Statement of Duties and Accomplishments

Sami Kaab

Embeded Software Engineering

NLT Digital Solutions

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Executive Summary

Sami Kaab has demonstrated excellent technical breadth and depth across software development, embedded systems, hardware design, and quality assurance. His work shows clear progression from individual tool development to comprehensive system architecture, with significant contributions to production deployment and process improvement.

In addition to strong technical contributions, Sami consistently worked effectively within collaborative, cross-functional teams—communicating clearly with colleagues across hardware, firmware, and software domains to ensure smooth integration and alignment of system components. His ability to coordinate efforts, share technical insights, and adapt solutions within a team-oriented environment contributed to the success of multiple complex projects.

The combination of hands-on implementation, system architecture design, quality-focused development, and thorough documentation reflects a well-rounded engineering professional capable of driving high-impact technical work in team-based settings.

Sami's work has delivered measurable business value through improved operational efficiency, reduced manual processes, enhanced product quality, and the establishment of scalable monitoring and testing frameworks that support both current operations and future growth.

Core Technical Competencies

Programming & Development

- **Python** – Web development (Flask), data processing/visualisation, automation scripts
- **C/C++** – Embedded firmware (Espressif, FreeRTOS, unit testing)
- **JavaScript/HTML/CSS** – Interactive dashboards, real-time charts
- **SQL** – Complex queries, data validation, schema optimization
- **Containerization** – Docker, Development containers

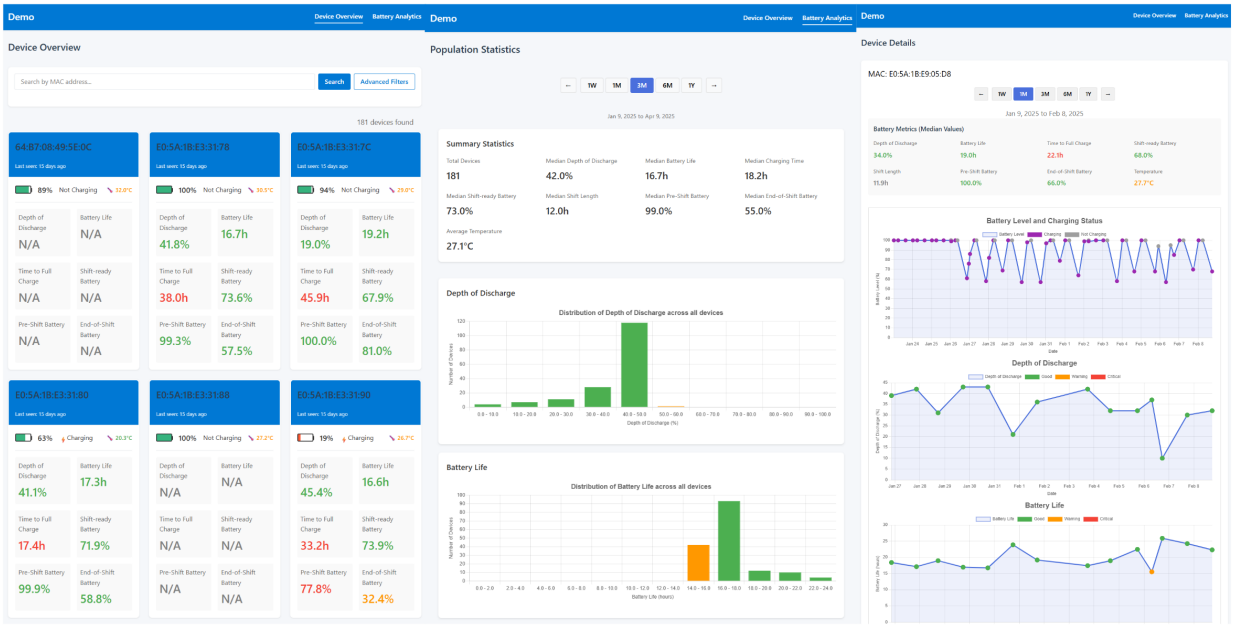
Systems & Technologies

- **Embedded Systems** – Arduino, ESP, PIC, Kendryte
- **Project management** – Jira, Confluence, Agile methodologies
- **Databases** – SQLite, MySQL, time-series optimization
- **Development/Version Control** – Git, Bitbucket pipelines, CI/CD
- **PCB Design** – Circuit Studio, Altium Designer, Altium 365

IoT Battery Monitoring System

Project Overview

Architected and deployed a production-scale IoT monitoring platform supporting 300+ distributed devices across two operational sites, featuring advanced analytics, predictive maintenance capabilities, and robust real-time data processing.



