THE BARTENDER BUTLER BOT

University of Central Florida
Senior Design II Critical Design Review

Group 13

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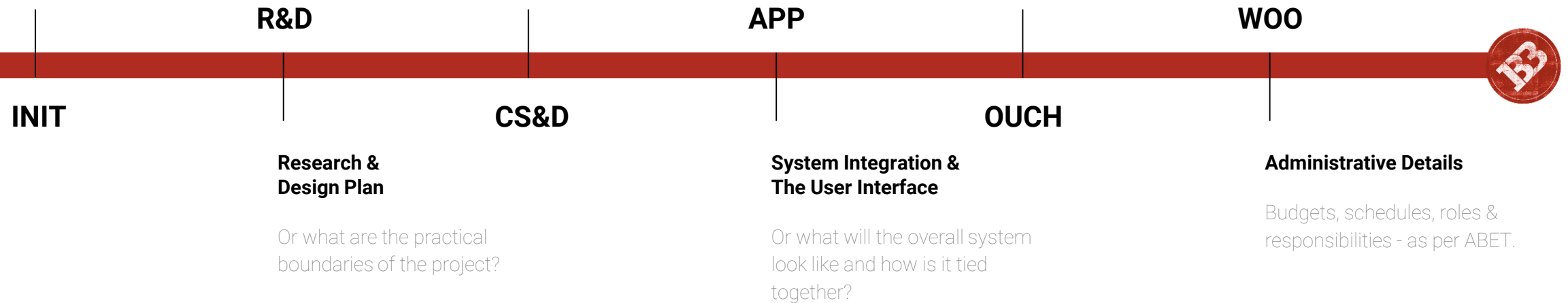
Overview

Motivations & Technical Objectives

Or what are we doing & what's the point?
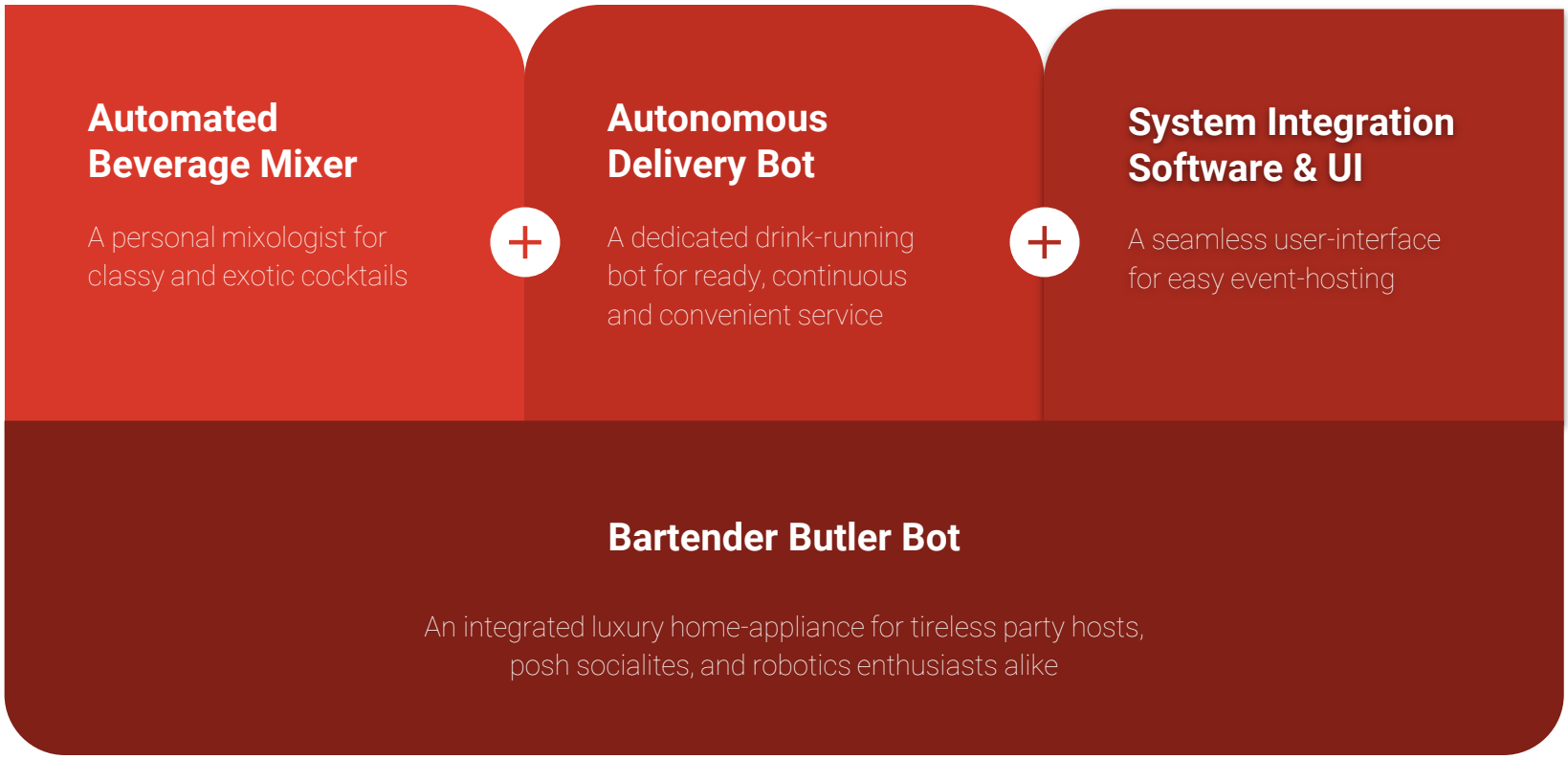
Component Selection & System Design

