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Title: Selection of IR PHY Modulations - A Supplement of Template Parameters of 4-ary PPM IR PHY

Author: Kwang-Cheng Chen, H.K. Lu, T.H. Tsaur
Department of Electrical Engineering
National Tsing Hua university
Hsinchu, Taiwan 30043, R.O.C.
TEL: +886 35 715131 ext. 4054
FAX: +886 35 715971
E-Mail: chenkc@ee.nthu.edu.tw
(K.C. Chen as a representative of the National Standard Buerau, Ministry of Econimics, R.O.C.)

M.T. Shih
Communication Technology Division
Comupter and Communication Laboratory
Industrial Technology Research Institute
Chutung, Taiwan, R.O.C.

Abstract

Choice of IR PHY mdulations should be based on technical merits, market concerns, and integration with MAC. Therefore, 2M bps (1M symbol rate) modulations should be adopted. 4-ary PPM should be adopted for 2Mbps baseband modulation.

Introduction

According to March meeting, the IR PHY has a structure as 0-5M Hz for baseband modulation, 5-15M Hz for coexisting band, and 15-30M Hz for multicarrier operation. We shall intend to show the right choice for IEEE 802.11 in our point of view.

Data Rate

According to the marketing survey to primary venders of PCs and LANs in Taiwan by the Comupter and Communication Laboratory, IR in wireless LANs should have **minimum speed of 2M bps or higher**. Standardization of IR transmission lower than 2M bps will just **prohibit wide deployment of IR LANs**. As a consequence, **2M bps 4-ary PPM**

and 2M bps FQPSK are two kinds of modulation to meet this criteria among current IR PHY modulation proposals.

As high bandwidth applications are critical for IR PHY which has actually limited bandwidth. Data rate is a fundamental issue to select IR modulation. 2M bps 4-ary PPM enjoying spectral efficiency of 0.5 (2M bps over 4M Hz in theory and well enough in 5M Hz in practice) can best team up with multicarrier (2M bps at 2.5M Hz for FQPSK). As a comparison, 16-ary PPM has a spectral efficiency of 0.25 to possibly transmit 2M bps over 8M Hz bandwidth in theory and even higher bandwidth in practice.

Myth on Power Efficiency at 2M bps

Is 16-ary PPM more power efficient? The answer is NO! In order to transmit 3-5m in typical small room (such as an office) and larger room (such as a meeting room), we calculated the necessary transmission power based on our prototyping experience. In a small room, 16-ary PPM needs 330mW instaneous power while 4-ary PPM needs 400mW. In a larger room, 16-ary PPM needs 645 mW while 4-ary PPM needs 405 mW. In other words, **4-ary PPM is more power efficient than 16-ary PPM** in robust operations.

In our prototyping experience, we found that the instaneous power decides more on power consumption for mobile units in practice. 4-ary PPM, due to its two-time spectral efficiency of 16-ary PPM, **is actually more power efficient** in robust diffused channels. Finally, all circtuits of 4-ary PPM systems operate half clock rate (or hald bandwidth) of 16-ary PPM. **4-ary PPM is easier to implement.**

Integration with MAC

4-ary PPM at 2M bps has 1M symbol rate which is identical to DS-PHY and FH-PHY. Multicarrier modulation such as FQPSK at 2M bps also has 1M symbol rate. This potential arrangement can minimize the work for MAC. (Note: Multicarrier structure is a channelized scheme as radio counterpart.) Thus, IR modulations with 1M symbol rate are most favorable for the consideration of the whole wireless LANs.

Conclusions

IR PHY should choose data rate of 2M bps (and/or higher) for market concerns.

IR PHY should choose 1M symbol rate modulations to match MAC.

4-ary PPM at 2M bps meets above two criterion and is more power efficient than 16-ary PPM (at 2M bps) in robust diffused operation.