Features and implementation

- **Multi-threaded MQTT Infrastructure:** Implemented robust message queuing, health monitoring, and exponential backoff reconnection with graceful degradation.
- **Advanced Analytics Engine:** Real-time computation of key performance metrics, lifecycle estimates, and operational thresholds using automated data analysis and event detection algorithms.
- **Interactive Web Dashboard:** Flask-based RESTful API with Chart.js visualizations, multi-metric filtering, and responsive design.
- **Database Optimization:** SQLAlchemy ORM with time-series optimization, automated data validation, and structured logging for performance monitoring.

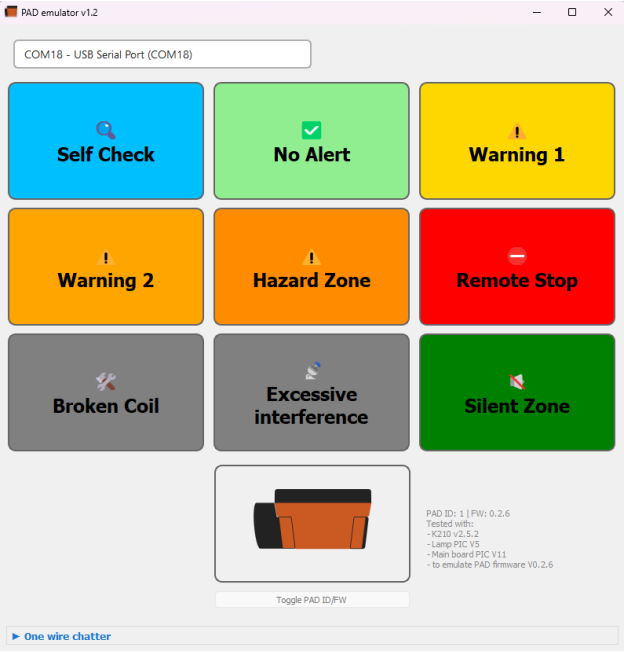
Impact

Delivered comprehensive battery lifecycle management by analyzing degradation trends and fleet-wide operational behavior to enable predictive maintenance, improve operational efficiency, and inform evidence-based strategies for deployment, maintenance scheduling, and performance optimization.

Virtual Peripheral Emulator for Firmware Testing

Project Overview

Designed a system to emulate unavailable third-party hardware during firmware development, enabling testing and integration without physical devices.



Features and implementation

- **Software-based Emulation** – Complete simulation of third-party device communication protocols
- **Custom Hardware Interface** – One-wire UART adapter with fully documented PCB design and protection circuits
- **Desktop GUI application** for device state management and protocol traffic observation
- **Comprehensive documentation** for setup, operation, and integration workflows

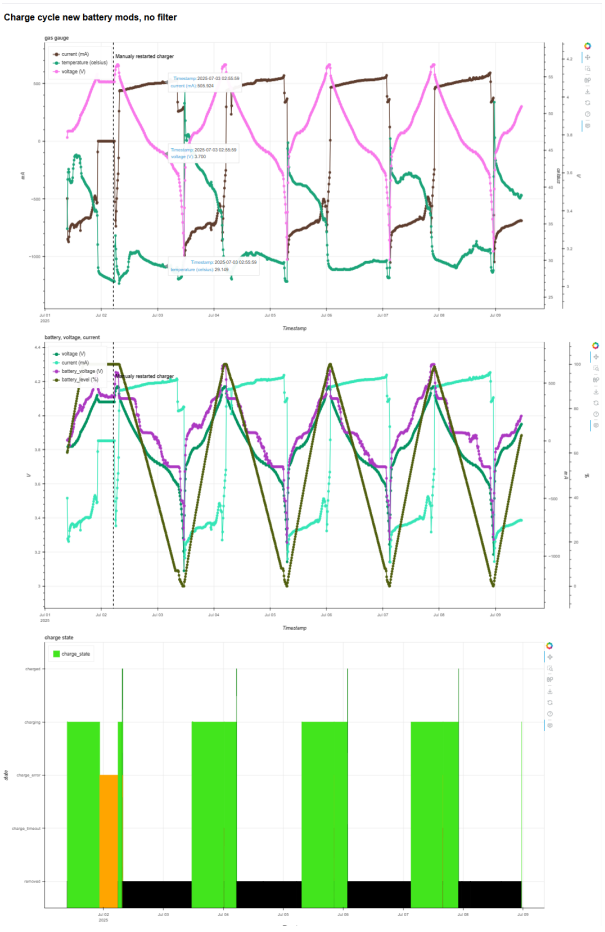
Impact

Eliminated hardware availability as a development blocker, reducing development cycle time and enabling comprehensive testing scenarios impossible with physical hardware constraints.

