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

WARWICK

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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:

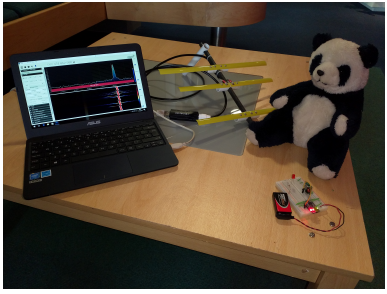
- A WSN that detects valuable assets
- A node broadcasting information about an asset

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

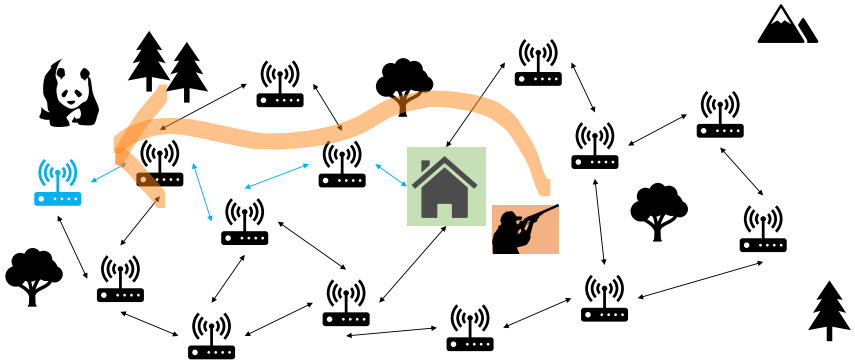


Figure 1: Attacker movements towards source

Attacker Movement With Protection

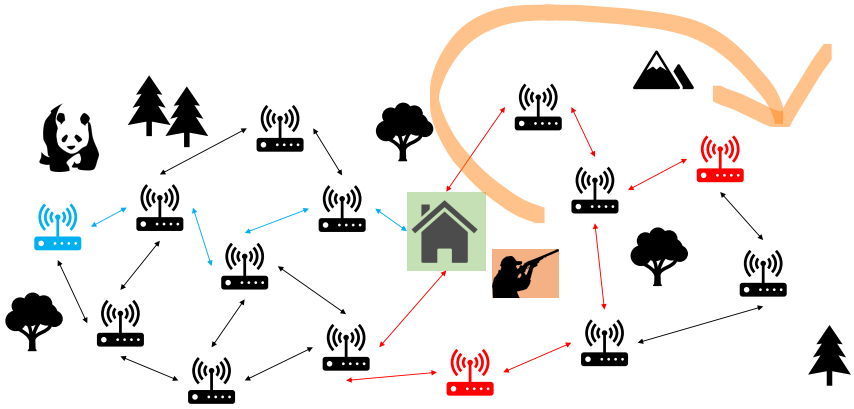
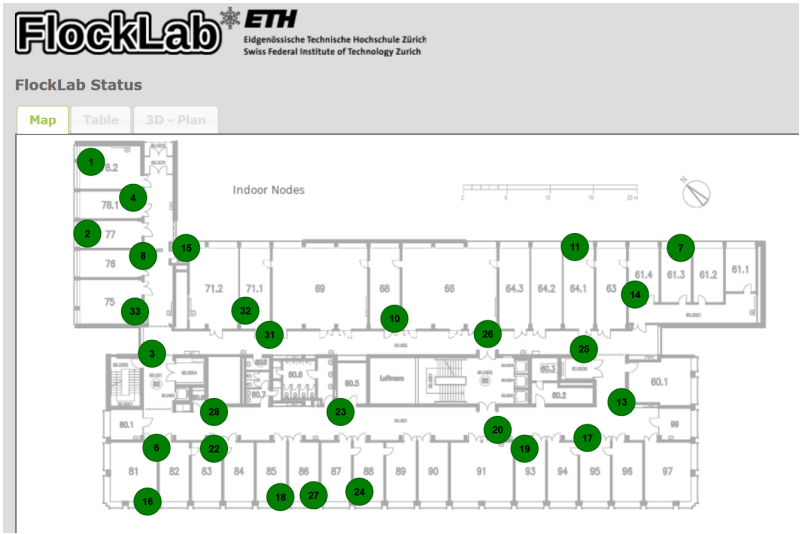


