WIMERA

Requirement Document
For
K2 – Cloud Application

Version No.: 1.0

Release Date: 23th Feb 2024

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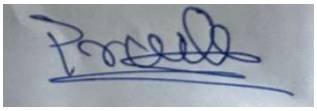
Document Information:

Project Name: Technical Solution Document for K2 - Cloud Application	
Project Code	PRJI-NP-20240918
Document Owner	Manjunath P
Document Version	V1.0
Document Date	23th Feb 2024
Prepared by	Sambit Kumar
Reviewed & approved by	Pradeep Chandrashekar

Distribution Information:

From: Wimera Systems Pvt. Ltd.			
Designation	Name	Acceptance/Sign off	Sign-off date
Director –Cloud Applications	Pradeep Chandrashekar		12th Mar 2024
To: Wimera Systems Pvt. Ltd.			
Designation	Name	Acceptance/Sign off	Sign-off date
Founder & CEO	Nagarajan		14th Mar 2024

Version Information:

Version	Version Date	Revised by	File Name/Description
V1.0	23th Feb 2024	Pradeep Chandrashekar	Requirement Document for K2 Cloud Application

Content

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1. PURPOSE OF DOCUMENT

This document walks through the detailed Documentation of the Problem Statement, Technical Solutions proposed, Architecture as well as the requirements and its features. This document serves as a blueprint for the system's design, development, and implementation, providing a clear understanding of the project objectives, functional and non-functional requirements, and the expected outcomes.

2. INTRODUCTION

K2 – Cloud Application aims to develop a smart device that providing real-time insights of machine performance and energy consumption. By replacing manual processes, it will help manufacturers optimize productivity, reduce energy costs, and improve operational efficiency.

This document outlines the requirements, system design, and proposed solution for the device, guiding the development and ensuring alignment with the project's objectives.

2.1 Present situation

Factory are relying on manual data collection and monitoring, leading to delayed responses, inaccurate data, and inefficiencies in production and energy management. The lack of real-time insights into critical metrics like breakdown and resources consumption would hinder timely interventions, causing increased downtimes, higher maintenance costs, and missed opportunities for optimization. Moreover, without automated energy monitoring, factories would struggle to identify inefficiencies, resulting in higher energy costs and wasted resources. Overall, the K2 project would lead to lower operational costs, efficiency, and reducing the lack of data-driven decision-making.

2.1 Business Benefits

We understood the situation and our Integrated IoT solution can address most of the above issues and we envisage the following benefits after implementing our solution.

1. **Cost Savings:** By automating data collection and monitoring processes. By reducing manual labour and minimizing human errors, factories can cut down on the time and resources spent on tracking production and energy metrics. Real-time insights into equipment performance and energy consumption will allow for timely interventions, reducing machine downtime and maintenance costs. It contributing to long-term cost savings.

2. **Efficiency:** K2 - Cloud Application is greatly enhancing operational efficiency by providing real-time data on equipment performance predictive maintenance features will minimize unplanned downtimes, keeping machines running at optimal levels. Energy monitoring will further improve efficiency by highlighting areas where energy consumption can be reduced.

3. **Accuracy**: Data accuracy by automating the collection of machine performance and energy consumption metrics, eliminating human error. This ensures precise, real-time data and consistent reporting.

4. **Quality Control**: Improves quality control by providing real-time monitoring of production processes and detecting defects early. By tracking performance and quality metrics automatically, the system helps reduce errors, minimize waste, and ensure consistent product quality.

5. **Communication**: Enhanced communication within the factory by centralizing data on machine performance and energy usage. Real-time dashboards and automated alerts ensure that all relevant stakeholders are promptly informed about performance issues or inefficiencies. This facilitates quicker responses, better coordination among teams and improved collaboration.

6. **Sustainability**: By providing detailed insights into energy usage and identifying inefficiencies, the system helps minimize unnecessary energy use and lowers the factory's carbon footprint. Automated monitoring and data-driven decisions contribute to more sustainable production practices.

7. **Scalability**: Designed for allowing easy expansion as the factory grows. The system supports the addition of new machines and production lines, and can handle increased data volume without performance degradation.