Or what is the fastest route to a functional prototype?

Challenges to Overcome

Or how have our efforts panned out thus far and what is left for us to do?

R&D

APP

WOO

INIT

CS&D

OUCH

Research & Design Plan

Or what are the practical boundaries of the project?

System Integration & The User Interface

Or what will the overall system look like and how is it tied together?

Administrative Details

Budgets, schedules, roles & responsibilities - as per ABET.

What is the B3?

Automated Beverage Mixer

A personal mixologist for classy and exotic cocktails

+

Autonomous Delivery Bot

A dedicated drink-running bot for ready, continuous and convenient service

+

System Integration Software & UI

A seamless user-interface for easy event-hosting

Bartender Butler Bot

An integrated luxury home-appliance for tireless party hosts, posh socialites, and robotics enthusiasts alike

R&D   APP   WOO

INIT   CSD   OUCH

Motivations

45%

The Core Problem is Relatable

The best and worst aspects of being a good and dutiful partymaking host resonate with us:

- Taking care of guests is work
- Missing out on conversations, games, or moments for dutiful partymaking errands
- "I'll fetch us another round!"
- "Oh, what did I miss?"

40%

The Technical Challenges are Alluring

The core problem demands a comprehensive multi-faceted technical approach which yields a bounty of open-ended design questions:

- Automation of beverage services
- Autonomous package delivery
- System integration for simple & seamless user experience
- Packaging for functionality vs. manufacturability vs. aesthetics

15%

The Commercial Space is Enticing

The prototype & development journey to and beyond commercial validation of a minimally viable product is itself intrinsically exciting:

- Bespoke designs vs. modular approach to scaling
- New & empirically derived market-ready design objectives
- New & improved technical challenges