Figure 2: Attacker movements with protection


FlockLab
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich
FlockLab Status
Map
Table
3D - Plan
Indoor Nodes
1
4
2
8
15
11
7
14
33
32
10
31
26
25
3
28
23
13
6
22
20
19
17
16
18
27
24

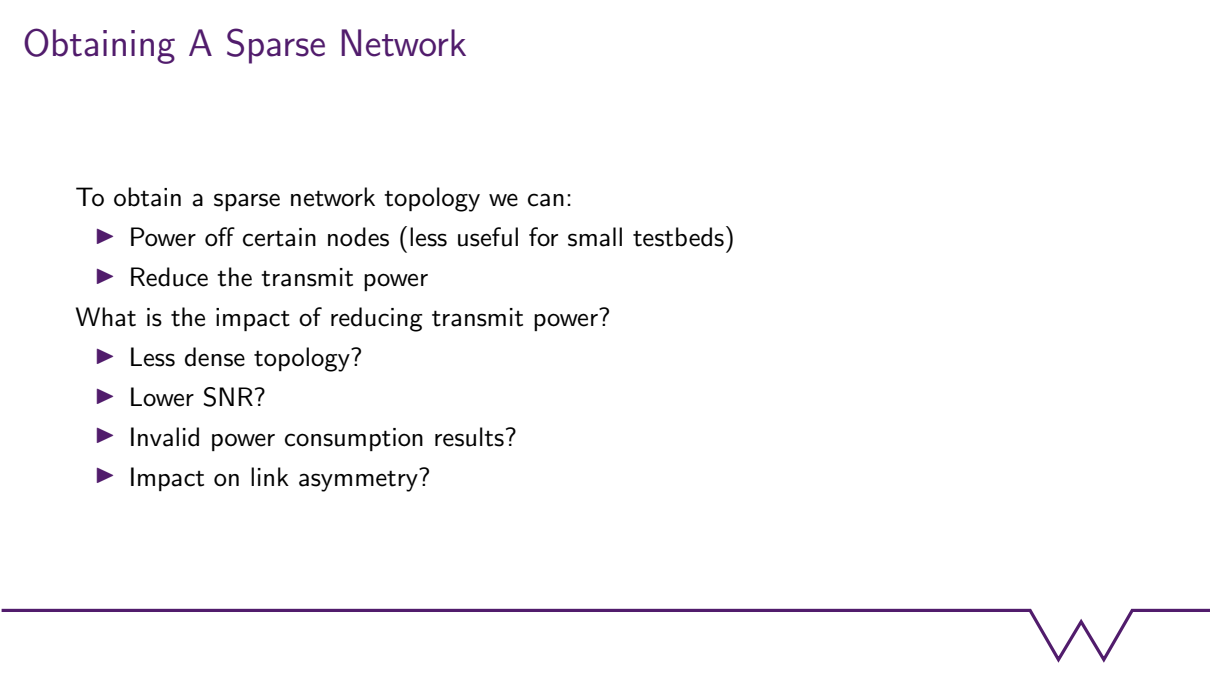
Obtaining A Sparse Network

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 . . .

