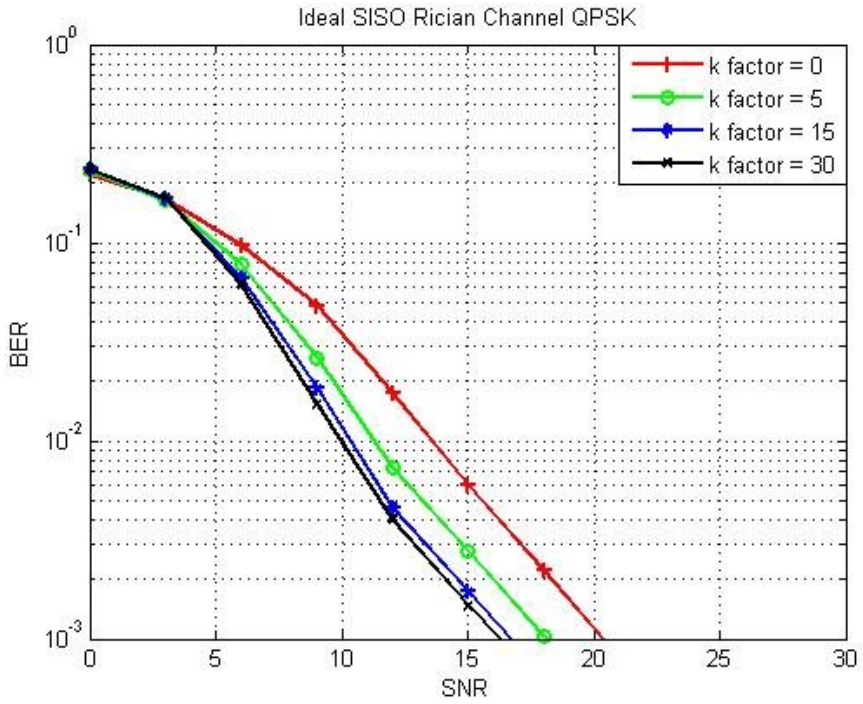

Fig. 1. SISO BER performance for QPSK

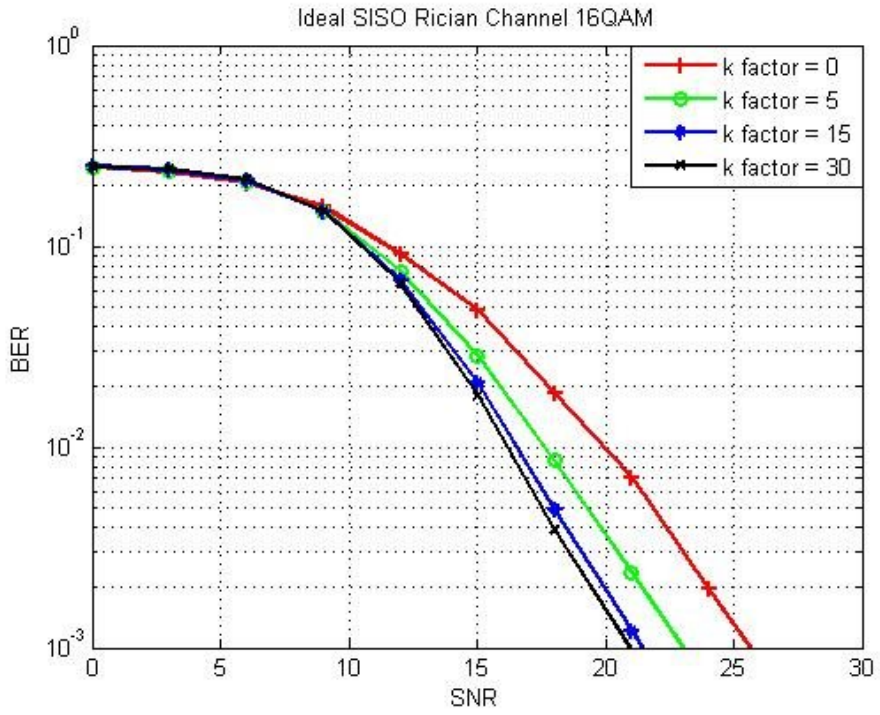

Fig. 2. SISO BER performance for 16QAM

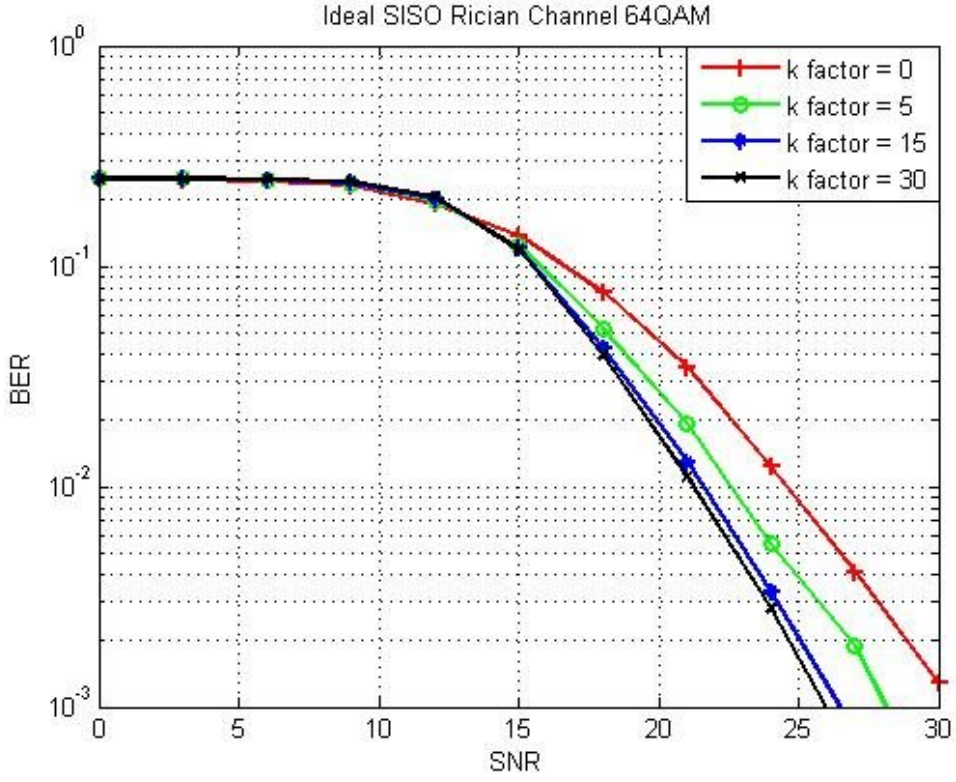

Fig. 3. SISO BER performance for 64QAM

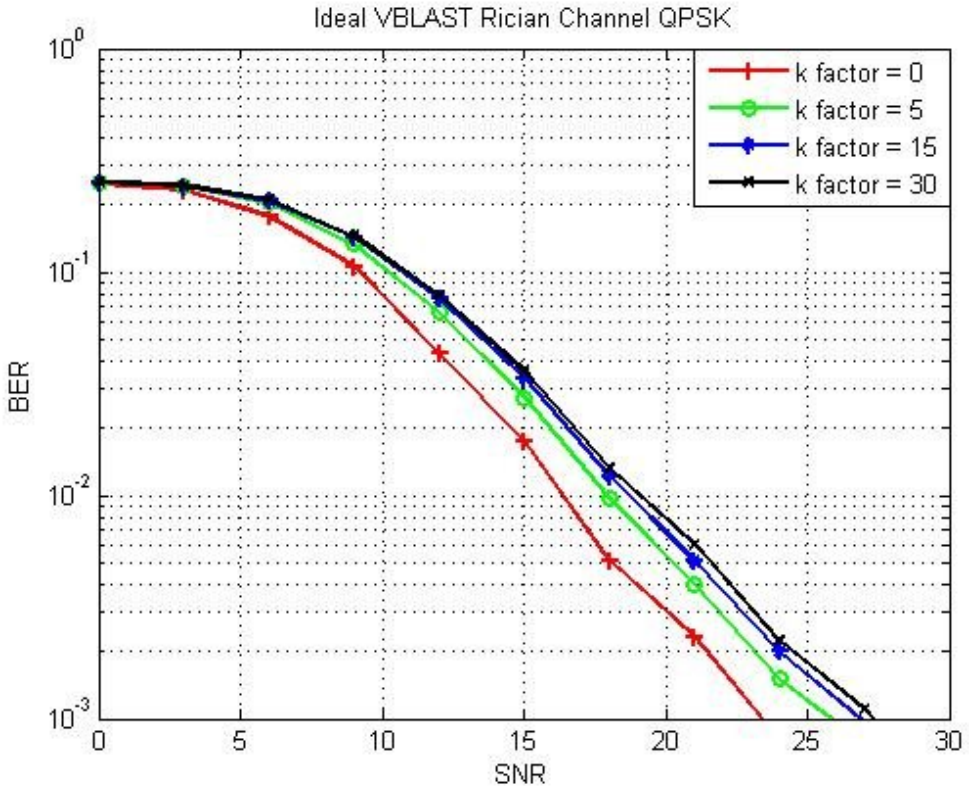

Fig. 4. VBLAST BER performance for QPSK

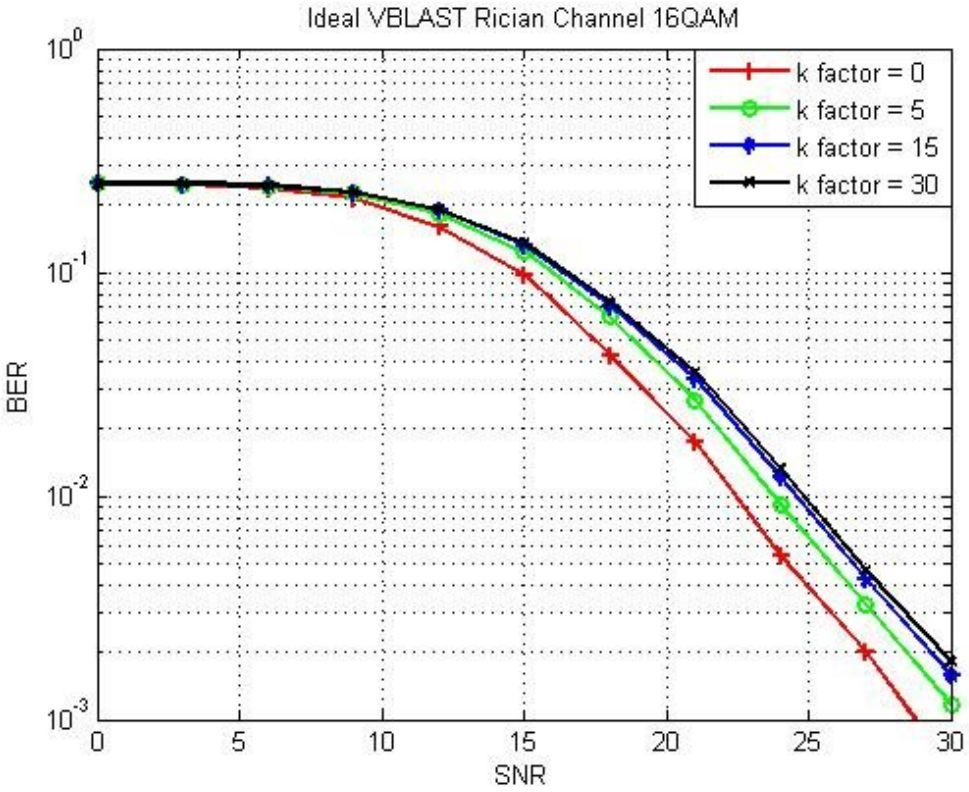

Fig. 5. VBLAST BER performance for 16QAM

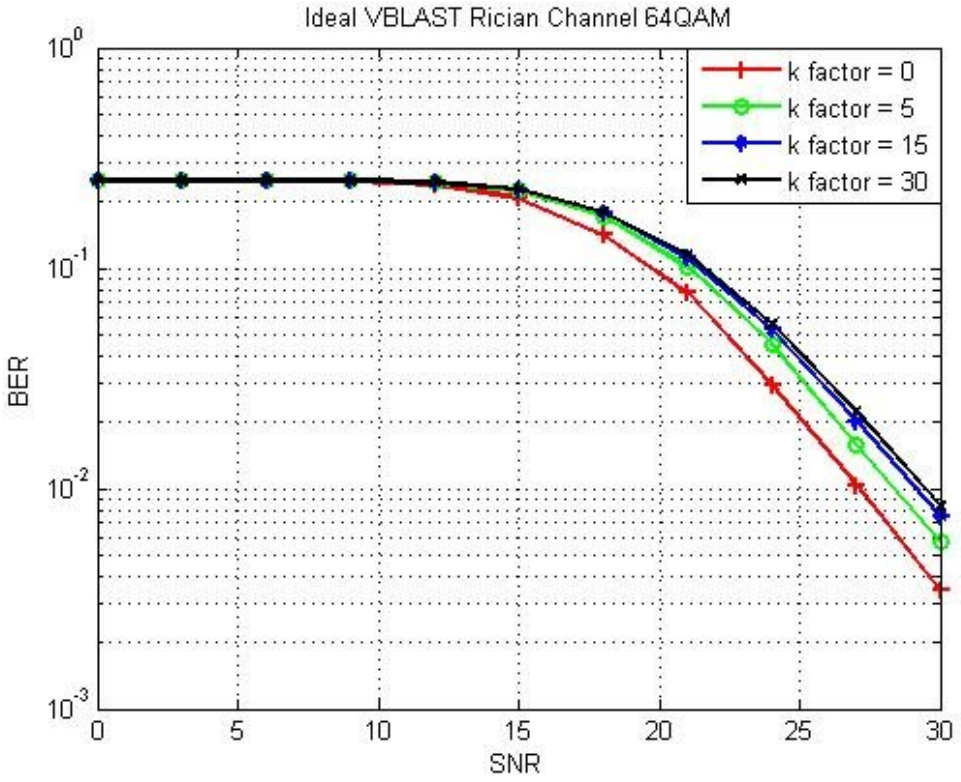

Fig. 6. VBLAST BER performance for 64QAM

Table 2. The best environmental conditions of the three systems

System	Proposed channel condition
