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Background Interference Measurements at 2.45 GHz in a Hospital Environment

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INTRODUCTION

The 2.40-2.4835 GHz frequency band, also known as the ISM (Industrial Scientific and Medical) band, is a license free band allocated for a variety of consumer applications. While no license needs to be purchased to operate devices in this band, regulations exist governing its use. Part 15 of the FCC code limits not only output power, but also the channel bandwidth and the air interface of those devices operating over this band. Short-range wireless devices such as Bluetooth and Wireless LANs operate in the ISM band. Over the next 5 to 10 years, these devices are expected to become widespread throughout hospital and medical environments for applications such as data transfer, patient monitoring and inventory control. In this paper we look into the interference that short-range wireless devices would experience in a typical hospital environment. Understanding and analyzing the background interference is crucial for the development of wireless devices/applications that provide a high quality of service (QoS). MPRG has developed PRISM (PRobe ISM), a software reconfigurable measurement device for studying the frequency spectrum of the ISM band.

Measurements and characterization of medical environments can be found in [1], [2], [3] and [4]. These studies have been confined to spectrum below 2.0 GHz, mainly to study impact on mobile radios and cellular phones.

THE MEASUREMENT SYSTEM

PRISM (Figures 1 and 2) is an automated passive measurements device centered at 2.45 GHz. Figure 1 shows a block diagram of PRISM.

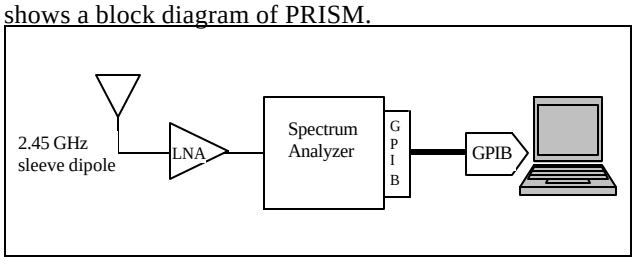

Figure 1: System Model of PRISM

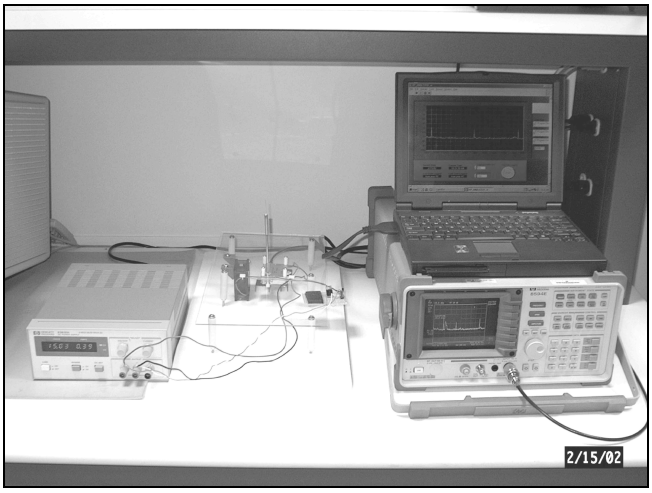

Figure 2: **PRISM**

The first element of this device is a vertical dipole sleeve antenna. This antenna is in turn connected through a LNA to a Hewlett-Packard (8594E) spectrum analyzer. The LNA has a noise figure of 1.5 dB and a gain of 30 dB, enabling the system to measure weak signals. Finally, the spectrum analyzer is connected to the PC through a GPIB interface. The PRISM software was developed in LabView, leveraging Lab View's interface to easily control the system settings and perform data logging. Post processing is performed in MATLAB, which provides an extensive tool set for data analysis and visualization.

RESULTS

Passive Measurements were performed at the Virginia-Maryland School of Veterinary Medicine. The measurements were taken in two minute intervals for a period of two days inside the clinical pathology lab and for one day outside the radiology unit. Measurements were taken in 1 MHz bins, where the maximum signal power observed in each bin during a two second time window was recorded.

Figures 3 & 4 show the Electromagnetic Interference (EMI) recorded inside the clinical pathology lab and

outside the radiology unit. The 3-D plot shows interference power as a function of frequency and time of day. Pronounced levels of interference were observed inside the clinical pathology lab between the hours of 11:00 am – 3:00 pm, and outside radiology between the hours of 11:00 am – 5:00 pm.

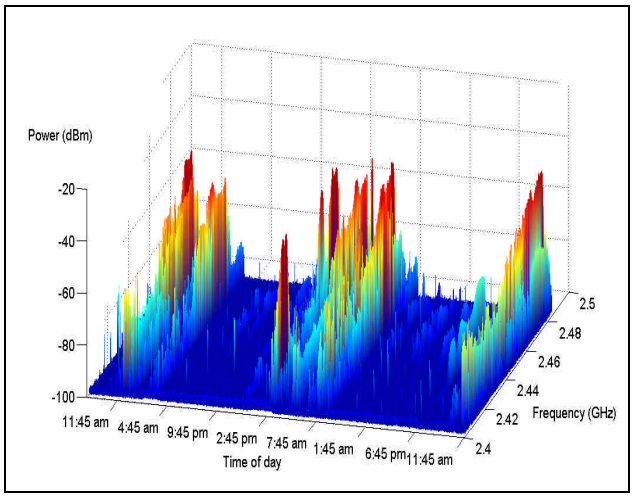

Figure 3: Background EMI noise in the 2.4 GHz ISM band recorded over a period of two days inside the clinical pathology lab at the Virginia Tech veterinary hospital

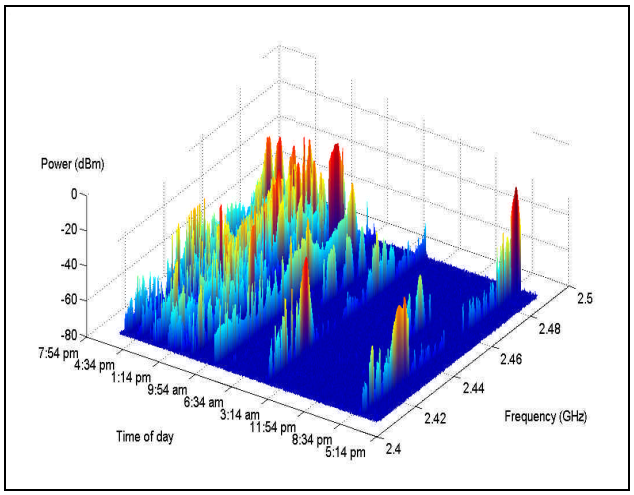

Figure 4: Background EMI noise in the 2.4 GHz ISM band recorded over a period of one day outside the radiology unit at the Virginia Tech veterinary hospital

DISCUSSSION

The majority of the strong interference can be attributed to the use of microwave ovens in the hospital, which can be identified by the signal strength, spectral characteristics and its frequency of operation [5]. The EMI activity in the hospital does not pose a threat to the operation of short-range wireless devices. However, a decrease in throughput due to lost and retransmitted packets in the presence of strong interference is expected. It is also expected that Bluetooth devices will have minimal effects on the operation of medical equipment, since the output power of these devices is comparable to the detected level of EMI activity.

CONCLUSIONS

PRISM is an effective system for measuring and studying EMI in the ISM band. The majority of EMI activity inside the clinical pathology lab and outside the radiology unit was observed during normal business hours. Microwave ovens accounted for a majority of the recorded interference. Bluetooth devices are capable of operating in these environments but an increase in frame error rate leading to some degradation in performance is expected. The impact of Bluetooth devices on the environment is also expected to be minimal, since the device output level is comparable to recorded levels of EMI.

ACKNOWLEDGMENTS

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