A role of Orthogonal Frequency Division Multiplexing Modulation System in the Disaster Management Systems

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Abstract: 4G wireless communication systems use OFDM modulation technique in order to provide reliable transmission in a propagation area. Issues of this scheme related with data lossless, low BER, PAPR and well synchronization are quite essential for emergency circumstances; especially in the natural disaster events, it is strictly required precise information transmission. In this manuscript, we mainly focus on performance of OFDM in the disaster management systems. Estimation of BER and PAPR in fading channels is superimposed by considering movement of objects in the disaster conditions.

Keywords: Disaster Management System, BER, PAPR, Rayleigh (Rician) fading channels.

I. Introduction

Environmental (earthquake, tsunami) and technical disasters (industrial accidents) devastate particular areas of the Earth and gave negative effect to population's health. In order prevent or recover such devastations, several applications have been being developed. Data transmission for Disaster Management Systems (DMS) plays an important role and BER, PAPR, well synchronization and interferences are main issues in physical layer of DMSs. One of well-known multiplexing technique is an OFDM technique, which can find solutions for counted problems and has recently received considerable attention for wireless networks. In OFDM the entire channel is divided into many narrow sub channels that are utilized in parallel transmission, thereby increasing a symbol period to an OFDM period that is much larger than the channel delay spread and thus reducing the effect of inter block interference (IBI) caused by the dispersive Rayleigh-fading environment [1]. Therefore, OFDM is an effective technique for combating multipath fading and for high-bit-rate transmission over mobile wireless channels. Several applications based on OFDM are used for WLANs, for instance, particularly DVB-T provides terrestrial digital video broadcasting services in the VHF (130-260 MHz) and the UHF (480 - 862 MHz) bands [2] and its transmitter uses the scheme below:

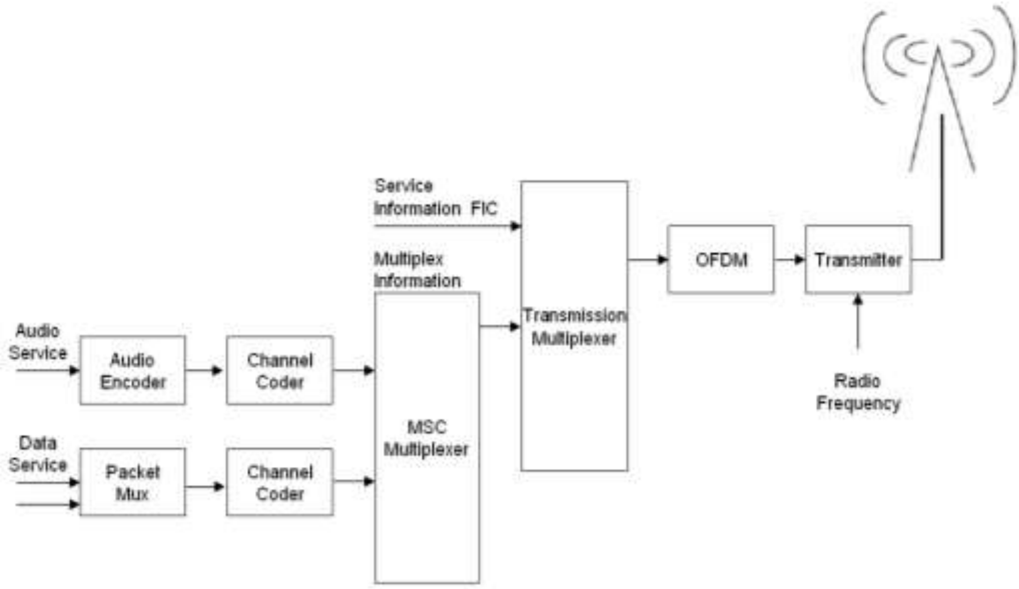


Diagram 1. DAB-T application of radio emergency.

II. DMS Architecture

IEEE 802.11 standards, such as IEEE 802.11p (working-June, 2010) is a wireless access in vehicular environment (WAVE) [3] and Advanced Air Interface (IEEE 802.16m with data rates of 100Mbit/s mobile and 1Gbit/s fixed [4]) full backward comfortable applications based on OFDM scheme support WLAN networks of DMS. As the diagram 2 below illustrates basic structure of DMS, 802.11p provides ambulance service, 802.16m maintains long distance signal transmission in a NLOS positions and Enterprise 802.11 WLANs are properly used for Disaster Management Agencies.