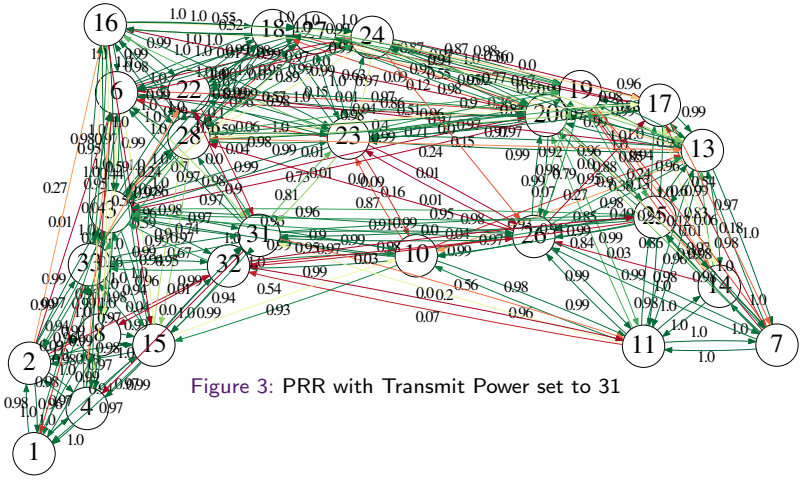


Figure 3: PRR with Transmit Power set to 31

. . . to this

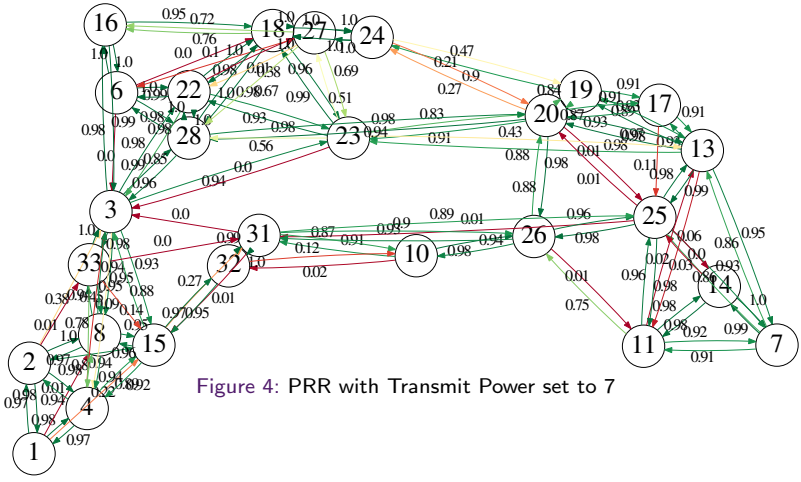
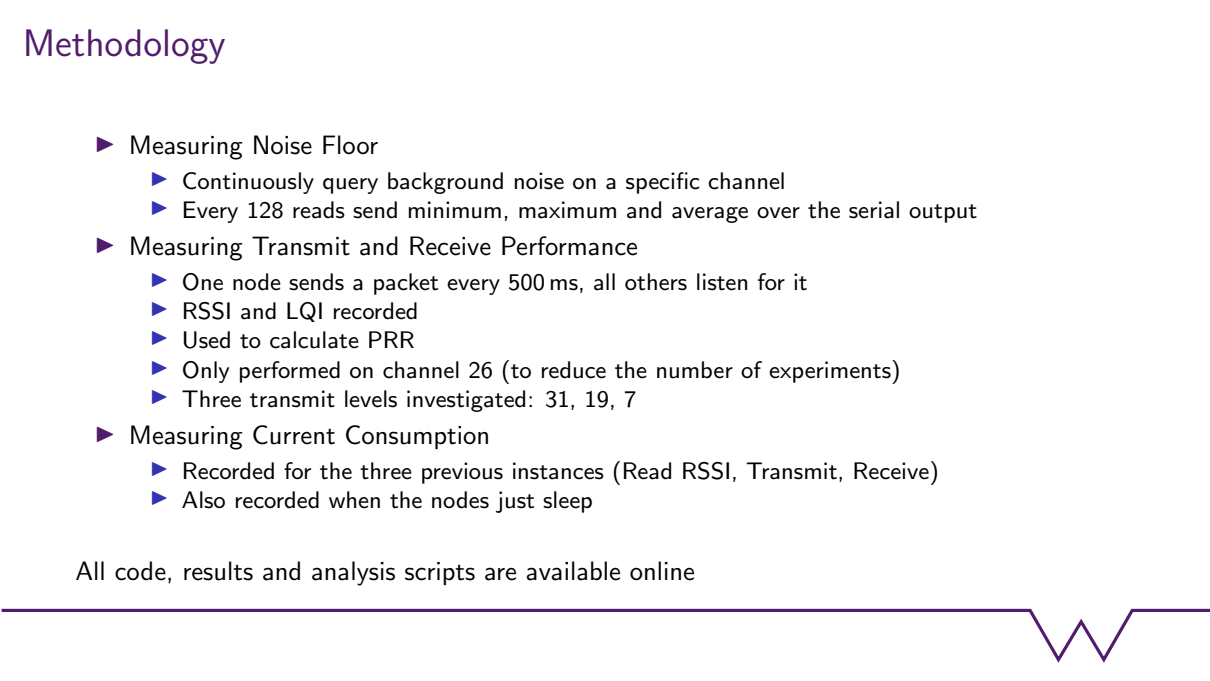