3. REQUIREMENT REVIEW

REQ ID	Item	Description
REQ001	Device Onboarding	The system should allow administrators to onboard new hardware devices into the system.
REQ002	Real-Time Data Acquisition	The system should continuously collect data from various machines, such as energy consumption along with timestamp.
REQ003	Device Health Monitoring	Periodically monitor the connectivity and status of each device to ensure consistent data collection.
REQ004	Data Ingestion	The system must provide an endpoint to receive and process data from IoT devices in real-time, including handling a large volume of incoming data.
REQ005	Data Aggregation	Aggregate data at different levels (hour and day) for efficient storage and processing.
REQ006	Time-Series Data Management	Store and manage time-series data from devices, allowing historical trends and analytics.
REQ007	Energy Consumption Tracking	Continuously monitor and record the energy consumption of each machine in real-time.
REQ008	Energy Efficiency Reports	Generate reports on energy efficiency, identifying high-consumption periods and potential areas for improvement.
REQ009	Energy Cost Analysis	Calculate and display the cost associated with energy consumption over specified periods.
REQ010	Peak Usage Alerts	Alert users when energy consumption exceeds predefined thresholds.

REQ011	OEE Calculation	Automatically calculate OEE using three metrics: Availability, Performance, and Quality.
REQ012	OEE Reports	Generate daily, weekly, and monthly reports on OEE performance.
REQ013	Dashboard for Real-Time Monitoring	Provide a live dashboard where users can view the real-time status of machines, energy usage, OEE and other key metrics.
REQ014	Alert Notifications	Send notifications via email and WhatsApp for log of status.
REQ015	Graphical Reports	Visualize machine performance, energy consumption, and OEE metrics using charts, graphs, and heatmaps.
REQ016	Historical Data Views	Allow users to view historical performance and energy data, with the ability to filter by time ranges.
REQ017	Tenant Isolation	Each tenant should have isolated data and configurations, ensuring that data is securely segregated.
REQ018	Tenant-Level Reporting	Generate reports for individual tenants showing energy usage, OEE, and machine performance.
REQ019	Role-Based Access Control (RBAC)	Define roles such as Admin, Manager, and Operator, with different levels of access to data and features.
REQ020	Multi-Tenant Authentication	Implement authentication mechanisms that allow tenants to log in to their specific environments.
REQ021	Device Management	Admins should be able to add, remove, and configure devices (e.g., set thresholds, update firmware).
REQ022	View Reports & Dashboards	Clients should be able to view real-time data and historical reports related to machine performance and energy usage.
REQ023	Export Reports	Allow clients to export reports in multiple formats (PDF) for offline use.
REQ024	CRUD Operations	Provide APIs for CRUD operations on devices, data, users, and settings.
REQ025	Data Access API	Offer REST APIs for to query their machine data, energy usage, and OEE.
REQ026	Data Encryption	Encrypt data in transit using secure protocols.
REQ027	Access Control	Ensure that only authorized personnel can access machine data and system settings.
REQ028	Fetch raw data	Fetch raw data from the data stored.
REQ029	Energy Consumption Optimization	Use machine learning to optimize energy consumption by identifying patterns and anomalies in energy usage.
REQ030	Energy Cost Prediction	Predict energy costs based on usage trends, peak consumption periods, and operational schedules.
REQ031	OEE Performance Prediction	Predict overall equipment effectiveness (OEE) based on real-time and historical performance data.

4. PROPOSED SOLUTION

The proposed solution for Cloud Application - **K2** is the development and implementation of a **smart IOT device** that integrates **Smart monitoring** and **Energy management** into a single, comprehensive system. This device aims to automate the collection, analysis, and visualization of production and energy data, replacing manual data tracking and inefficient monitoring methods. The system will enable real-time insights into machine performance, production efficiency, and energy consumption, helping to optimize operations, reduce costs, and improve overall equipment effectiveness.

This comprehensive system will revolutionize factory operations by improving both **equipment effectiveness** and **energy efficiency**, providing a robust platform for continuous improvement and operational excellence.

