Lab 1 Draft - Team Sapphire
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1. Introduction

Living in shared spaces such as apartments, dormitories, and townhomes often comes with one of the most common and frustrating conflicts: noise. Excessive noise, whether caused by loud music, late-night gatherings, or simply everyday activities, has consistently ranked among the top sources of tenant complaints. Yet, the process of resolving these disputes remains inherently flawed. Complaints typically rely on personal accounts, which are subjective and often unreliable, leaving property managers to act without neutral evidence. This lack of objectivity not only creates tension between neighbors but also undermines trust in management.

The problem extends beyond inconvenience. The American Public Health Association has noted that chronic noise exposure, even at relatively low levels, contributes to annoyance, disrupted sleep, stress, and long-term health risks such as cardiovascular disease and premature mortality (APHA, 2021). Recent environmental health studies also demonstrate that noise is not just an irritant but a significant factor in mental well-being, with chronic exposure linked to increased anxiety, depression, and reduced stress resilience (Hahad et al., 2025). Furthermore, research into cardiovascular impacts shows that transportation and environmental noise accelerate morbidity and mortality, underscoring the seriousness of unmanaged sound in daily life (Munzel et al., 2024).

Despite these findings, tenants lack the tools to protect themselves from false accusations or to prove when they are being disturbed, while managers have no fair means of distinguishing between legitimate grievances and exaggerated claims. This creates a

growing demand for objective, privacy-conscious solutions capable of improving both the tenant experience and the ability of property managers to resolve conflicts consistently.

The Sapphire Sound Monitor seeks to meet this need. Designed as a software-enabled noise monitoring system, Sapphire Sound bridges the gap between subjective perception and verifiable data. By combining real-time noise tracking with privacy-preserving technology, it empowers tenants and managers alike to address disturbances fairly and effectively.

2. Sapphire Sounds Product Description

Sapphire Sound is a web application that connects to a compact noise-detection sensor. Rather than recording conversations or audio content, the device measures sound intensity in decibels. If levels remain too high for a prolonged period, the system automatically registers a noise event and generates a timestamped noise report documenting the disturbance. These noise reports are shared directly with property managers to ensure transparent resolution of complaints. Tenants, meanwhile, can access their own noise histories, receive real-time alerts when they exceed acceptable levels, and even participate in an optional rewards system that encourages respectful behavior. At its core, Sapphire Sound promotes more peaceful community living by replacing subjective claims with clear, unbiased evidence.

2.1 Key Product Features and Capabilities

At the heart of Sapphire Sound is its commitment to objectivity and privacy. Unlike traditional surveillance systems, it does not capture or analyze conversations, ensuring that tenant privacy remains fully intact. Instead, it relies on decibel-based measurements, providing an impartial record of noise disturbances. These timestamped logs serve as verifiable evidence for dispute resolution, enabling property managers to act fairly while also protecting tenants from false accusations.

The system introduces several innovations to improve shared living environments. Its privacy-first monitoring ensures that only sound intensity is measured, sound content is never recorded. By replacing subjective complaints with reliable data, it shifts conflict resolution from personal accusations to clear evidence. Tenants also benefit from real-time alerts, which allow them to self-correct before complaints escalate. Finally, the inclusion of a

positive reinforcement system, where tenants can earn rewards for maintaining acceptable noise levels, encourages not only compliance but also community cooperation.

