INFLUENCE OF PEOPLE SHADOWING ON BIT ERROR RATE OF IEEE802.11 2.4GHZ CHANNEL

Rajiv Mathur, Martin Klepal, Alan McGibney, Dirk Pesch
Adaptive Wireless Systems Group,
Cork Institute of Technology,
Cork, Ireland
rmathur@cit.ie, mklepal@cit.ie, amcgibney@cit.ie, dpesch@cit.ie

ABSTRACT

With their low cost and high-speed data rate capabilities, installations of IEEE 802.11-based wireless local area networks (WLANs) are growing exponentially. Although many organisations have started using WLANs, there are still very few tools available that can help the design of WLAN networks. As a result, the current deployment of WLAN networks remains ad-hoc in nature. The objective of this research is to investigate performance of WLAN networks by optimising the position of access points. The hypothesis being that the number and positioning of access points in a large WLAN network can be optimised depending upon the structure of the building, presence or absence of obstacles in the propagation path etc. The research presented in this paper specifically addresses the effect of ***moving*** *obstacles in the propagation path between a WLAN access point and a WLAN node, thus noting its effect on channel BER. Propagation models will be used that can predict the signal strength and interference in a WLAN system by taking into account environment specific parameters such as the structure of the building, presence or absence of* ***stationary*** *obstacles etc [1]. This paper will investigate the influence of* ***moving*** *obstacles, such as people, on radio wave propagation inside a building and the effect on received signal quality in a WLAN system in terms of the residual bit error rate (BER). Our findings suggest that the presence of* ***moving*** *obstacles, such as people, seriously affects the performance of the system by introducing heavy variations in the received signal strength and BER.*

EXTENDED ABSTRACT

Introduction

WLAN networks have become very popular means for providing a low cost wireless networking facility for home users, educational institutions, companies etc. due to their ease of installation and their high data rate provision, apart from providing, albeit limited, mobility to users. Most people deploy WLAN access points in the immediate vicinity of where wireless coverage is desired and the system typically appears to work. However, such an ad-hoc deployment will only work well if there are few access points, as the performance of such an ad-hoc deployed network is typically much less than what could be achieved by proper network design. Indeed, many organisations are already noticing the actual data rate limitations of large scale, highly loaded WLANs that have been installed in an ad-hoc fashion. The optimal deployment of a WLAN system, however, should consider various factors that influence the performance of the system and the overall network performance and Quality of Service (QoS) that can be achieved. An important performance measure in this is the Bit Error Rate (BER), which depends on the properties of the radio channel and its effect on signal quality. Moving obstacles in the propagation path introduce large variations in the received signal strength due to fast fading and changing small area shadowing. Most common RF propagation prediction techniques alone are only capable of predicting the mean received signal strength.

This paper investigates the prediction of complete received signal statistics rather than just its mean value and investigates the influence of variable shadowing due to the movement of people in the propagation area and its effect on the received residual bit error rate of the IEEE802.11 2.4GHz radio channel.

The full paper is organised as follows. Section I will give an introduction, rationale and motivation behind the current research. Section II will describe the measurement campaign conducted for the purpose of collecting data for statistical investigation into the influence of people on the received signal strength. The proposed novel method of site-specific prediction of signal statistics and SIR will be described in Section III. Section IV will demonstrate the impact of moving people shadowing and interference generated by close by installations of WLAN access points on BER, which was found to be very significant in crowded office environments. Section IV will conclude final paper.

Environment-specific radio signal prediction

Some initial results obtained from computer simulation of a typical building having one main corridor and rooms on both sides are shown below. The communications channel has been modelled by taking into account path-loss, shadowing by people, fast fading, interference from other transmitters and additive white gaussian noise (AWG) as shown in Fig.1. The building is assumed to have one corridor with rooms on both sides as shown in Fig.2. A transmitter (access point) is placed at one point (shown by blue in Fig.2.) and some areas have been assumed to have a density of moving obstacles (people, marked by pink in Fig.2). In order to accurately predict the signal quality in the channel (Fig.1), at every point of the investigated scenario (Fig.2.), all parameters, except the AWG (Additive White Gaussian Noise), must be site-specifically predicted. Path loss prediction (Fig.3) is performed by a deterministic Motif Model [2]. The prediction of the standard deviation of signal fluctuation due to moving people shadowing (Fig.4) will be fully described in the final paper. The Motif model also predicts the fast fading statistics. Fast fading statistics are represented by the channel's Ricean *k* factor and are also predicted by the Motif model (Fig.5-6). The level of interference is changing in nature, however its variation has been mainly neglected and its local mean level, the sum of contribution from surrounding interferers, is based on the appropriately filtered mean signal level predicted from surrounding interfering Access Points and other appliances such as microwave ovens, e.g. However, the temporal influence of other appliances on an optimal network deployment need to be address in the further research.

