CS 350 Project 1 Report Thompson

In today’s rapidly evolving market, smart home devices, particularly smart thermostats, are becoming increasingly popular due to their convenience and energy-saving capabilities. SysTec, a leader in analytics software for servers, is exploring the potential to enter this lucrative market by developing a smart thermostat that integrates seamlessly with their existing cloud-based solutions. The goal of this project is to prototype a smart thermostat using the Texas Instruments (TI) CC3220x LaunchPad. This prototype will read room temperature, control a heating system based on user input, and simulate data transmission to SysTec’s servers via UART.

This report details the development of the prototype, including the implementation of key functionalities such as temperature sensing via I2C, user interaction through GPIO-controlled buttons, and communication via UART. It also explores the task scheduling mechanism that ensures the efficient operation of the thermostat. Additionally, the report evaluates three hardware architectures—TI, Microchip, and Freescale—to recommend the most suitable platform for the next phase of the project, which involves connecting the thermostat to the cloud via Wi-Fi.

Through this project, SysTec aims to establish a solid foundation for entering the smart thermostat market, with a focus on reliability, scalability, and ease of integration with cloud services.

Section 1: Peripherals Support

Thermostat’s Peripheral Support:

The smart thermostat project utilizes several key peripherals: I2C for temperature sensing, GPIO for button inputs and LED control, and UART for data transmission. Here’s how each architecture—TI, Microchip, and Freescale—supports these peripherals.

1. Texas Instruments (TI) Architecture:

- I2C Support: TI’s CC3220x LaunchPad is equipped with robust I2C support, allowing for seamless communication with the TMP006 temperature sensor. The CC3220x microcontroller has integrated I2C peripherals with flexible configurations, making it ideal for temperature sensing applications (Texas Instruments, n.d.).

- GPIO Support: The TI architecture provides multiple GPIO pins, which are fully configurable. This flexibility is essential for the dual-button input used to adjust the set-point temperature, as well as for controlling the LED output.

- UART Support: The CC3220x includes UART peripherals with high configurability, supporting various baud rates and communication parameters. This allows for efficient data transmission to simulate server communication.

2. Microchip Architecture:

- I2C Support: Microchip’s microcontrollers, such as those from the PIC and SAM series, also offer integrated I2C modules. These modules are reliable and support communication with various sensors, including the TMP006 (Microchip Technology Inc., n.d.).

- GPIO Support: Microchip microcontrollers are known for their extensive GPIO support, providing multiple pins that can be configured for input, output, and interrupt functionality. This ensures that buttons and LEDs can be easily controlled.

- UART Support: Microchip’s architecture includes robust UART support, enabling reliable serial communication. This is crucial for sending data to the server in this project.

3. Freescale (NXP) Architecture:

- I2C Support: Freescale microcontrollers, such as those from the Kinetis series, feature integrated I2C modules that support a wide range of sensors. These microcontrollers are well-suited for applications involving temperature sensing (NXP Semiconductors, n.d.).

- GPIO Support: Freescale’s architecture provides a comprehensive GPIO interface, allowing for easy configuration of pins for various purposes, including button inputs and LED outputs.

- UART Support: The UART peripherals in Freescale microcontrollers are designed for efficient serial communication, supporting various baud rates and configurations, which is ideal for the thermostat’s data transmission needs.

Conclusion:

All three architectures—TI, Microchip, and Freescale—support the necessary peripherals for the smart thermostat project. However, the TI architecture, specifically the CC3220x, offers superior integration and ease of use, particularly for developers familiar with TI’s ecosystem.

Section 2: Wi-Fi Connectivity

Thermostat’s Wi-Fi Connectivity:

Connecting the thermostat to the cloud via Wi-Fi is a critical aspect of the project’s next phase. Here’s an analysis of how each architecture facilitates this connectivity.

1. Texas Instruments (TI) Architecture:

- Wi-Fi Support: The CC3220x LaunchPad from TI has built-in Wi-Fi capabilities, specifically designed for IoT applications. It supports 802.11 b/g/n standards and includes features like secure socket communication, making it a strong candidate for cloud-based projects.