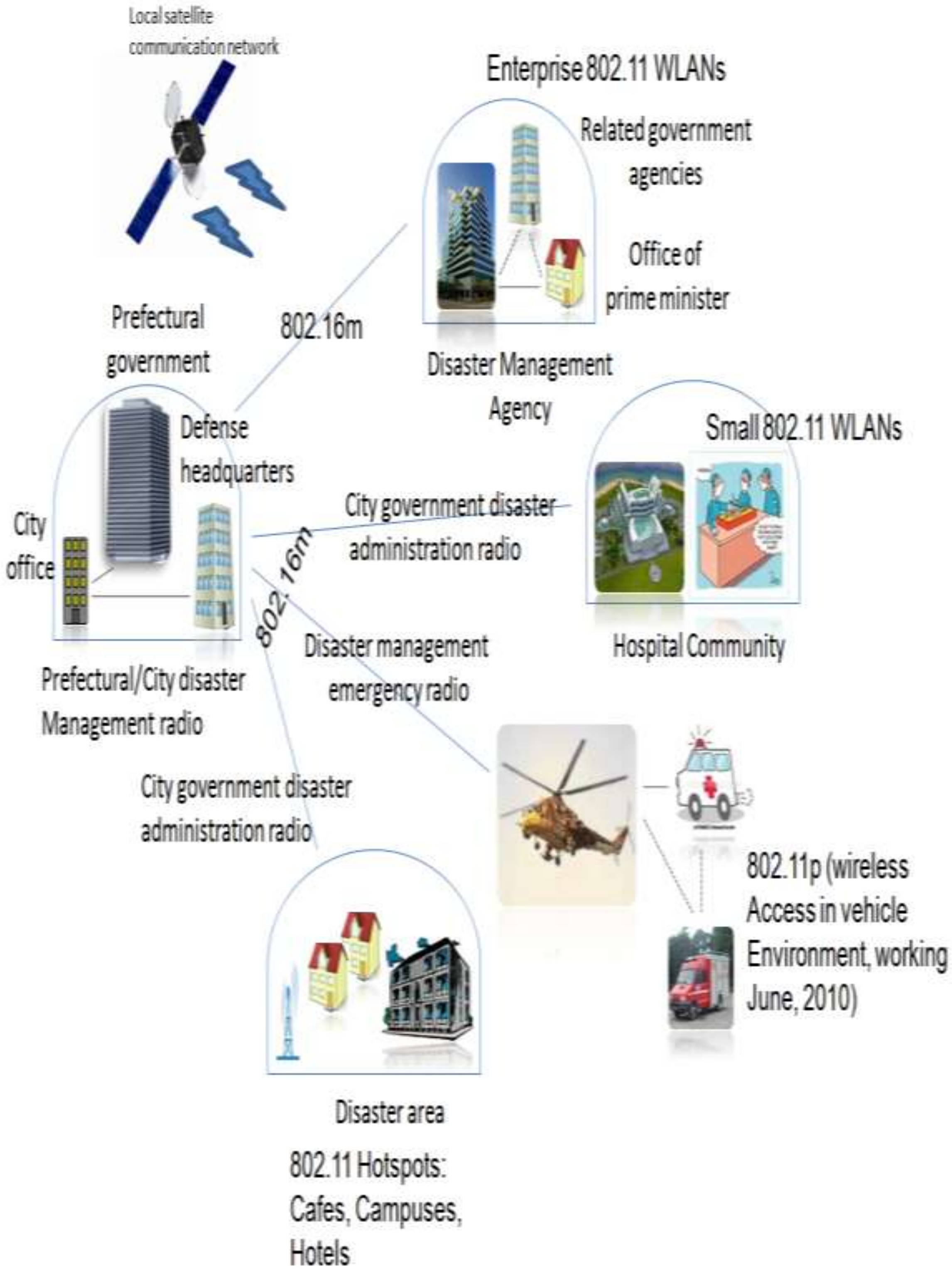


Diagram 2. DMS architecture.

In DMS, in order track the RFID tagged rescuers, we use the device produced by TrakBANK. It (picture 1) uses table 1 applications, such as GPS/Wi-Fi with Bar Code Reading Capability and Paired Bluetooth Alpha-Numeric Keypad&TrakBAN. Additionally, the object being searched could be found by using free open source web based system called Sahana FOSS. Sahana FOSS [5], one of DMS by Indians, is web based tool solves the problem of coordination during the disaster events.

Picture 1. DMS-05426 by TrakBANK.

