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Title: A Proposed Diffused Infrared PHY Structure

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Abstract

Based on the evaluation on various modulations, we propose a choice of IR PHY to consist of baseband and passband multicarrier schemes. 0-6M Hz is reserved for baseband modulation which is decided by the choice of data rate. 15-30M Hz is reserved for 5-dedicated-channel multicarrier scheme. For 6-15M Hz, we put this as a co-existing band and both approaches can use it. The modualtions for baseabnd and multicarrier are suggested as this paper. We further suggest to consider WDM in IR PHY.

Introduction

Since IBM recaped diffused IR as a possible PHY for wireless LANs [1], many proposals to define the IR PHY of the IEEE 802.11 have been proposed [2-4]. The primary task to make the final decision is the choice of modulation and speed. Several speeds have been mentioned and they are 1, 2, 4, and 10 M bps. The possible modulations include Manchester, binary PPM, 4-ary PPM, 16-ary PPM, NRBI (non-return-to-zero with bit insersion), MRLC (modified run length codes), DCGPPM (differentially coded and guarded PPM), PSK and FSK. We evaluated various possible combinations of above

proposals based on the conclusion from the channel measurements and simulations done by the IBM, UC Berkeley, Portugal and Spainish universities, and National Tsing Hua University, then propose a complete structure for IR PHY.

Summary of Direct Detect Modulations

[5] analyzed the error rate performance of various direct detect modulations in indoor channel with direct path and under shadowing. It is observed that the performance depends heavily on data rate. More practical implementation issues were also considered, including spectral efficiency, power efficiency (i.e. average number of pulses per bit), estimation of threshold, pulse in each symbol (i.e. synchronization). If direct detect modulation is used, [5] suggested 16-ary PPM or 4-ary PPM at 1-2M bps, DCGPPM at 10M bps, DCGPPM or 4-ary PPM at 20M bps, OOK/NRBI/MRLC at 40M bps, MRLC at 50-100M bps. MRLC is the only direct detect modulation working at 100M bps while no complicated equalization is assumed. However, MRLC at 100M bps is still not satisfactory under shadowing. A limitation of applying direct detect modulation is expected.

Proposed IR PHY Structure

In light of the simplicity of direct detect modulation, IR has a strong edge on baseband modulation. However, to serve high bandwidth application is another critical edge for IR. The picture for IR PHY is therefore pretty clear that it must consist of a baseband modulation and multi-carrier modulation beyond the baseband. The proposed frequency plan is 0-6M Hz for baseband modulation and 15-30M Hz for FSK/PSK type multicarrier signaling which can be FQPSK as it promises most data transmission rate with constant envelope to alleviate a great deal of problems such as phase noise. Or, it can be any modulation adopted by the higher-speed FH PHY. For baseband modulation, it is proposed to conduct the conclusion of [5]. At 10M bps, 4-ary PPM is the next best modulation behind DCGPPM. 6-15M Hz band acts as a co-existing band. Therefore, baseband modulation can use 0-15M Hz at most and multicarrier approach can use 6-30M Hz, that is, 8 carriers at most. The frequency range is, of course, subject to the component technology for future improvement.

In the mean tiime, we would like to propose consideration on both 880 nm and 1.3 micron wavelength infrared into utilization. Both are good for transmission in air and components are widely available for both. If so, we can have a further "wavelength division multiplexing" (WDM) to provide more transmission throughput and "co-existing" situation no longer exists.

Notice: ***DCGPPM, a pending patent, was filed by the IBM Corp. and invented by K.C. Chen while working with the IBM T.J. Watson Research Center. This documentation cites DCGPPM only for technical research purpose and has no implications on IBM's products, marketing, and position at the IEEE 802.11.***

Acknowledgement

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References

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