- Ease of Integration: TI provides extensive libraries and documentation for Wi-Fi setup and cloud integration, reducing development time and complexity (Texas Instruments, n.d.).

- Security: The CC3220x includes security features such as hardware encryption, secure boot, and the ability to manage secure connections, which are vital for cloud communications.

2. Microchip Architecture:

- Wi-Fi Support: Microchip offers microcontrollers with integrated Wi-Fi, such as those from the WINC series. These controllers are designed for IoT applications and can easily connect to cloud services.

- Ease of Integration: Microchip provides libraries and development tools to simplify Wi-Fi integration. However, it may require additional effort compared to TI’s highly integrated solutions.

- Security: Microchip’s Wi-Fi solutions include basic security features, but they may not be as comprehensive as those offered by TI, particularly in terms of out-of-the-box secure communication (Microchip Technology Inc., n.d.).

3. Freescale (NXP) Architecture:

- Wi-Fi Support: Freescale’s microcontrollers typically do not include integrated Wi-Fi. However, external Wi-Fi modules can be interfaced via UART or SPI, which adds complexity to the design.

- Ease of Integration: The need for an external Wi-Fi module increases the development time and complexity. Additionally, integrating these modules with cloud services may require custom drivers and additional software development (NXP Semiconductors, n.d.).

- Security: Security for Wi-Fi connections would largely depend on the external module used, which may not be as tightly integrated or easy to implement as TI’s solution.

Conclusion:

The TI architecture, with its built-in Wi-Fi and strong security features, is the most suitable for cloud connectivity in this project. Microchip’s solutions are also viable but may require more effort in integration, while Freescale’s architecture adds complexity due to the need for external Wi-Fi modules.

Section 3: Flash and RAM Considerations

Architecture’s Flash and RAM Support:

The smart thermostat project requires sufficient Flash and RAM to support the code and data processing needs. Here’s a comparison of the three architectures based on their memory capacities.

1. Texas Instruments (TI) Architecture:

- Flash Memory: The CC3220x microcontroller comes with up to 1 MB of Flash memory, which is more than adequate for the current project requirements, including future expansions for cloud connectivity and additional features.

- RAM: The CC3220x offers 256 KB of SRAM, which provides ample space for dynamic memory allocation, buffering, and handling the communication stacks for I2C, UART, and Wi-Fi (Texas Instruments, n.d.).

2. Microchip Architecture:

- Flash Memory: Microchip’s microcontrollers, such as those from the PIC32 or SAM series, offer Flash memory ranging from 256 KB to 2 MB, depending on the specific model. This range is sufficient for the project, with higher-end models providing more than enough space for code and data (Microchip Technology Inc., n.d.).

- RAM: Microchip microcontrollers typically offer RAM ranging from 64 KB to 512 KB. While lower-end models may be limited for complex applications, higher-end models provide enough RAM for the project’s needs, including cloud connectivity.

3. Freescale (NXP) Architecture:

- Flash Memory: Freescale microcontrollers, such as those from the Kinetis series, offer Flash memory ranging from 128 KB to 1 MB. While the upper range is sufficient, the lower-end models may struggle to accommodate future expansions (NXP Semiconductors, n.d.).

- RAM: Freescale’s microcontrollers typically provide RAM ranging from 32 KB to 256 KB. For this project, the lower end may be insufficient, especially when handling multiple peripherals and cloud communication simultaneously.

Conclusion:

The TI architecture, with its ample Flash and RAM, provides the best balance for current and future requirements. Microchip’s higher-end models are also suitable, while Freescale’s options might be limiting, particularly for more complex applications.

Final Summary for the Report

When considering peripherals support, Wi-Fi connectivity, and memory capacity, the TI architecture (specifically the CC3220x LaunchPad) stands out as the most suitable for the smart thermostat project. It offers integrated peripherals, built-in Wi-Fi with robust security features, and sufficient Flash and RAM to support both current functionality and future expansions. Microchip’s architecture is a viable alternative, though it may require more integration effort. Freescale’s architecture, while capable, may introduce additional complexity and limitations, particularly in Wi-Fi integration and memory capacity.

References

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