4.1. IOT Data Processing Architecture

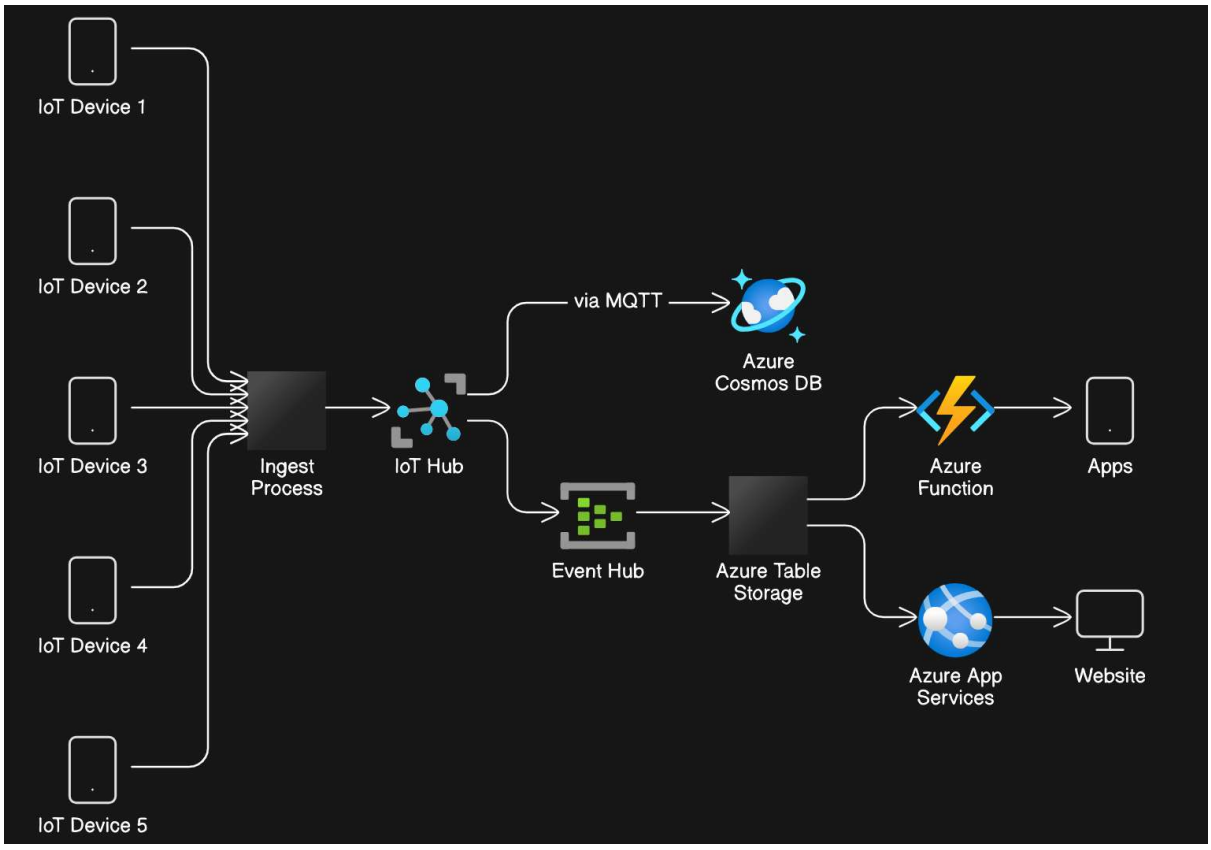

Fig. 1 – Flow diagram of K2 - Cloud Application

4.2. Application Feature

- **Device Onboarding**: The system should allow administrators to onboard new hardware devices into the system.
- **Device Health Monitoring:** Periodically monitor the connectivity and status of each device to ensure consistent data collection**.**

- **Data Visualizations**: Graphs, charts, and gauges for visualizing K2 project components (availability, performance, quality) and energy usage over time.
- **KPIs at a Glance**: Summarize critical KPIs for quick access, including downtime, production efficiency, and energy costs.
- **Shift-Based Monitoring**: View OEE data by production shift or time period, allowing for performance comparison.
- **Energy Cost Analysis**: Calculate and display the cost associated with energy consumption over specified periods.
- **Downtime Analysis**: Identify causes of downtime and provide detailed breakdowns (e.g., planned vs. unplanned downtime).
- **Production Line Monitoring**: Track individual machine performance or overall production line effectiveness.
- **OEE Calculation**: Automatic calculation of OEE using data on machine availability, performance, and quality.
- **Real-Time Notifications / Alerts**: Notify users via SMS, email, or app push notifications when key metrics fall outside acceptable ranges.
- **Automated Reports**: Generate automatic reports of downtime, energy consumption, and efficiency at daily, weekly, or monthly intervals.
- **Graphical Reports**: Visualize machine performance, energy consumption, and OEE metrics using charts, graphs, and heatmaps.
- **View Reports & Dashboards:** Clients should be able to view real-time data and historical reports related to machine performance and energy usage**.**

