TI Wi-SUN FAN DHCP Service Adaptation for IoT Networks

UTDesign II
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ECE 2145: Sapna Chandrasekhar (CE), Rita Kaushik (CE), Rayju Paul (EE), Tahsin Rishove (CE)

CS 2191: Lawson Lay (CS), Anh Nguyen (CS), Michael Duvall (CS), Rowan White (CS), Khiem Nguyen (CS), Khue Vu (CS)

Company Mentors: Robert Liang, Caden Stewart

University Faculty: Dr. Neal Skinner, Dr. Miguel Razo-Razo

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Abstract and Introduction

This project implements an adaptable and scalable DHCP service for Wi-SUN Field Area Networks (FAN), designed for smart city IoT applications. Using BeaglePlay® as a host device and Texas Instruments' LP-CC1352P7-1 evaluation boards as router nodes, we integrate a Kea DHCPv6 server and Stork dashboard to manage IPv6 address allocation. The system supports both sensor and light nodes, demonstrating functionality through interactive smart city demos such as dynamic lighting and room capacity monitoring. A custom web interface allows users to visualize real-time device activity and control endpoints. The system showcases the potential for low-power, long-range wireless communication in dense urban settings.

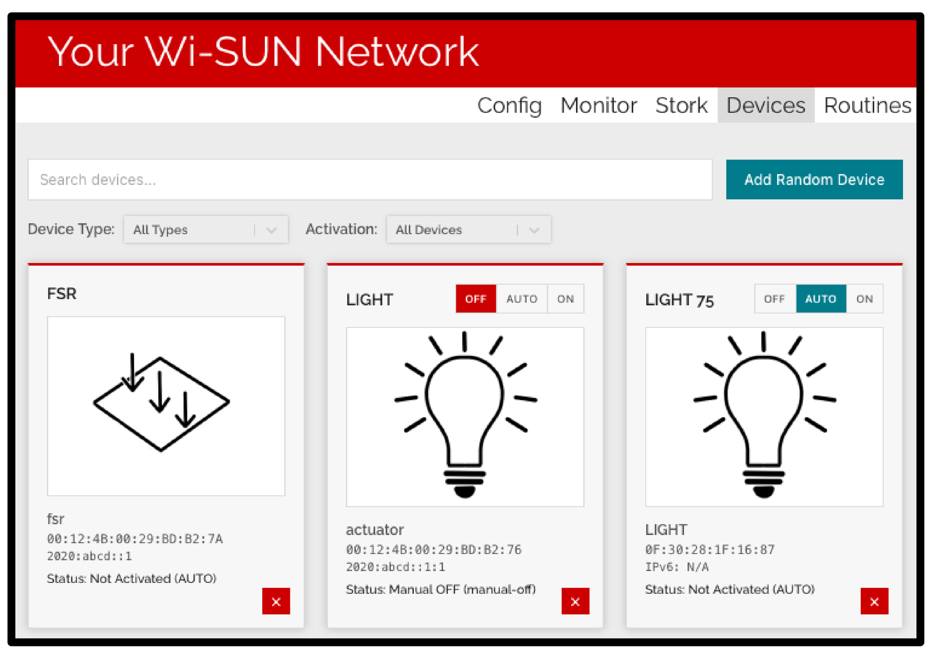
Architecture

Hardware Stack

BeaglePlay® | Contains the Debian Linux OS, Kea DHCPv6 server, and hosts the ti-web-app

TI LaunchPad™ **(LP-CC1352P7-1)** | Deployed as Router Nodes with sensors or lights as end devices

Border Router (CC1352P7 MCU) | Relays communication between BeaglePlay® and the Router Nodes