Figure 4: PRR with Transmit Power set to 7

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

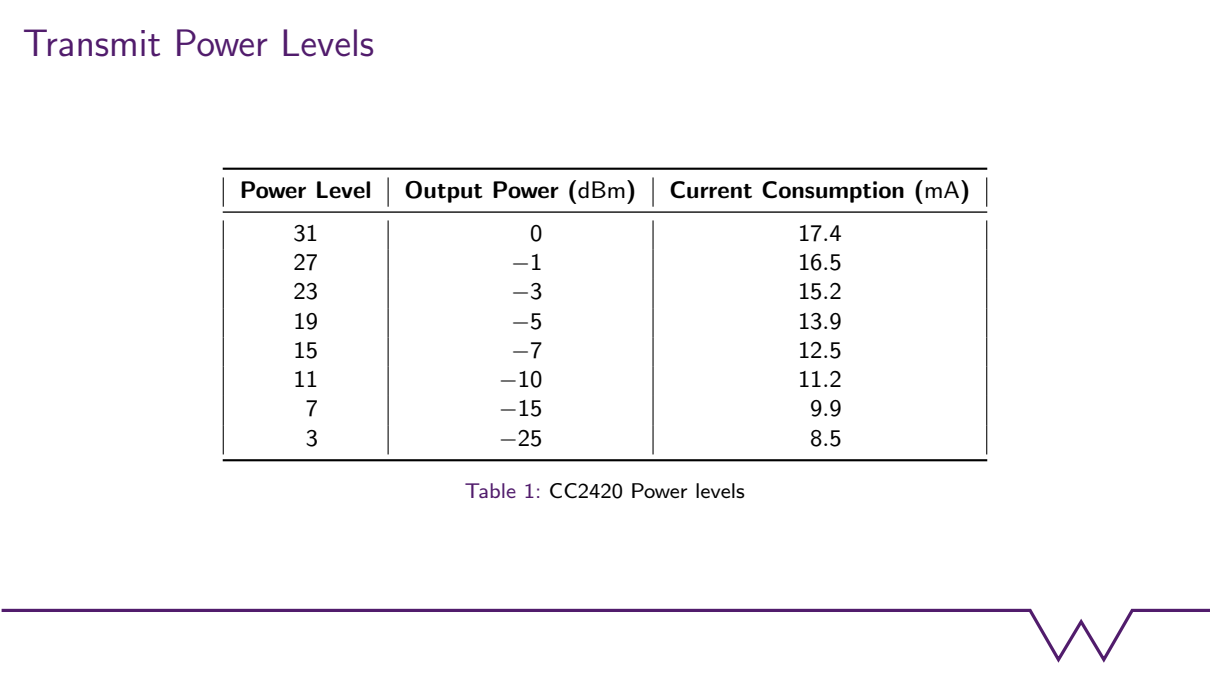
All code, results and analysis scripts are available online