2.2. Major Components (Hardware/Software)

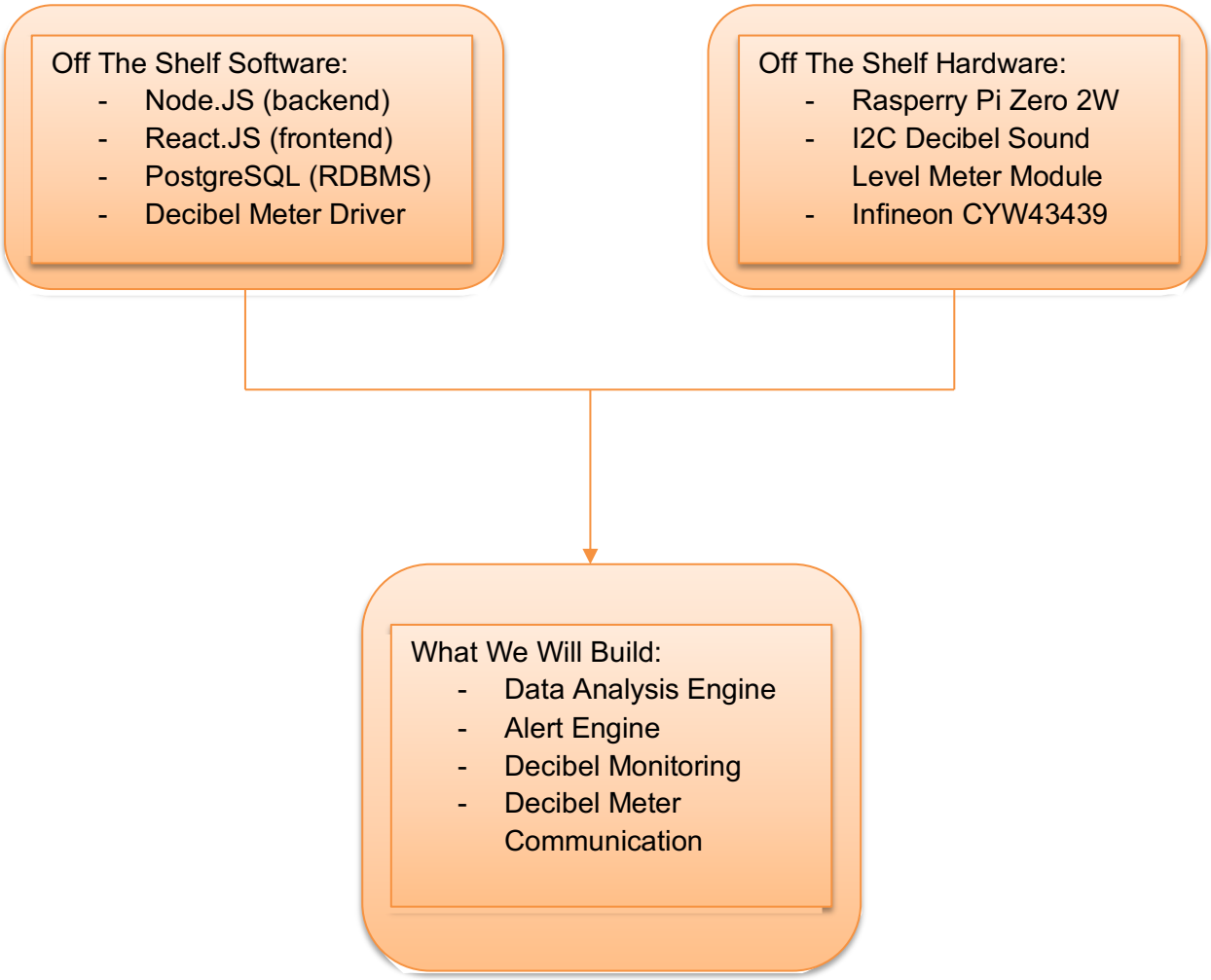

Figure 1: Major Functional Components Diagram

Sapphire Sound combines both hardware and software components to create a seamless, experience. On the hardware side, the system relies on a Raspberry Pi Zero 2 W, which serves as the controller and collects data from a decibel-level sound sensor. The embedded Infineon CYW43439 Wi-Fi chip enables wireless connectivity, allowing the

device to transmit noise data securely over a network. The I2C-based decibel sound level meter continuously measures real-time noise levels, while the Raspberry Pi timestamps and organizes the readings before securely transmitting them.

On the software side, the solution employs a modern, scalable architecture. The frontend, built with React.js, provides an intuitive web and mobile interface for tenants and property managers to view logs, alerts, and reports. A Node.js backend manages sensor data ingestion, user authentication, and noise analysis while implementing the alert and reporting logic. All data is stored in a PostgreSQL database, which maintains timestamped logs, user activity, and reward tracking. Development and version control are managed through GitHub to support collaboration and continuous integration.

3. Identification of Case Study

The primary users of Sapphire Sound are tenants and property managers in multi-unit housing communities. It may be enforced by an HOA in a condo or townhome; it may also be required by the landlord in an apartment complex. For tenants, the system offers a way to monitor their own noise habits, avoid disputes, and demonstrate compliance when faced with accusations. For property managers, it provides a fair, transparent, and privacy-compliant method of addressing complaints, identifying chronic issues, and preserving peace within the community.

Sapphire Sound is especially important in shared living environments, where noise consistently ranks as one of the most frequent sources of conflict. Without objective evidence, disputes often escalate into retaliation, strained neighbor relations, or unfair blame. By providing neutral data, Sapphire Sound enables managers to act with consistency and fairness. Beyond residential applications as described above, future adoption may extend to settings such as university dormitories, co-living spaces, and even hotels, where maintaining an environment of respect and quiet is equally vital.

4. Glossary

- dB (Decibel): A unit to measure the intensity of sounds.
- Noise-detection Sensor: a physical device that monitors sound levels without recording audio.
- Noise Event: An occurrence when decibel thresholds are reached for a specific duration. Used for reporting.
- Noise Report: A structured report generated by the system, detailing the noise event.
- Tenant: A resident or occupant of a shared or multi-unit housing space using the system to manage and monitor noise activity.

5. References

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