User Needs and Requirements Lightning Talk

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Client/Advisor: Dr. Duwe

Project Overview

- Design a microcontroller with radio communication capabilities
- Open-source
- Can be fabricated
- Will be used by ISU ChipForge group, possibly faculty and hobbyists
- Designed using the Caravel platform from Efabless
- Inspired by the TI CC1352P (block diagram shown to the right)

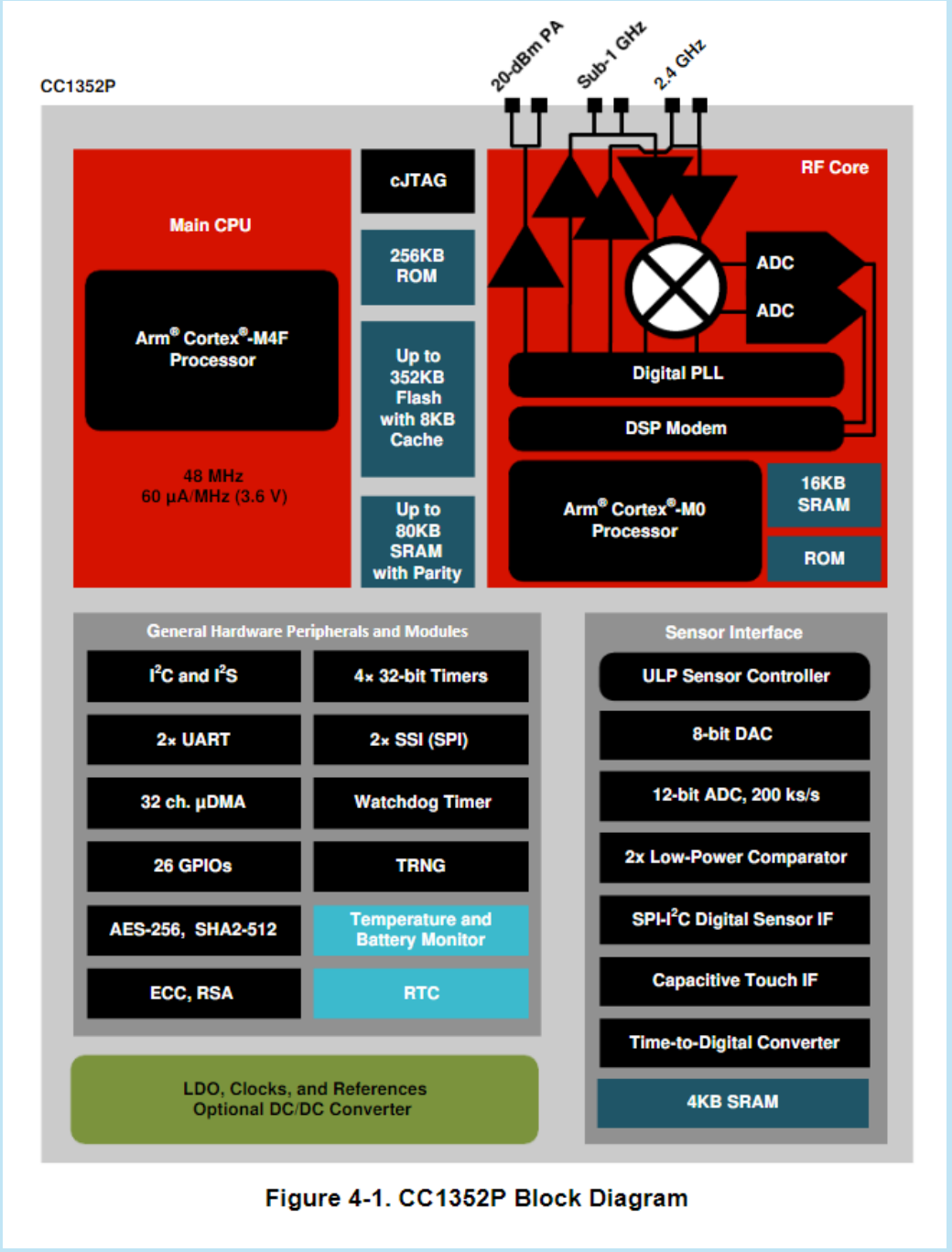

Figure 4-1. CC1352P Block Diagram

Image Source: https://www.ti.com/lit/ds/symlink/cc1352p.pdf?ts=1727935470469&ref_url=https%253A%252F%252Fwww.mouser.es%252F

Users

- Three primary groups
  - ISU ChipForge
    - Co-curricular focused on IC design
    - Open to all experience levels from novice to expert
  - Faculty
    - Professors teaching classes using microcontrollers (MCUs)
  - Radio Hobbyists
    - People with a general interest in radios, MCUs, Internet of Things (IoT), etc.

