Intelligent Factory Floor Optimization

Overview

Data is generated and resides everywhere in manufacturing—in Enterprise Resource Planning (ERP) systems, Product Lifecycle Management (PLM) systems, Manufacturing Execution Systems (MES) and Supplier Relationship Management (SRM) system and even in modern machine tools. The intelligent factory floor optimizes production and drives down costs by using the data generated by sensors and machines on the production line to drive real-time analytics, balance lines and make operational improvements.

Manufacturers can leverage edge intelligent IIoT technology like FreeWave's **IQ** Application Environment to use this data in four powerful ways.

1. Production Line Balancing
2. Labor Time Savings
3. Predictive Analytics Based Optimization
4. Operational Improvements and Kaizen

By creating a custom industrial app in FreeWave's Linux-based **IQ** Application Environment and deploying it on ZumIQ™ Edge Computers, FreeWave factory floor management utilizes production line data to obtain a holistic, historical, real-time and predictive view of operations. This allows managers to identify opportunities to develop competitive advantages in production costs and lead times.

Needs and Pain Points

FreeWave's current line of Samsung machine tools utilize red, yellow and green stack lights for status monitoring. Loaded with sensors, these machines monitor variables like voltage, pressure, temperature and part positioning. Operators wanted to manage the production line not by perceptions from visual observations of these stack lights, but by actionable real-time data and trends over time. Moreover, FreeWave factory operations managers needed to improve machine load efficiency and line balancing without incurring the substantial implementation and annual recurring costs of MES software and services.

Machine Line Balancing

FreeWave is a high-mix, low volume manufacturer, with dozens of different solution and product lines that require constant changeover and setup of its three machine tools. This constant changing of machine components leads to unbalanced machine loads that reduce production line efficiency. Operators needed to use the data generated by the machines to determine optimum load levels. Balancing the overall line load would boost output and reduce machine idle time.

Predictive Analytics and Labor Time Savings

Replacing exhausted machine parts on an ad hoc basis increases production downtime and leads to increased labor costs. Furthermore, insufficient machine feeder reels not only lead to unbalanced lines, but also require labor to replace them and keep the machine feeder at optimum levels. Operators wanted to use machine data for analysis and trending that would serve as a foundation for predictive maintenance and supply, thus, reducing labor costs.

Use Real-Time Data for Kaizen (Continuous Improvement)

In short, FreeWave factory floor managers needed a manufacturing application that would improve quality and productivity. By relying on machine generated, real-time data rather than a ten second glance at stack lights, operations could focus on applying small, daily changes that result in major improvements over time—the foundation of Kaizen.

SOLUTION

App Functionality

Utilizing the **IQ** Application Environment, FreeWave software engineers used Node-RED to develop an app that is tied to the analog signal of the stack light LEDs to determine machine state. Node-RED is a flow-based development tool originally created by IBM for wiring together hardware devices, APIs and online services as part of the Internet of Things.

The app interprets the machine state from the light status. Built in algorithms can read uptime or downtime based on stack light status. The app determines the status of the machines on the entire line and pushes this data to the FreeWave network. In turn, the app takes the input signal of three lights on the machine and writes the state to an SQL database.

Data can be accessed and viewed in several ways. Real-time state changes can be viewed on a display screen. This enables operators to look at the state of the line and address issues right on the floor. Additionally, records of state can be saved to a CSV file for trending and analysis or a basic text file that can be accessed from desktop or mobile device.

Network Equipment

At each of the three machines on the manufacturing floor, a FreeWave IOE-4404 I/O module is connected to a ZumIQ Edge Computer via a serial connection. The IOE-4404 determines the state of the individual red, green, and yellow lights on the light stack and conveys this to the ZumIQ, which determines the operational state of the machine based on the light combination via an embedded app.

One of the three ZumIQ Edge Computers also acts as a "gateway". The gateway collects the real-time status of each of the three machines and analyzes it to determine the collective state of the production line and efficiency of each part in the system.

This information is then added to FreeWave's existing production SQL database and displayed on a large screen for viewing from the production floor. (Figure 1)
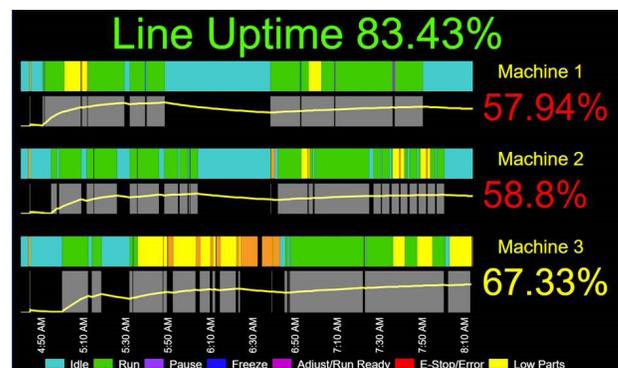

Figure 1: Production Floor Status Screen

With 1 GB of flash and 512 MB of RAM, the ruggedized, low-power ZumIQ Edge Computer records timestamps from the machine and stores a predetermined amount of data.
Figure 2 shows the network architecture.

Although the ZumIQ Edge Computer can be configured to send data to Cloud services like Amazon Web Services (AWS), FreeWave operations managers expressed the need to implement a local solution with no Cloud connectivity whatsoever.

Implementation

The application was written in a matter of days and only took an additional 2 days to install and set up the network. Testing the application took another 2 weeks with light state table setup taking up the majority of that time.
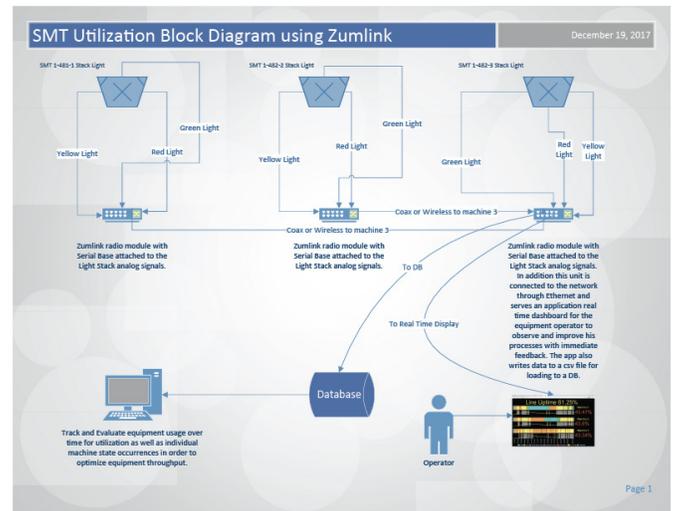

Figure 2: Network Architecture

EXPECTED RESULTS AND ROI

> **Estimated $50,000.00 savings in software costs.** The custom Node-RED app, running on FreeWave's **IQ** Application Environment, bypasses the use of the MES. The app represents an effective, low-CAPEX/OPEX middle ground.

> **FreeWave expects a 25% improvement** in throughput because meaningful insights into the production line are being generated by the app.

> **Improved load optimization.** The app provides information on feeder status. That data identifies components that can increase size of reels to minimize changeover times.

> **Labor reduction time.** The app data drives predictive analytics and provides data on how many times a part expires and when to expect a part to expire.

> **Eliminates the need for custom MES.** The app eliminates visual inspections but provides the same data as a custom MES.

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