RISC-V Based 5G IIoT Hub

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INTRODUCTION

This capstone project, sponsored by Lattice Semiconductor Corporation, is focused on developing a 5G Industrial Internet of Things (IIoT) Hub using the Certus-NX Versa FPGA Board with BG96 5G modem.

Solution and Objective: Previous systems employed wired communications, resulting in unavailability of remote control and monitoring of production lines. To improve that, our solution:

Enables 5G → **Improves Transmission** → **Expands Capacity**

Which enhances operational production efficiency and responsiveness.

METHODS

- **5G Modem and FPGA:** Integrates Lattice FPGA boards with a 5G modem to enable data and command processing with AWS.
- **Motor Control:** Controls the RPM of Brushless DC motors, adjusting speed based on incoming commands.
- **MQTT Communication Protocol:** Utilizes MQTT for seamless data exchange between the IIoT device and AWS.

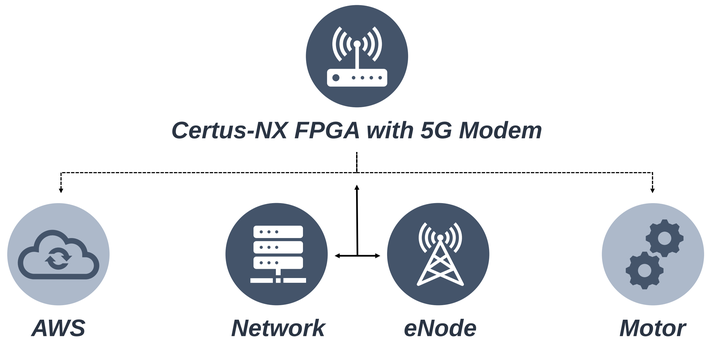

Figure 1: System Architecture of the 5G IIoT Hub

- **Operating System:** Runs on a custom RISC-V SoC with Lattice Propel and Radiant, optimizing task scheduling and operations.
- **Data Transmission:** Manages MQTT communications from AWS for motor control, ensuring secure data exchanges.
- **System Verification:** Rigorously tests MQTT command execution for precise motor control and system responsiveness.

IMPLEMENTATION

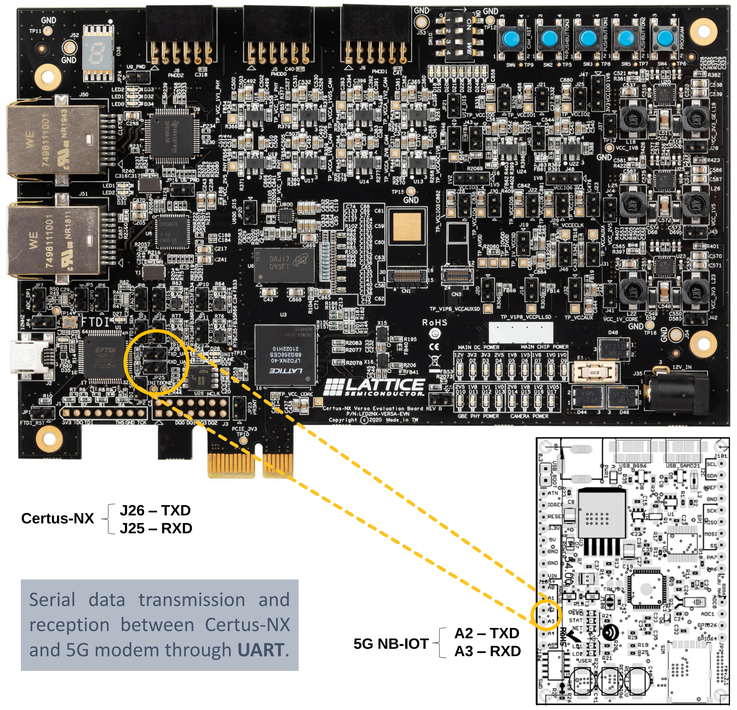

Figure 2: Universal Asynchronous Receiver / Transmitter implementation

RESULTS

The system reliably executed parsed commands received via MQTT from AWS, to control BLDC motor. Effectiveness and performance data were analyst to proof solution capacity for industrial production.

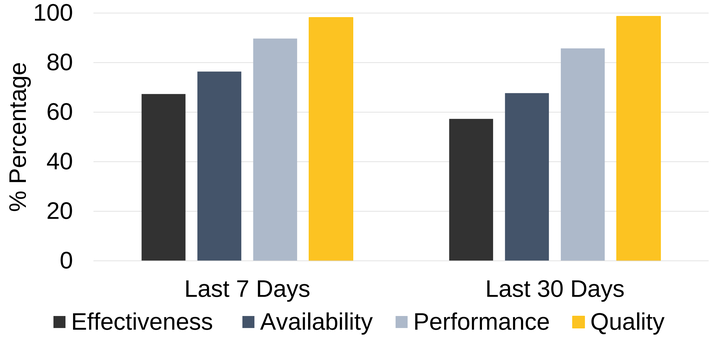

Figure 3: Effectiveness and Performance analysis

DISCUSSIONS

Integrating 5G with Lattice FPGA enhanced motor control, boosting **the OEE of BLDC motor to 67.33% over the last week and 57.3% over past month.** Despite challenges such as equipment delay, lack of documentation, and software incompatibility, implementation of 5G dramatically improved response times.

Future efforts will focus on optimizing these technologies to further elevate effectiveness and expand their application across other production lines.

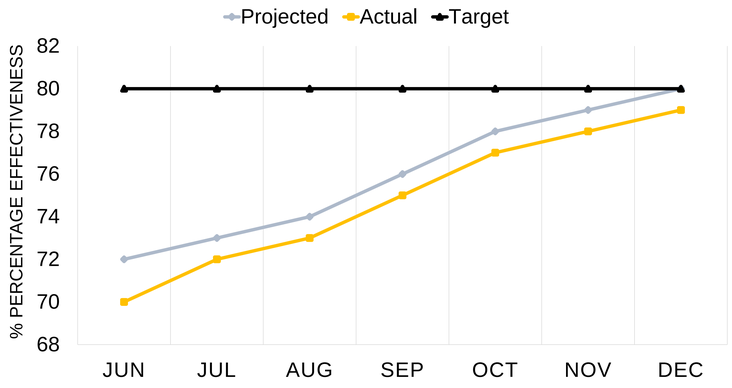

Figure 4: 2024 Effectiveness Trajectory with 80% benchmark

CONCLUSION

Moving forward, this solution could benefit from further optimization of the MQTT communication setup to reduce latency and enhance data throughput. Additionally, expanding the user interface to include more control options and real-time data feedback could significantly improve user experience and system functionality.

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