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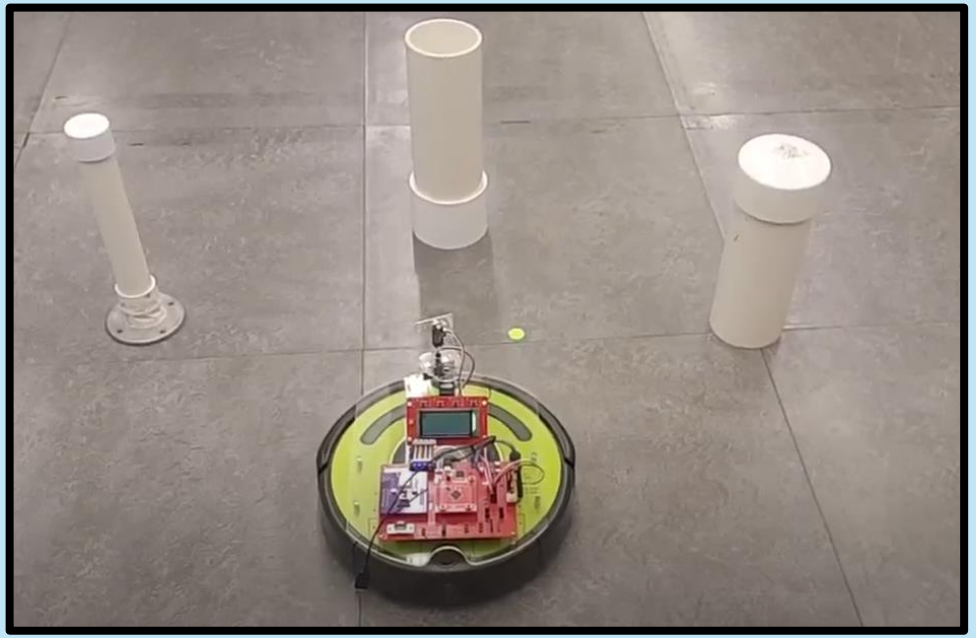
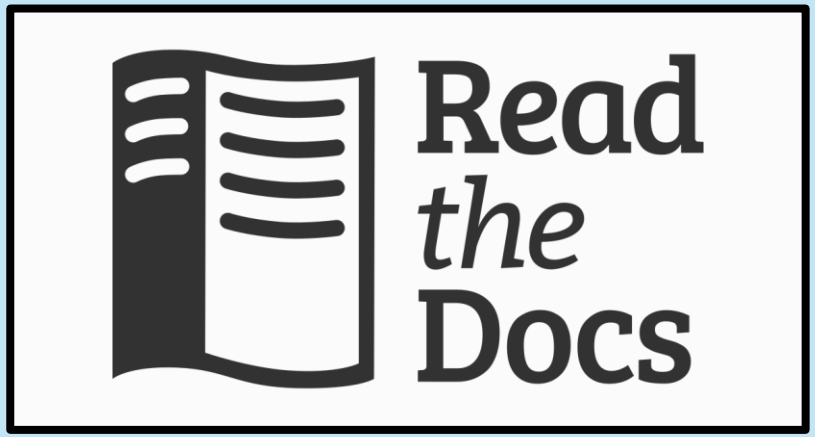


ISU Wordmark Source: https://www.brandmarketing.iastate.edu/wordmark/primary/

CyBot Image: Taken by Nolan Eastburn

User Needs - ChipForge

- Good documentation
  - Focus on board bringup and testing
  - Must be understandable by people with little experience
  - Must have sufficient detail for people with experience
- Learning experience
  - MCU should provide insights into capabilities of Efabless process
  - Allow students and faculty advisors to better gauge what can be done in future projects
- Able to be fabricated
  - Must use the Efabless 130 nm process available to ChipForge