SISO	high k-factor (above 15), high SNR (above 25dB)
STBC	middle k-factor (5~15), high SNR
VBLAST	low k-factor (below 5), high SNR

In addition to the mode selection, the Rician k-factor can also be used as an indicator for channel flatness. Greater k-factor implies that the LOS component dominates the signal transmission, such that the channel is relative flat compared to the channels with lower k-factors. Figure 7 illustrates the channel frequency responses with different Rician k-factors. Therefore, the Rician k-factor can also be used to determine the size of band grouping for different modulation and coding schemes. Furthermore, regarding the overhead of channel feedback, the Rician k-factor can also be used to reduce the feedback overhead if the channel is relative flat.

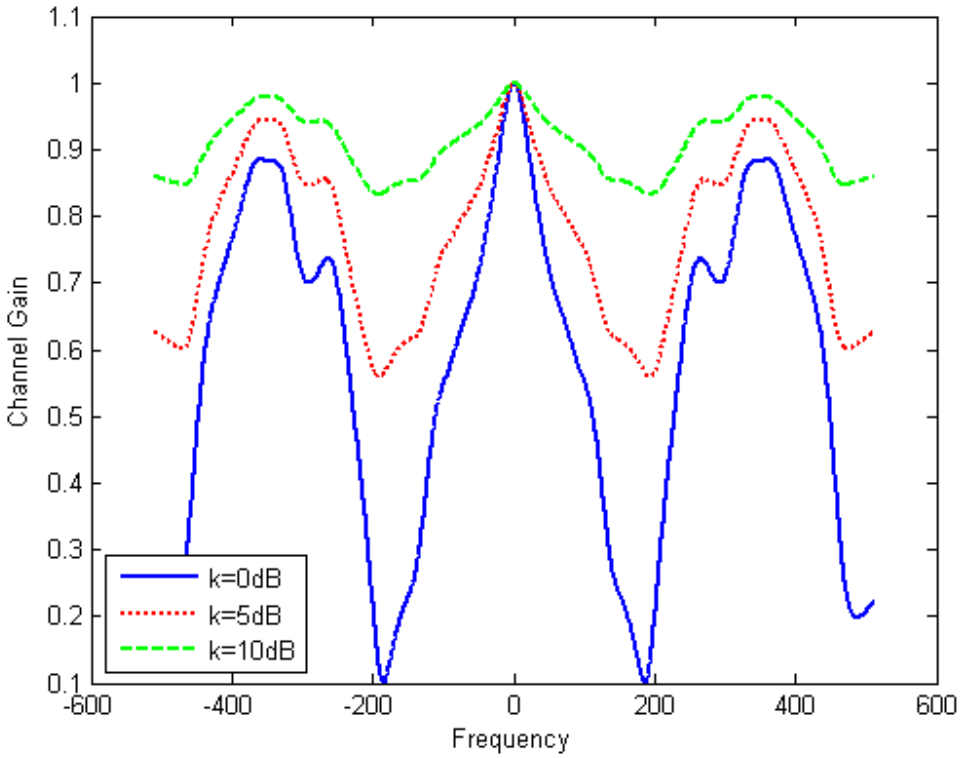

Fig. 7. Channel frequency responses of multi-path channels with different k-factors

Proposed Text

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11 Physical layer

11.x Link Adaptation Schemes

Rician channel k-factor can be considered in link adaptation for 802.16m systems. It can be used for the determination of transmission mode, size of band grouping, and size of channel feedback overhead.

11.x Channel quality feedback information

Rician channel k-factor can be included in CQI feedback. The reduction of CQI feedback overhead can be supported by the estimation of Rician channel k-factor.

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References

[1] Xianbin Wang, Yiyan Wu, Jean-Yves Chouinard, Sili Lu, and Bernard Caron, “A Channel Characterization Technique Using Frequency Domain Pilot Time Domain Correlation Method for DVB-T Systems,” IEEE Trans. on Consumer Electronics, vol. 49, no. 4, Nov. 2003.