	UTRA	*WLAN*	*Bluetooth*	*PAN*	*WB-PANs*
Data rates	Maximum 2 Mbps (384 Kbps)	5.1–54 Mbps	Maximum 721 Kbps	Max. 10 Mbps	1 Gbps
Technology	TD-CDMA and WCDMA	OFDM	DS or FH	OFDM	OFDM/DS-CDMA/SHF-CDMA
Cell radius	30m–20 km	50–300m	0.1–10m	To the distance an voice reaches	Similar to PAN
Mobility	High	Low	Very low	Very low	Very low
Standard availability	1999	2000	1999	2004	2012
Frequency band	2 GHz	5 GHz	2.4-GHz ISM band	5–10 GHz	60 GHz
Frequency license	Necessary	Not necessary	Not necessary	Not necessary	Not necessary
Application	Public environments (likely restricted use in hospitals, on airplanes)	Corporate environments (industrial applications); public hotspots (airports, exhibitions, convention centers)	Substitution for infrared communications; low cost networks for SoHo and residential applications	Personal peripheral device communications	Surrounding environment

Table 1. Currently using applications for DMS.

III. PAPR and BER estimation in the DMS

In OFDM, the peak occurs after symbols fed to FFT to produce time domain signal, adding signals up coherently and its probability is counted by this equation:

$$\Pr[rR_{x_s} + n \le T_{x_s}] \approx 1-(1-e^{-T_{x_s}})^{2.8N}$$ [6] (1)

This probability for a certain selected threshold in Rayleigh Fading Channel (RyFC) can be expressed by error functions as follows:

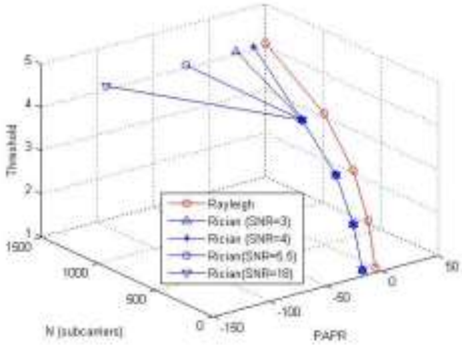
$$\Pr[rR_{x_s} + n \le T_{x_s}] = 1-[erf(\frac{\sqrt{P_m T_{x_s}}}{\sqrt{2}\delta_n})... + \frac{1}{2}e^{\frac{\delta_n^2+2\delta_r\delta_{R_{x_s}}\sqrt{P_m T_{x_s}}}{2\delta_r^2\delta_{R_{x_s}}^2}} erfc(\frac{\delta_n^2+\delta_r\delta_{R_{x_s}}\sqrt{P_m T_{x_s}}}{\sqrt{2}\delta_n\delta_r\delta_{R_{x_s}}})... - \frac{1}{2}e^{\frac{\delta_n^2-2\delta_r\delta_{R_{x_s}}\sqrt{P_m T_{x_s}}}{2\delta_r^2\delta_{R_{x_s}}^2}} erfc(\frac{\delta_n^2-\delta_r\delta_{R_{x_s}}\sqrt{P_m T_{x_s}}}{\sqrt{2}\delta_n\delta_r\delta_{R_{x_s}}})]^{2.8N} \quad (2)$$

Where

$$P_m = 2\delta_r^2\delta_{R_{x_s}}^2 + \delta_n^2 . \quad (3)$$

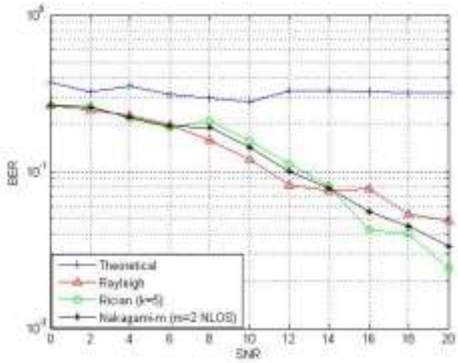
For other cases for (3) see [7].

Simulation 1 depicts the probability of PAPR over RyFC. Rician Fading Channel (RcFC) on different HC-OFDM [8] subcarriers in a range of 1-18 Db SNR shows approximately -18 lower PAPR at proper thresholds in an RcFC.



Simulation 1. PAPR probability in RyFC and RcFC on different subcarriers (N=64, 128, 256, 512, 1024).

System simulations were carried out on Mat lab interface envelope 16-QAM modulation on 512 HC-OFDM subcarriers, where the speed of the antenna is 80km/h (ambulances) and there are 50 reflected paths in the propagation area. Simulation 2 illustrates the BER performance over faded paths, where an RcFC environment for k=5 gives higher performance than the others.



Simulation 2. BER comparison over RyFC, RcFC and NFC environments.

We simulated the performance of the system on HC-QAM/OFDM signals over RyFC and RcFC. The BER comparison tables of MFSK (DPSK)/COFDM in NFC given in [9].

IV. Conclusion

In conclusion, we can notice that the DMS systems play an important role among today's rescuer or disaster prevention systems. In order improve DMS's performance, we took in a count new IEEE standards and highlighted OFDM technique by reducing 18 lower PAPR and considerably BER in the RcFc.

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