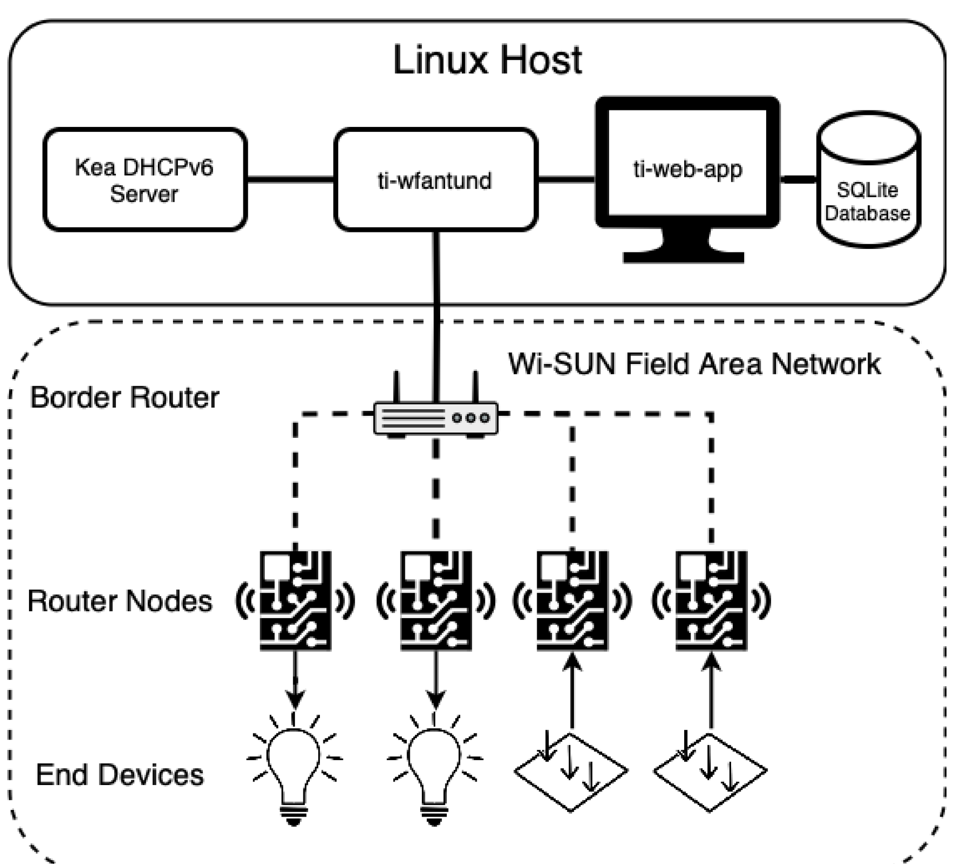
Software Stack

Kea DHCPv6 and Stork | Assigns and visualizes IPv6 address allocations dynamically based on the device's DHCPv6 vendor ID

ti-wfantund | Handles communication between the Linux OS and the Border Router

ti-web-app | React website application to show real-time end device states and allows remote manual control of the lights

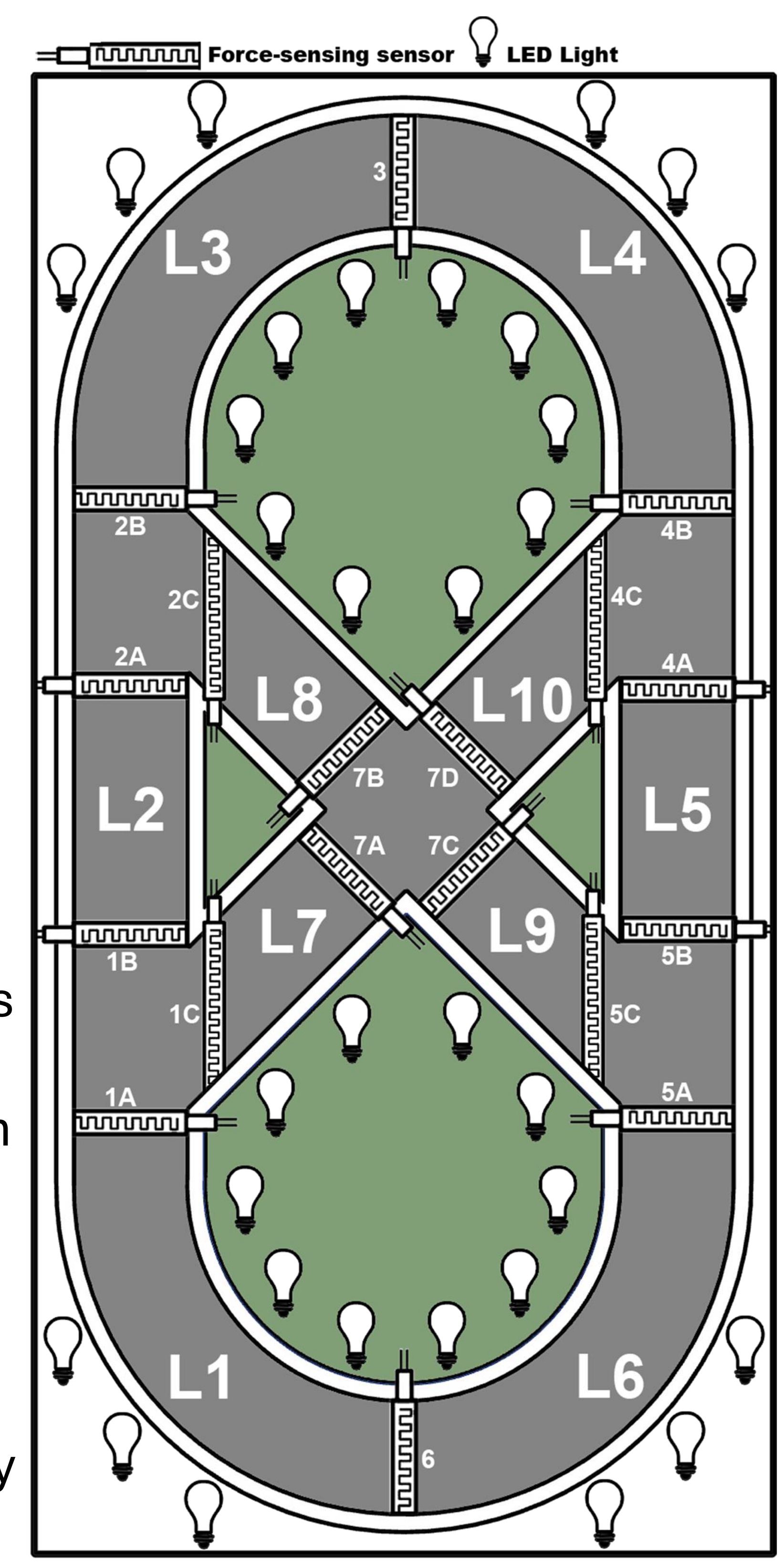
SQLite Database | Stores MAC addresses, user-defined names, and routine mappings



