The Impact of Decreasing Transmit Power Levels on FlockLab To Achieve a Sparse Network

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Introduction

- It is vital to perform experiments on testbeds to check real world performance
- Testbeds tend to be located indoors and have a dense topology
- Not all applications will be deployed in this environment
A Brief Summary of Source Location Privacy

Given:
- A WSN that detects valuable assets
- A node broadcasting information about an asset

Found:
- An attacker can find the source node by backtracking the messages sent through the network.
- So by deploying a network to monitor a valuable asset, a way has been provided for it to be captured.

Solutions require one or a combination of:
- Spatial Redundancy
- Temporal Redundancy
Attacker Movement Without Protection

Figure 1: Attacker movements towards source
Figure 2: Attacker movements with protection
To obtain a sparse network topology we can:

- Power off certain nodes (less useful for small testbeds)
- Reduce the transmit power

What is the impact of reducing transmit power?

- Less dense topology?
- Lower SNR?
- Invalid power consumption results?
- Impact on link asymmetry?
This means we want to go from this...
Figure 4: PRR with Transmit Power set to 7
Methodology

▶ Measuring Noise Floor
  ▶ Continuously query background noise on a specific channel
  ▶ Every 128 reads send minimum, maximum and average over the serial output

▶ Measuring Transmit and Receive Performance
  ▶ One node sends a packet every 500 ms, all others listen for it
  ▶ RSSI and LQI recorded
  ▶ Used to calculate PRR
  ▶ Only performed on channel 26 (to reduce the number of experiments)
  ▶ Three transmit levels investigated: 31, 19, 7

▶ Measuring Current Consumption
  ▶ Recorded for the three previous instances (Read RSSI, Transmit, Receive)
  ▶ Also recorded when the nodes just sleep

All code, results and analysis scripts are available online
## Transmit Power Levels

<table>
<thead>
<tr>
<th>Power Level</th>
<th>Output Power (dBm)</th>
<th>Current Consumption (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>0</td>
<td>17.4</td>
</tr>
<tr>
<td>27</td>
<td>−1</td>
<td>16.5</td>
</tr>
<tr>
<td>23</td>
<td>−3</td>
<td>15.2</td>
</tr>
<tr>
<td>19</td>
<td>−5</td>
<td>13.9</td>
</tr>
<tr>
<td>15</td>
<td>−7</td>
<td>12.5</td>
</tr>
<tr>
<td>11</td>
<td>−10</td>
<td>11.2</td>
</tr>
<tr>
<td>7</td>
<td>−15</td>
<td>9.9</td>
</tr>
<tr>
<td>3</td>
<td>−25</td>
<td>8.5</td>
</tr>
</tbody>
</table>

*Table 1: CC2420 Power levels*
Figure 5: Noise floor (dBm) readings for FlockLab nodes on IEEE 802.15.4 channels 11–26.
Link Metrics

(a) Broadcast power 31

(b) Broadcast power 7
Link Asymmetry

(a) Broadcast power 31

(b) Broadcast power 7
Figure 8: Average current draw (mA) in four different situations.
Experiences Using FlockLab

- No voltage measurements, only current draw
- Time Synchronisation
  - A change in the NTP server led to issues
  - Our logging showed messages being received before they were sent
  - Switching to a more accurate time server fixed this issue
  - Potential for logical clocks to mitigate this kind of issue?
- Node Availability
  - Not all nodes consistently available
  - Difficult to ensure reproducible network topology
  - When replacing nodes give them a new identifier, even if in the same location
Conclusions

- Decreasing transmit power is an effective way to obtain a less dense network
- Current measurements at different transmit powers have a low standard deviation

However:
- Each node has a different performance profile, including current draw for the same activity
- Some patterns will turn up in a testbed that would be unexpected in other scenarios (e.g., the higher levels of noise on the three WiFi channels)
- Logging over serial will impact current draw results
- Still need to consider the impact environmental aspects have: time of day, date, how busy the building is, and other factors
Thank You for Listening

Any Questions?