# Monitoring of Bluetooth Low Energy Devices


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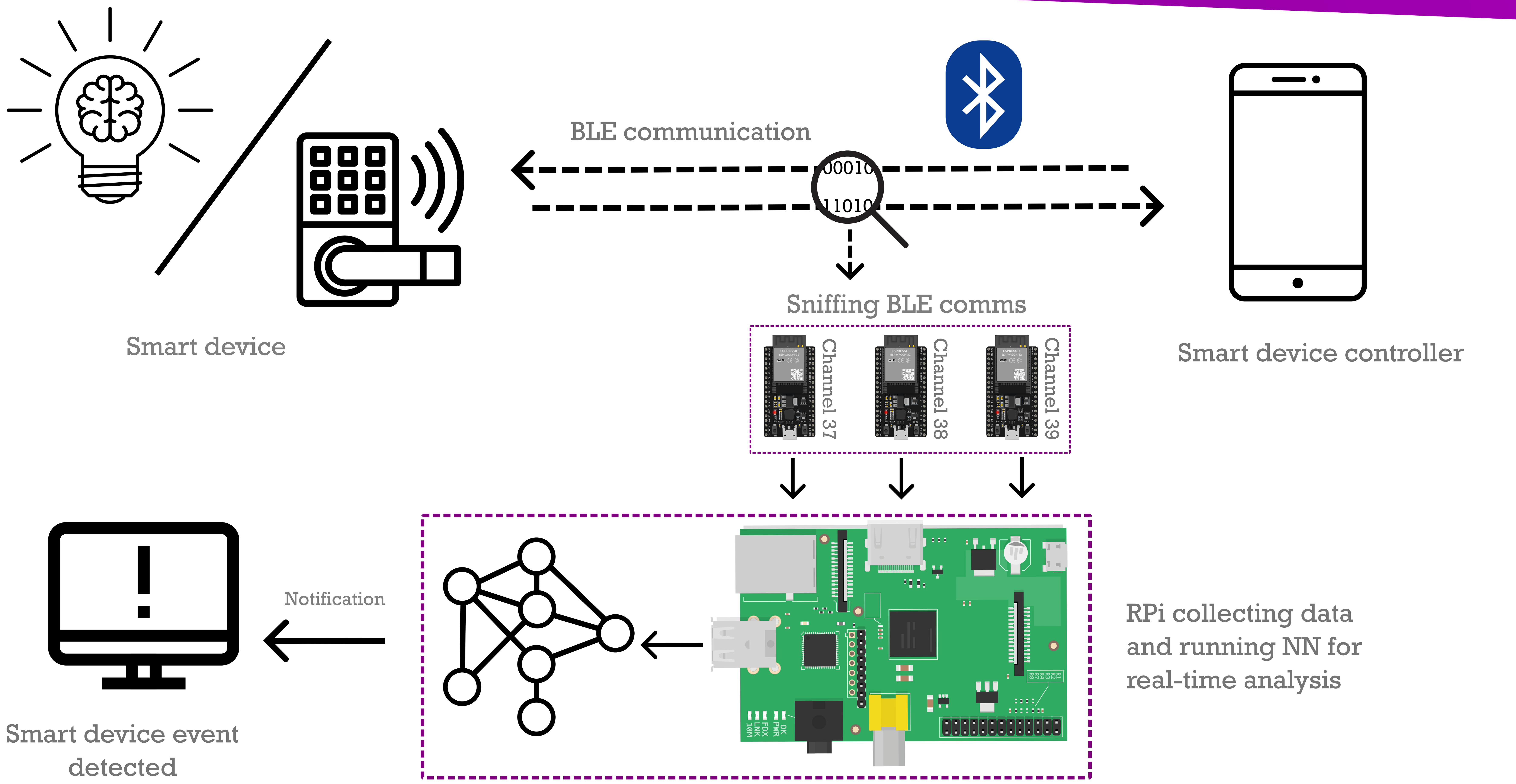