Transmit Power Levels

Power Level	**Output Power** (dBm)	**Current Consumption** (mA)
31	0	17.4
27	−1	16.5
23	−3	15.2
19	−5	13.9
15	−7	12.5
11	−10	11.2
7	−15	9.9
3	−25	8.5

Table 1: CC2420 Power levels



Noise Floor

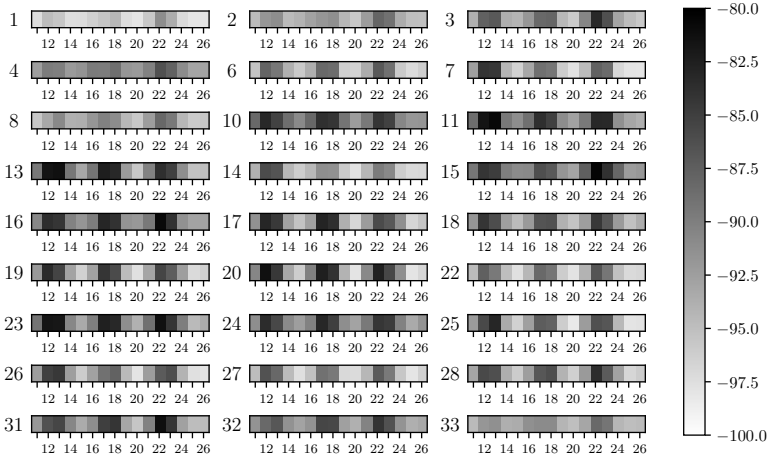
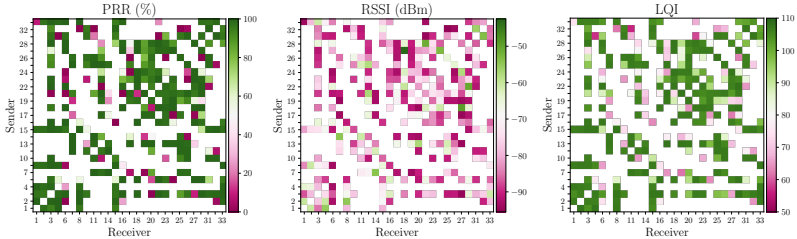
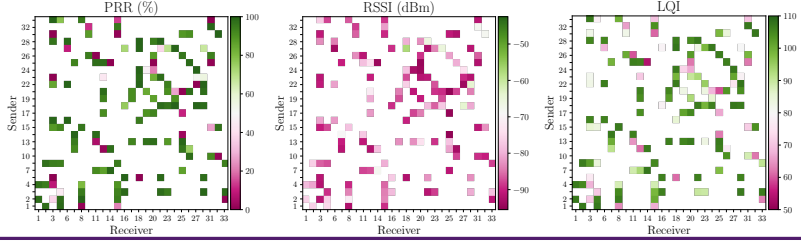


Figure 5: Noise floor (dBm) readings for FlockLab nodes on IEEE 802.15.4 channels 11–26.

