INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Evaluation Procedures for Deploying Spread Spectrum Interconnect

Introduction

The Indiana Department of Transportation (INDOT) is beginning to make widespread use of wireless communications for interconnect of traffic signals in coordinated systems. The radio technology adopted for use in these systems is based upon spread spectrum modulation (either frequency hopped or direct sequence) and the frequency band is typically the 900 MHz unlicensed ISM band. There are a number of manufacturers of applicable radios. The main goal of this project was to support INDOT's systems engineering by designing and building a testbed radio network on the Purdue campus, which could be used to test various vendor's radios. The radio network has been constructed and tested. The network involves three nodes terminating in the Wireless Communications Research Laboratory, one node terminating in the Harold L. Michael Traffic Operations Laboratory, and one node terminating in a traffic signal cabinet located at the intersection of Northwestern and Stadium Avenue in West Lafayette. In addition, portable nodes were constructed for testing at other locations or outside of West Lafayette. The network was used in a number of tests in West Lafayette and Indianapolis.

Findings

The major findings of this project are:

1. In order to support INDOT systems engineering, a capability needs to be maintained for evaluating current and future spread spectrum radio technologies. The testbed constructed in this project can serve in this role. In addition, the software developed for radio network testing can be used with all current vendor radios and can be used without the Purdue University testbed.
2. The MDS 9810 radios tested can be used in non-line-sight applications provided that additional communications protocols can be inserted to protect applications from the higher data loss rate expected in these situations. Unfortunately, most traffic signal controller vendors do not provide the needed interface information to allow such protocol design. This issue should be addressed with these vendors.
3. Field testing did not discover serious current problems with interference either in West Lafayette or Indianapolis. However, in tests where interference was intentionally generated it was found that the throughput of MDS 9810 radios was significantly impacted. Interference problems will grow over time and could begin to degrade network performance after deployment. Also, INDOT should use care in deploying such networks in proximity to each other.

Implementation

A testbed for spread spectrum radio testing was designed, built, and tested with the radios of three vendors approved for use in INDOT projects (Microwave Data Systems, GINA, and

EnCom). Software was developed for operating the network and testing the radios in terms of bit error rate, data loss rate, and throughput. The testbed and software are available for INDOT use in testing the network with radios from other vendors. The software is applicable to any radio that presents an RS-232 (byte oriented) interface to computer or signal controller equipment. In addition, the testbed can be integrated with traffic signal controller equipment located in the Harold L. Michael Traffic Operations Laboratory.

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