Path Capacity Estimation in IEEE 802.15.4 Enabled Wireless Sensor Network via SenProbe *

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Abstract

In this demonstration, we will showcase SenProbe, a lightweight capacity estimation technique specifically designed for the CSMA based wireless sensor networks. SenProbe is a packet train technique based on the concept pioneer by CapProbe, but designed specially for the wireless environment. We will use wireless devices with limited radio ranges to display the properties of multi-hop wireless networks (a table top experiment). More specifically, we will illustrate wireless properties with IEEE 802.15.4 enabled devices, and offer insights into how the capacity of a wireless path changes in real wireless environments can be deployed, measured, and used. This tool will be useful for network users as well as network designers to gain better understanding of their network, and plan their activities accordingly. This demonstration aims to provide results that can be of assistance in various facets of IEEE 802.15.4 enabled intelligent home/industrial networking environments.

1. Introduction

IEEE 802.15.4 is a standard addressing the needs of Low-Rate Wireless Personal Area Networks (LR-WPAN) with a focus on enabling various pervasive and ubiquitous applications that require interactions with our surrounding environments. The design principles of IEEE 802.15.4 are ultra-low complexity, low date rate, low cost, and extremely low power consumption. The primary applications of IEEE 802.15.4 are in the field of intelligent home automation, automotive networks, industrial networks, interactive toys, remote metering, and etc. In the near future, it will become increasing important for network users as well as network designer to gain better understanding of their wireless network, this tool is one more step towards achieve such objective.

With the potential varieties of IEEE 802.15.4 networking applications, fundamental network properties will soon be of interest to network designers. Knowing the effective capacity, one can select the most efficient path to connect to Internet or transmit data in the most appropriate rate, which can save energy and facilitate faster data transfers.

However, estimating effective path capacity in wireless networks is a challenging task. Wireless capacity estimation depends not only on the rate of the "narrowest" link along the path (as in a wired network), but also on the network topology, interference between nodes along the path and several other environmental parameters. Moreover, the estimation must be independent of cross traffic, and it needs to be non-intrusive so that it does not disturb the ongoing applications. A successful capacity estimation mechanism must understand and satisfy these factors respectively.

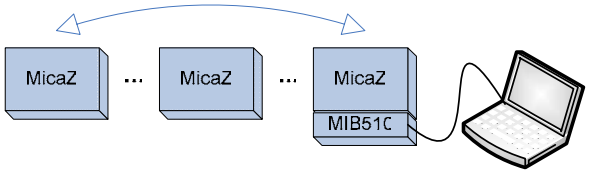

Figure 1: Conceptual illustration of demonstration setup

In this demonstration, we will showcase SenProbe, a lightweight capacity estimation technique specifically designed for the CSMA based wireless sensor networks. SenProbe is a packet train technique based on the concept pioneer by CapProbe, but designed specially for the wireless environment. We will use wireless devices with limited radio ranges to display the properties of multi-hop wireless networks (a table top experiment). More specifically, we will illustrate

* This work is funded by NSF under NRT grant ANI-0335302.

wireless properties with IEEE 802.15.4 enabled devices as depict in Figure 1, and offer insights into how the capacity of a wireless path changes in real wireless environments can be deployed, measured, and used.

2. System Requirements

2.1. Space, Power, and Networking Requirements (provided by the conference)

Space	This demonstration requires one table for the table-top deployment of motes and for the display of results. We will also need a poster stand for a pre-prepared poster boards.
Power	2 power outlets are required.
Networking	2 Internet connections are required (A 100Mbps Ethernet connection, and an 802.11b/g wireless connection).

2.2. Hardware and Software Requirements (provided by the demonstrators)

Software	1. SenProbe Sender 2. SenProbe Receiver 3. SOSSRV serial port data forwarder in SOS (Sensor Operating System) 4. Capacity Calculation engine 5. SenProbe Illustration Java GUI
Hardware	1. One laptop 2. One MIB510 Interface boards 3. One serial connection cable 4. Five IEEE 802.15.4 enabled MicaZ motes 5. Batteries

3. Demonstration Details

The demonstration setup is depicted in Figure 1, and we will describe the demonstration steps in detail as follows.

3.1. Demo Procedure

1. Connect the MIB510 interface board to the laptop computer
2. Install SenProbe Sender program onto the MicaZ motes (responsible for the sending) via the MIB510 interface board
3. Install SenProbe Receiver program onto all the other MicaZ motes via the MIB510 interface board
4. Set all MicaZ devices equal distance apart
5. Enable all MicaZ devices
6. Enable the SOS serial forwarding program on the laptop
7. Enable the Java Gui on the laptop to visually depict the results
8. Enable the SenProbe sender
9. SenProbe sender probes the wireless capacity for 1-hop, 2-hop, 3-hop, and 4-hop networks respectively and automatically.
10. Observe the various wireless capacities for 1-hop, 2-hop, 3-hop, and 4-hop networks accordingly.

Figure 2: Demonstration Setup

3.2. GUI display on Screen

(Sample representation)