Automated Test Infrastructure Framework

Project Overview

Architected and implemented a comprehensive Python-based automation infrastructure enabling synchronized multi-day testing across diverse instrumentation platforms, supporting concurrent data collection from multiple sources with unified processing and analysis capabilities.



Core Modules:

- **Serial Logger:** Real-time capture and parsing of serial communications with configurable regex based filtering and pattern matching.
- **Oscilloscope Logger:** Continuous measurement and/or waveform acquisition from laboratory equipment.
- **MQTT Telemetry Collector:** Distributed device monitoring with message processing and reconnection handling.
- **Vision-Based Status Monitor:** Automated detection of visual indicators using image processing for LED states and display readings.
- **Switch Controller:** Conditional automation of external systems based on collected data thresholds and test progression.
- **Live Data Visualizer:** Real-time plotting and trend analysis for immediate test feedback and anomaly detection.
- **Notification System:** Automated alert generation with webhook integration for test completion and failure notification.

Features and implementation

- **Unified Infrastructure:** Built standardized BaseModule architecture providing configuration management, logging, signal handling, and error recovery patterns across all components.
- **Multi-Source Synchronization:** Coordinated real-time data collection from serial interfaces, MQTT telemetry, laboratory instruments, and vision-based monitoring systems with timestamp correlation.
- **Extended Test Automation:** Supported multi-day continuous testing with data validation, and buffered output ensuring data integrity during long-duration test scenarios.

- **Processing Pipeline:** Implemented configurable input/transform/output architecture with regex-based parsing, data filtering, and real-time analysis capabilities.
- **Concurrent Processing:** Multi-threaded design enabling simultaneous data acquisition from multiple instruments with independent processing pipelines and error isolation.
- **Configuration Management:** YAML-based unified configuration system with validation, hot-reloading, and environment-specific parameter sets.

Impact

Transformed manual testing workflows into automated, remotely monitored systems by implementing synchronized data collection across multiple sources, enabling real-time visualization, immediate feedback, and continuous monitoring—significantly enhancing test reliability, data quality, and operational efficiency

Embedded Power Monitoring Platform

ESP8266-Based IoT Solution

Project Overview

Developed a complete embedded monitoring system for critical infrastructure power monitoring, including custom firmware, PCB design, and deployment automation to ensure reliable telemetry for operational decision-making.

Features and implementation

- **Real-time Monitoring** – Continuous power source state monitoring
- **Reliable Telemetry** – Structured regular MQTT messaging and event-driven updates
- **Web Configuration** – Built-in browser interface for field configuration and status monitoring
- **Enterprise Ready** – Static IP assignment, and time synchronization
- **ESP-IDF firmware** with FreeRTOS for concurrent task management
- **Non-volatile configuration** storage with structured data formats and field-updateable parameters
- **Custom PCB design** with complete manufacturing documentation and component sourcing
- **CI/CD deployment** pipeline with automated firmware packaging and configuration tools

Impact

Provided a stable, scalable embedded monitoring solution with full hardware and software lifecycle support, suitable for operational deployment at scale.

RFID Receiver Evaluation and Range Testing

Project Overview

Evaluated Wavetrend RFID receiver performance through systematic signal strength and range testing to inform deployment strategies and hardware selection.

Features and implementation

- **Test Planning:** Designed and executed controlled experiments to measure RFID tag detection range and signal reliability under varying environmental conditions.
- **Data Acquisition:** Automated logging of RSSI (Received Signal Strength Indicator) and tag detection events using custom Python scripts interfacing with the receiver.
- **Analysis:** Visualized signal strength decay and detection reliability as a function of distance and obstacles, producing actionable plots and summary statistics.
- **Reporting:** Delivered concise technical report with recommendations for optimal receiver placement and system configuration.

Impact

Enabled data-driven decisions for RFID system deployment, reducing risk of coverage gaps and ensuring robust asset tracking performance.

I confirm that the information above accurately reflects the duties, accomplishments, and technical contributions of Sami Kaab during their tenure at NLT Digital Solutions.

Supervisor Name:

Rodrigo Sánchez

Title:

Head of Electronics Design

Signature:

Date: