Improving reliability in wireless sensor networks using multiple radio

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Abstract

Packet Reception Rate is one of the key aspects in wireless sensor networks link reliability. Using retransmission and multipath can improve reliability with overhead on traffic, energy consumption and delay. This is fatal for networks that has high traffic or time sensitive characteristic. We used multiple radios base station to improve PRR in WSNs. The performance measurements shows improvement on PRR.

Objective

Improving Packet Reception Ratio (PRR) without any overhead on the sensors.

Introduction

Wireless Sensor Networks (WSN) are useful in many civil and military applications. WSNs can consist of thousands of nodes, which sense and send data to the base station.

To save energy it is reasonable to reduce the transmission. Multiple packet transmissions also put an extra overhead on the network that may affect delivery ratio and make our wireless network unresponsive. Time constraint is another issue that we have to consider since a received packet after our allowed delay in the network is useless.

In this poster we present and analyze a new WSN platform. It can be used as a base station or a simple relay node in the network bottleneck. It utilizes up to eight parallel radio transceivers to receive packets. The use of multiple radios increases network performance significantly by allowing simultaneous data reception with several neighbors.

Multi Radio Sensor

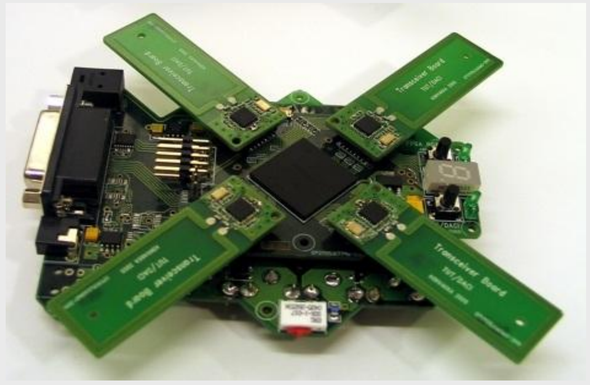

Figure 1. Implemented multi-radio WSN with four radio.

Experiment

We used Iris motes with TinyOS 2.1. We created one-hop WSN where sensors programmed to send a packet every 50ms. We located four sensors to send packets and a base station with eight receivers. Our goal in this setup was to maximize interference to have a network with high traffic. We run the experiments for 40 minutes. In each case, we counted the number of messages that are sent and received to get the packet reception ratio. We setup the senders and receiver as in figure 2.

Sensors Location

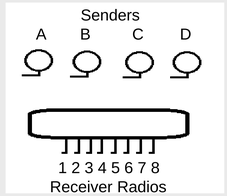

Figure2. Senders and receiver radios.

Results

Based on results from the experiments, it is obvious that using multiple radio receiver can improve packet reception ratio significantly. The ratio of improvement is different based on the packet reception ratio. The worse reception cases become a good target for improvement. In figure 3 the improvement from the minimum single radio to maximum single radio and the eight combined radio has shown. The improvement varies in different senders although they have the same condition and distance from the receiver. The improvement is also varies in each sender.

Delivery Ratio based on Senders

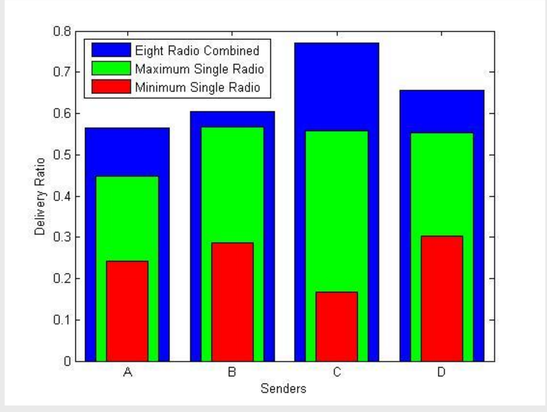

Figure 3. Combined radio and single radio max and min delivery ratio.