Fabrication and Metrics

Data Flow

When a sensor is activated, it sends a signal to its respective Router Node. The Router Node will then send a CoAP packet to the Border Router wirelessly via the sub 1-GHz Wi-SUN FAN. Once the Border Router receives the packet, it will forward it to the Linux host using ti-wfantund. Using the IPv6 address allocated by the Kea DHCPv6 server, the ti-web-app can sort and interpret the CoAP request and route the proper output to the set light.



Fabrication

The smart city demo was created with plywood, paint, 3D printed parts, and perf boards. We connected the lights and sensors to the perf boards with the proper resistors, and then attached them to the LPs. We sorted the board's lights and sensors into light and sensor zones for ease of configuration on the website.

Metrics

We met all functional expectations set by the company sponsor. We exceeded the expectations for the physical demonstration and expanded upon the initial goal. The project is scalable and fits within the Wi-SUN standard with acceptable delay. The website interface is simple to configure and easy to use, and the technology stack is simple to setup and maintain.

Impact and Ethics

Impact

The project's impact lies in creating a proof of concept for an improved, scalable, and configurable IoT network designed for smart city applications. By using the sub 1-GHz band, the network can cover several kilometers with less interference and power consumption than 2.4-GHz bands. This makes it ideal for large-scale IoT deployments, such as smart lighting, public infrastructure management and more. By using IPv6, we can create much larger networks than an IPv4 network could. For TI, the project demonstrates the usage of Wi-SUN in long-range and city environments. It provides an easy-to-use structure for beginners and clearly showcase its flexibility.

Ethics

Our project adheres to ethical principles by prioritizing the integrity, reliability, and safety of its systems. We are committed to collaborative teamwork, respecting all ideas, and crediting contributors appropriately.

Summary

This smart city demonstration showcases one possible technology stack required to deploy a Wi-SUN network in a public metropolitan area. In our demonstration, we have a volunteer drive a RC car around the track, setting off force-sensing resistors. The sensors and lights communicate via the Wi-SUN FAN, and they can be easily monitored and configured from our modified version of the ti-web-app. When a sensor is activated, the corresponding nearby lights will turn on within an acceptable delay.

Security and Privacy

Security

When deploying this product into a public metropolitan area, the IoT network must be resistant to unauthorized access and external threats. However, this was beyond our scope of the project. Wi-SUN uses the EAPOL to encrypt and propagate messages within its own FAN. Endpoints should be secured via an alternative Router Node host with no open ports to easily read binary data from. By securing all hardware physically and data via encryption, we can attempt to prevent any potential attack vectors.

Privacy

This project does not intentionally collect any personal data; therefore, we do not provide any privacy risk to any form of personally identifiable information or secrets unless our version provided is modified. All data that is used in our context and application should be public, such as sensor and light location, and street names to label relationships.