Figure 1: project pipeline

## Detection Method

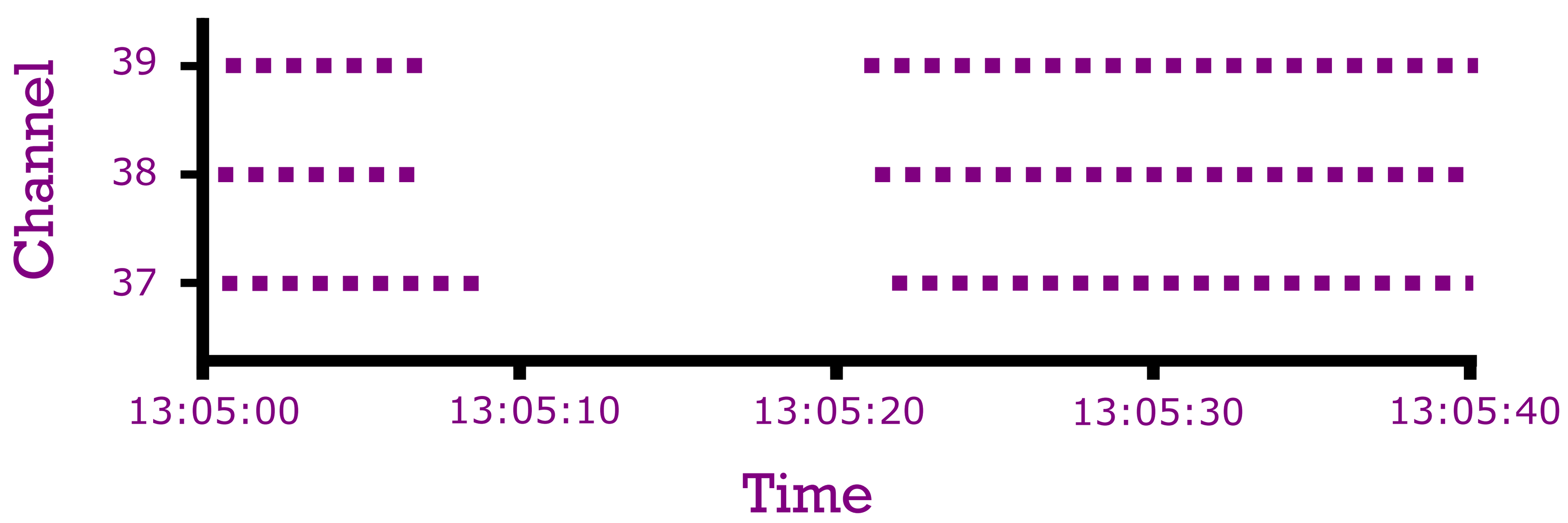


Figure 2: Intermittment pattern

- Devices advertise periodically on channels **37**, **38**, **39** when unconnected.
- Intermittent Pattern: Advertising stops during active connections (See Fig 2).
- Detection: Identify connections passively via large gaps in ad timings.
- Works best for devices showing clear intermittent patterns

Uses 3 **ESP32**s for parallel sniffing (one per advertising channel).

## Machine Learning

**Goal:** Apply Machine Learning to improve passive BLE connection detection accuracy.
**Motivation:** Address limitations of prior methods (statistical/simple ML) in generalizing across devices.
**Focus:** Enhance generalization - create a model that works reliably for various device types.
**Aim:** Develop a more robust and practical monitoring solution using advertising data patterns.

## Solution

**Technique:** Employed a Multilayer Perceptron (MLP) neural network for classification.
**Input:** Fed the MLP a sequence of recent advertising time deltas. Input sequence provides better context to help identify true connection gaps.
**Output:** Model predicts binary state: Connection (1) or No Connection (0).
**Exploration:** Also experimented with 1D ConvNet architectures

### Results

(F1/P/R): 0.88 / 0.87 / 0.89


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