Chapter 3

Satellite Channels Based on IEEE 802.16 Standard

ABSTRACT

This chapter considers the modeling of RPAS/Aircraft data transmission via channels based on IEEE 802.16 standard. RPAS communication channel with a fading was analyzed using original model. Dependencies of a SNR in ground receiver on a SNR in downlink for different types of RPAS amplifier nonlinearity were obtained. Signals constellations of received signals were compared for different Doppler shifts. The influence of the aircraft transmitter nonlinearity for different types of fading in the channel was studied using “80216dstbc Rayleigh,” “80216dstbc Rician,” “80216d Rayleigh,” and “80216d Rician” models. The possibility of the nonlinearity correction using pre-distortion was revealed. The impact of space-time diversity (MISO 2x1) for different types of fading in the channels was investigated. The effect of the Doppler’s frequency shift on the operation of communication channels was analyzed.

INTRODUCTION

WiMAX Standards IEEE 802.16

The standard WiMAX was published at the end of 2001. In accordance with the hierarchy of wireless access standards, it belongs to the class MAN (Metropolitan Area Network). For a number of factors, such as bandwidth, coverage and services, WiMAX outperforms the Wi-Fi standard (IEEE802.11)
of the LAN class (Local Area Network), allowing it to build regional, national and even global networks with a developed infrastructure. At the physical level, two fundamentally different technologies are used in the WiMAX standard. Data can be transmitted by modulating one carrier frequency (SC-Single Carrier) or multiple sub-carriers-OFDM technology. In the SC mode, the same requirements apply to radio channels as in radio relay networks: the use of direct rays only and the use of narrowly directional antennas, suppression of all reflected beams in order to eliminate intersymbol interference. In this regard, SC technology cannot be used in mass-use networks with multipath propagation of radio waves in communication channels.

The transition to OFDM technology occurred in 2004 with the advent of the new WiMAX standard: 802.16-2004. This technology eliminates intersymbol interference. In the next version of the standard, the OFDM parameters were significantly changed. In particular, they switched to scalable OFDM: the number of subcarriers used became dependent on the operating band (SOFDM), and the subscriber began to allocate a certain number of sub-channels (SOFDMA - Scalable OFDM Access). In addition, there was an opportunity of realization of handovers. This version of the WiMAX standard was given the name of mobile WiMAX or 802.16e standard. The 802.16e option is the basic one in the existing WiMAX networks. The last few years the standard was constantly improved. For example, it was supplemented with 802.16i and 802.16j standards. The latter allows expanding existing networks by using repeaters. In 2011, a new version of the WiMAX standard, 802.16m, was approved. It is designed for building networks with a bandwidth above 100 Mb/s and for implementing a number of new promising services.

**IEEE 802.16:** Was released in 2001; frequency bands 11 – 66 GHz; mobility – no; technology – SC; channel width - 20, 25, 28 MHz.

**IEEE 802.16-2004 (802.16d):** Was released in 2004; frequency bands 2 – 11 GHz; mobility – no; technology – SC or OFDM (256); channel width - 1,75; 3,5; 7; 14; 1,25; 5; 10; 15; 8,75 MHz.

**IEEE 802.16e:** Was released in 2005; frequency bands 11 – 66 GHz, 2 - 11 GHz (fixed), 2 – 6 GHz (mobile); mobility – yes; technology – SC or OFDM (256), or SOFDM (128, 512, 1024, 2048); channel width - 1,25; 5; 10; 20 MHz.

**IEEE 802.16k:** Was released in 2007; frequency bands 11 – 66 GHz, 2 – 11 GHz (mobile); mobility – yes; technology – SC or OFDM (256), or SOFDM (128, 512, 1024, 2048); channel width - 1,25; 5; 10; 20 MHz.
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