Link Metrics

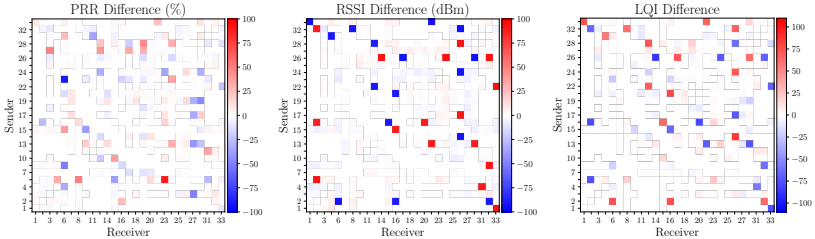


(a) Broadcast power 31

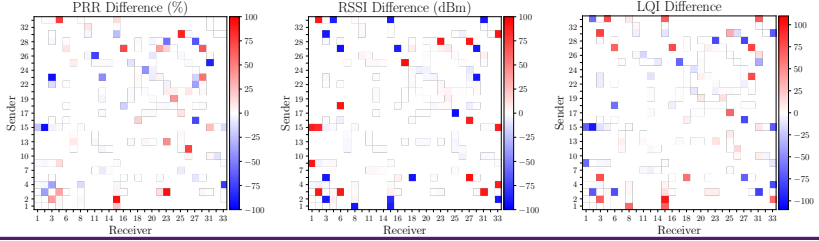


(b) Broadcast power 7

Link Asymmetry



(a) Broadcast power 31



(b) Broadcast power 7

Current Draw

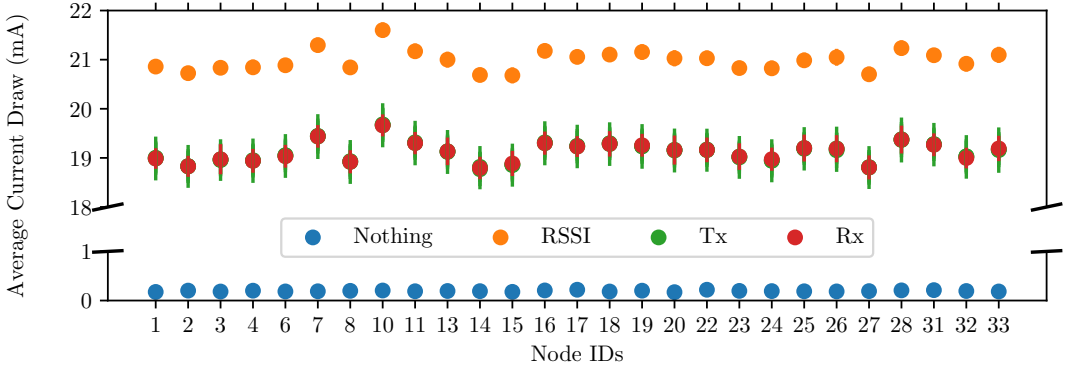
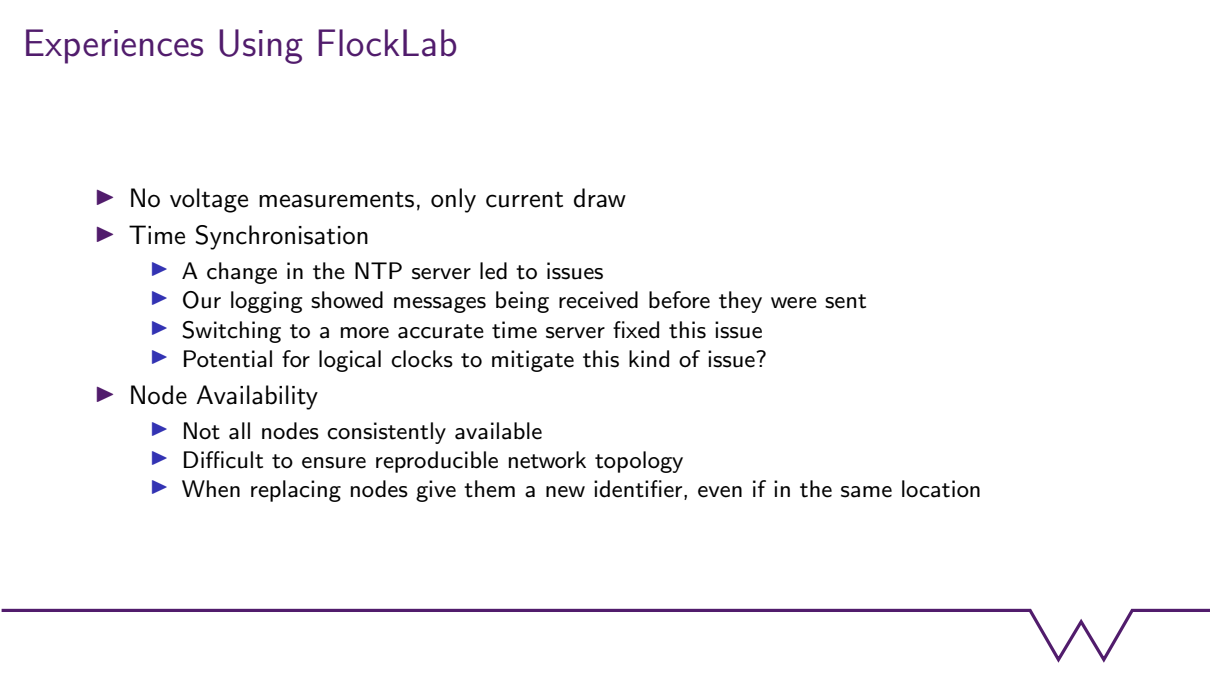