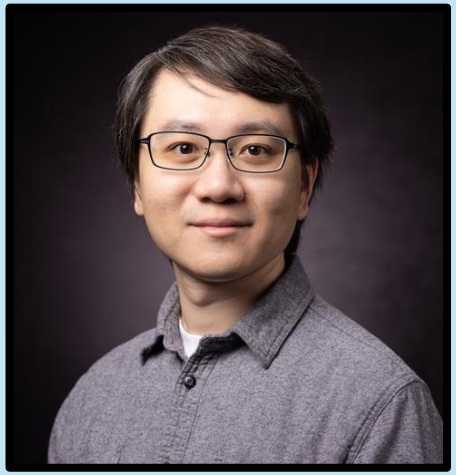
Read the Docs Logo Source: https://about.readthedocs.com/images/logo-opengraph.png

Google + Skywater Source: https://raw.githubusercontent.com/google/skywater-pdk/main/docs/_static/skywater-pdk-logo.png

User Needs - Faculty

- Good documentation and tooling
  - Design could be used inside of lab assignments
  - Needs to be understandable and usable by undergraduates
  - Reduce time needed to port existing labs to new MCU
- Reliability
  - Reduce wasted time and frustration developing and executing labs
- Security learning opportunity
  - Teach students about cybersecurity starting at a hardware level
  - Not possible with existing MCUs, since they are closed source

Dr. Duwe



Dr. Huang

Faculty Profile Images: https://www.ece.iastate.edu/ece-directory

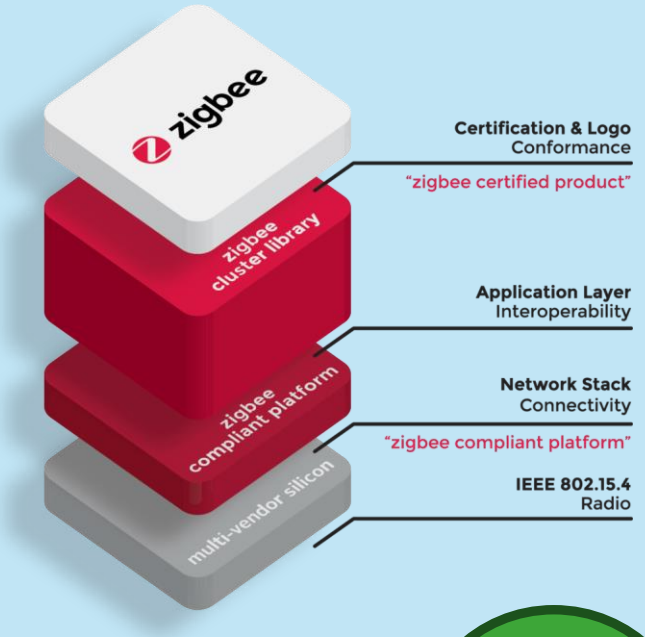
User Needs – Radio Hobbyists

- Good documentation and tooling
  - Commercially successful MCUs are easy to get up and running
  - Huge factor is documentation and support
- Features
  - Most hobbyists want interesting features
  - Need to connect to existing devices
- Flexibility
  - Many hobbyists like to tinker
  - Can extend our design if they have money to fabricate

Radio MCU Article Image Source: https://quartzcomponents.com/cdn/shop/articles/TEA5767_FM_Radio_Module_interfacing_with_Arduino_750x.jpg?v=1698227738

Requirements

- The MCU shall be developed using the Efabless Caravel platform
- The MCU shall implement the Zigbee communication stack
- The MCU shall be programmable
- The MCU shall contain standard peripherals
  - UART, I2C, SPI, Timers
- The artifacts used for fabrication of the MCU shall be open-source
- The documentation for the MCU shall be open-source



Efabless Logo Source: https://efabless.com/lib_CUsguFEVafmoKCKW/ns6hm1s6vu8ctynd.png?w=334

Zigbee Stack Image Source: https://csa-iot.org/wp-content/uploads/2021/12/zigbee-stack-1015x1024.png

Open Source Logo: https://upload.wikimedia.org/wikipedia/commons/e/eb/Open_Source_Initiative.svg

Applicable Engineering Standards

- IEEE 802.15.1
  - Standard for Bluetooth
  - Defines PHY and MAC layers
- IEEE 802.15.4
  - Standard for ZigBee
  - Defines PHY and MAC layers
- IEEE 1481-2019
  - Provides a standard way to analyze IC designs for timing, signal integrity, behavior, and power consumption

IEEE Logo: https://upload.wikimedia.org/wikipedia/commons/thumb/2/21/IEEE_logo.svg/1200px-IEEE_logo.svg.png

Conclusion

- It is important to think about the different types of users when creating requirements
- Requirements need to be clear and be written with respect to the various users
- Many engineering standards exist, use the ones that are relevant to your project!