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**Smart Thermostat Cloud Integration Architecture**

The smart thermostat prototype developed earlier in the course demonstrated core functionality, including temperature sensing, LED indicators, user input via buttons, and LCD output. The next phase of development is to connect the device to the cloud for remote monitoring and integration with SysTec’s backend systems.

This report compares two Adafruit candidate hardware platforms for production deployment:

* **Raspberry Pi Zero W**
* **Microchip ATSAMD51 microcontroller paired with the WINC1500 Wi-Fi module**

The selected platform must support all existing peripherals, provide Wi-Fi connectivity, and include sufficient memory resources to support the codebase. The system should also be power efficient and suitable for deployment in a residential environment.

**Project Requirements**

**Functional Requirements**

* Support for the following interfaces:
  + **I2C** for AHT20 temperature sensor
  + **GPIO/PWM** for LED and button control
  + **UART** for serial communication
* Capability to send status data over **Wi-Fi** to a remote server
* Adequate **Flash and RAM** for program storage and runtime operation

**Practical Requirements**

* Reliable for continuous operation in a home setting
* Low power consumption for energy efficiency
* Viable for scaling into multiple production units

**Architecture Comparison**

| **Feature** | **Raspberry Pi Zero W** | **Microchip ATSAMD51 + WINC1500** |
| --- | --- | --- |
| **Peripheral Support** | Full (Linux GPIO, I2C, PWM, UART) | Full (native I/O support) |
| **Wi-Fi Connectivity** | Integrated Broadcom module | SPI-based WINC1500 with TLS/MQTT support |
| **Flash Memory** | External microSD | 1–2MB internal Flash |
| **RAM** | 512MB SDRAM | 256–512KB SRAM |
| **Power Consumption** | Moderate (Linux overhead) | Low (MCU and Wi-Fi optimized for IoT) |
| **Security Support** | Basic (Linux services) | Secure boot and crypto features |
| **Development Tools** | Python, Linux tools, GPIO libraries | C/C++ using Microchip IDE or Arduino core |
| **Unit Cost (estimate)** | ~$10–12 | ~$5–6 in volume |

**Analysis**

**Raspberry Pi Zero W**

The Raspberry Pi Zero W is a powerful platform for prototyping. It offers high RAM, built-in Wi-Fi, and accessible tools for development. However, it has a few significant limitations for embedded deployment:

* Relies on **external microSD cards**, which are prone to corruption over time with repeated read/write operations (Raspberry Pi Foundation, 2023).
* Power consumption is higher than necessary for a device expected to run 24/7 in a home.
* While development is fast and flexible, it includes many unused resources for a thermostat application, adding unnecessary overhead.

**Microchip ATSAMD51 + WINC1500**

The ATSAMD51 microcontroller and WINC1500 Wi-Fi module offer a compact and embedded-focused alternative:

* All required interfaces are available directly from the MCU.
* Flash and RAM are more limited than the Raspberry Pi, but sufficient for the thermostat firmware and network stack.
* The **WINC1500 module** supports TLS encryption and MQTT communication, which are well-suited for secure IoT data exchange (Microchip Technology Inc., 2021).
* This platform is specifically built for low-power, Wi-Fi-enabled embedded systems and is widely used in consumer IoT products.

**Conclusion**

Between the two platforms, the **Microchip ATSAMD51 with WINC1500 Wi-Fi module** is the more appropriate choice for moving the smart thermostat into a connected, production-ready version. It meets all interface and performance requirements while offering a more efficient and reliable foundation for continuous operation.

The Raspberry Pi remains useful for early prototyping, but its reliance on a full Linux OS, higher power consumption, and use of external storage make it less suited for long-term embedded deployment.

**References**

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