Results - con't

Radios on multi radio receiver has different reception ratio in time, which means one radio that has high reception compare to the others, does not have the same attitude along the time. In figure 4 radio 3 has higher ratio to other radios in the early time periods as later radio 5 has highest ratio and several other radio has higher ratio than radio 3, so radios are not consistent on delivery ratio in time and using multiple radios can mitigate this problem.

Sender A fixed windows size 400 seconds

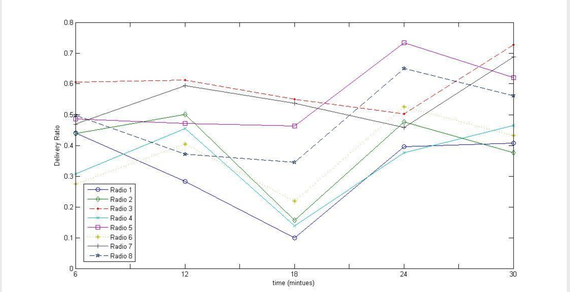

Figure 4. Delivery ratio for different radios for Sender A in minutes with 8000 packets windows size.

Combining radios will improve the delivery ratio from 10% to 20% from the best single radio. In figure 5 the combination of two, four and eight radios shows how it will improve the delivery ratio for sender C. In Figure 6 states that even combining two or four radios can improve delivery ratio significantly.

Delivery Ratio Radio Combination from Sender C

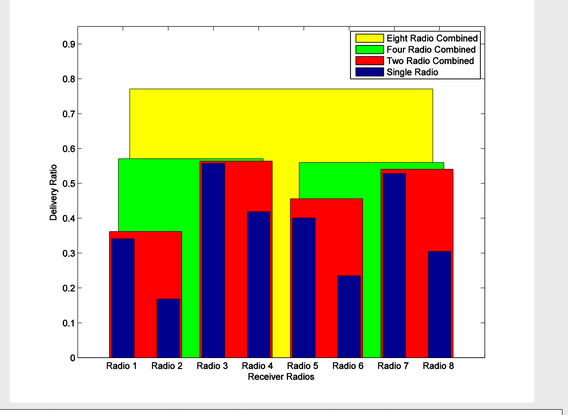

Figure 5. Delivery ratio for Receiver Radios from Sender C.

Results - con't

Delivery Ratio Radio Combination from Sender A

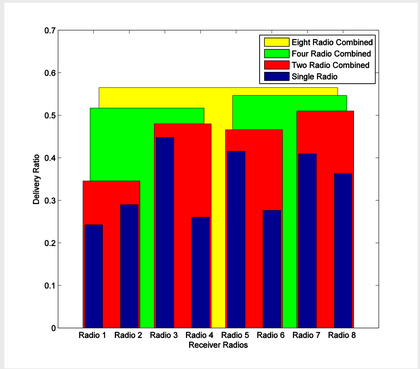

Figure 6. Delivery ratio for Receiver Radios from Sender C.

In the Figure 7 the distribution of receiver radios for each sender has shown.

Delivery Ratio distribution for Senders

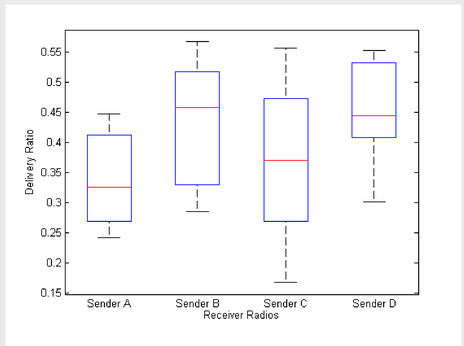

Figure 7. Delivery ratio for receiver radios from each sender.

Conclusions

- Improved reliability can be achieved by using multiple radios for receivers.
- It has the advantage over retransmission since energy and delay constraints conditions can be satisfied.
- It can recover lost packets without any cost.
- Retransmission can be used to improve reliability to achieve 100% delivery ratio.