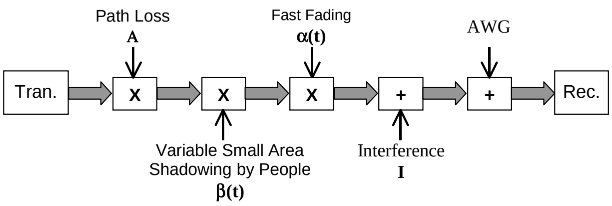

Fig. 1. Model of communication channel for link BER estimation

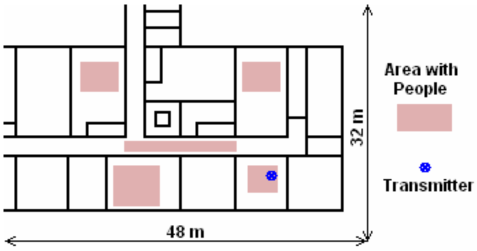

Fig. 2 Environment with specified areas of major people appearance

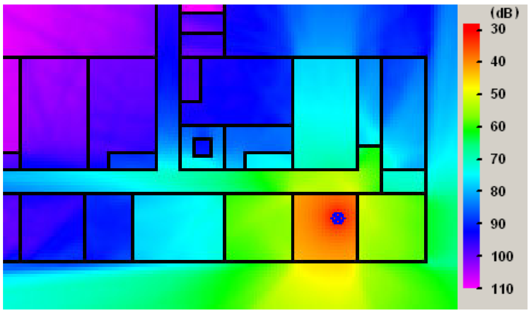

Fig.3. Mean path loss prediction

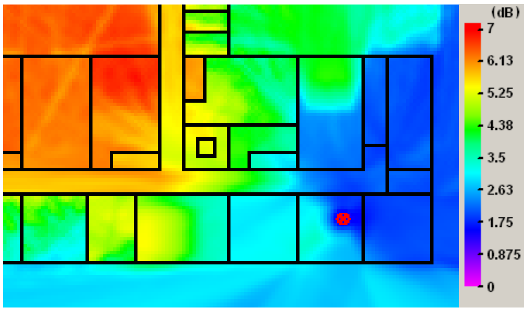

Fig. 4. Standard deviation of signal fluctuation due to shadowing by moving people

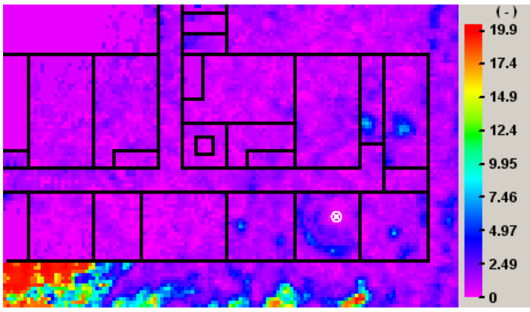

Fig. 5. Ricean *k* factor prediction for fast fading characterisation

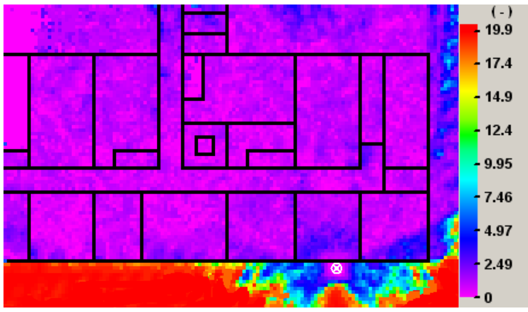

Fig. 6. Ricean *k* factor prediction for an antenna outside the building

Conclusions

This paper presents an accurate prediction of the effects of moving people shadowing in an indoor radio propagation environment. In particular the effects on the Bit Error Rate of the IEEE802.11 2.4GHz WLAN channel by moving people shadowing and interference by WLAN access point installations are investigated.

References

[1] COST231 Final Report, "Digital Mobile Radio: COST231 View on the Evolution towards 3rd Generation Systems", *European Commission / COST Telecommunications*, Brussels, 1998

[2] M. Klepal, P. Pechac, "Large Dynamic Range Prediction of AOA, AOD and PDP for MIMO Systems", *IEE 12th International Conference on Antennas & Propagation*, Exeter, March 2003, pp. 775-779, ISBN 0-85296-7527