5. DELIVERABLES

The following mentioned items are deliverable at the end of the project.

SL#	Component Type	Description
1	Project Plan	• Outlines of project's goals, tasks, timelines, resources.
2	Product Backlog	• Prioritized list of features and fixes required for a product's development
3	Design Document	• Details architecture and specifications of a system for development
4	Requirement Traceability	• Tracks requirements through all development stages
5	Sprint Planning	• Planning defines the team's goals and tasks for the next sprint
6	Sprint Retrospect	• Reviews the past sprint to identify improvements
7	Change Request	• Formal proposal to modify a product or project scope

Note: Above mentioned Deliverables are only internal Use Only.

6. LIST OF KPIs

The Following KPIs will be derived from Wimmera PCB

a. Real-Time Data Acquisition
b. Device Health Monitoring
c. Data Ingestion
d. Time-Series Data Management
e. Energy Consumption Tracking
f. Configure Required elements (user, Machine, Shift, Reason list)

g. Energy Efficiency Reports
h. Energy Cost Analysis
i. OEE Calculation
j. OEE Reports
k. Dashboard for Real-Time Monitoring
l. Alert Notifications
m. Tenant Isolation
n. Historical Data Views
o. Multi-Tenant Authentication
p. View Reports & Dashboards

7. PROJECT TIMELINES

a) Requirement Gathering (3 weeks)

- **Understand Business and Technical Requirements:** Engage with stakeholders to gather business requirements, define metrics, devices, and data sources.
- **Feasibility Study & Technology Evaluation:** Identify the IoT devices, platforms, and cloud services.
- **Define KPIs & User Stories:** Document use cases, data to be collected - energy consumption and end-user goals.
- **Review and Finalization:** Ensure all requirements are documented and signed off.

b) Design (3 weeks)

- **High-Level Architecture Design:** Define the overall architecture, including devices, communication protocols, cloud infrastructure, databases, and dashboards.
- **Data Flow and Network Design:** Plan data ingestion, processing, and storage. Choose the protocols (MQTT), database types (time-series databases Azure Cosmos DB).
- **Security and Compliance Consideration:** Ensure compliance with relevant standards and design security (certificate-based authentication, data encryption, secure device communication).
- **API Design & Integration Planning:** Develop APIs
- **UI/UX Design:** Create wireframes/mock-ups for dashboards or user-facing applications.
- **Design Review and Sign-Off:** Get stakeholder approval before moving to implementation.

c) Implementation (16 weeks)

- **IoT Device Setup:** Configure devices.
- **Cloud Infrastructure Setup:** Set up cloud services Azure IoT Hub, Cosmos DB for time-series data, and stream processing using Event Hubs.
- **Data Ingestion & Processing:** Implement data collection, real-time processing, and storage mechanisms.
- **Backend Development:** Develop APIs and logic to manage data and deliver insights - energy usage analysis
- **Frontend Development:** Build dashboards or mobile apps to visualize data, alerts, and energy consumption trends.
- **Security Implementation:** Apply security best practices, including encryption, authentication, and data protection.

d) Testing (4 weeks)

- **Unit Testing:** Ensure each individual component (Dashboard, APIs, etc.) works as expected.
- **Integration Testing:** Test the interactions between devices, data flow, cloud services, and the application.
- **End-to-End Testing:** Simulate real-world scenarios to ensure the system operates as expected from device to cloud to dashboard.
- **Performance and Scalability Testing:** Test the system under high data loads to ensure it can scale.
- **Security Testing:** Perform security testing and check for vulnerabilities.
- **User Acceptance Testing (UAT):** Allow stakeholders to test the system and provide feedback before launch.