Figure 8: Average current draw (mA) in four different situations.

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

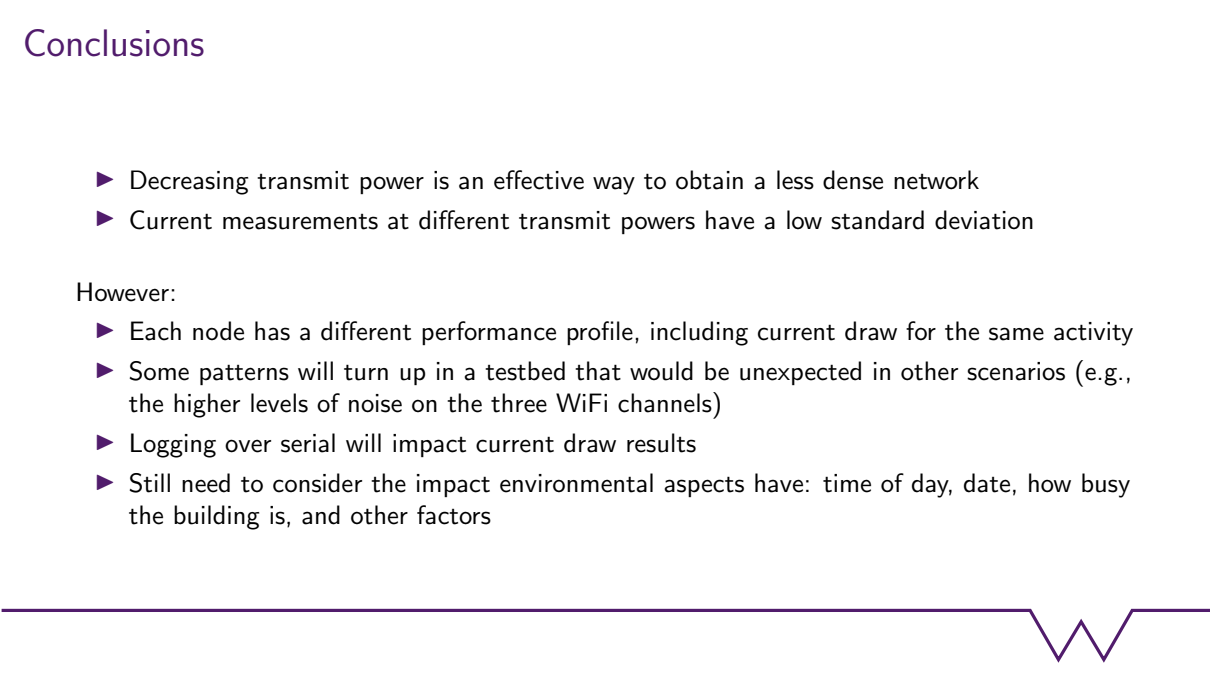


Conclusions

- 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?