R&D   APP   WOO

INIT   CSD   OUCH

Key Objectives
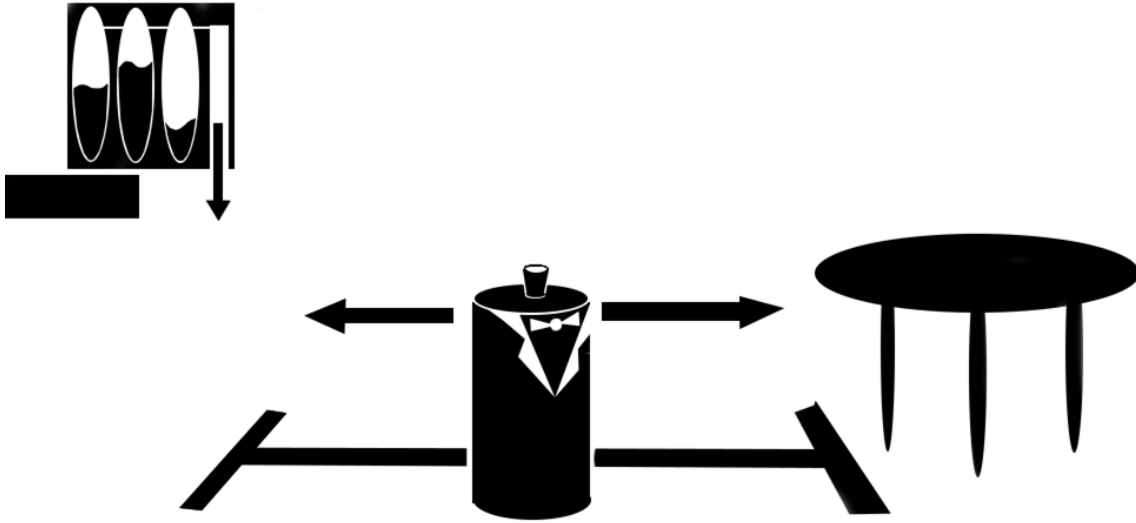
Overall
- **Automate** the multistep process of **mixing and delivering a beverage** across a predefined path

Corollaries
- **Maximize** the number of **off-the-shelf** or open-source subsystems
- **Minimize** the number of **mechanical** subsystems
- **Minimize** the overall **cost** of the system

INIT   R&D   CSD   APP   OUCH   WOO

Research

Bartendro
- Raspberry Pi
- Peristaltic Pumps

SirMixaBot
- Peristaltic Pumps

RaspRobot
- OpenCV
- Object Tracking Technique

Arduino Elliot
- IR Sensor Array
- PID Line Following

INIT — R&D — CSD — APP — OUCH — WOO
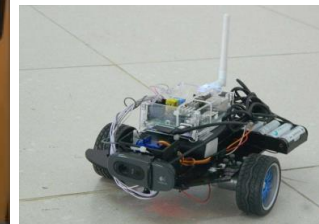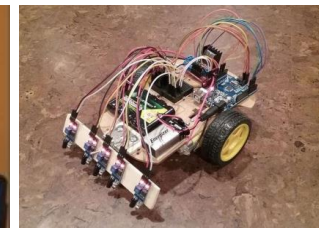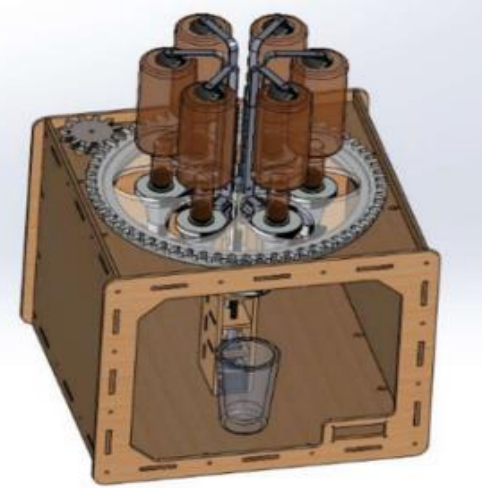
Requirement Specs

		Unit	Requirement	Achieved?
1	Max. Avg. Bartender Configuration Time	Minutes	< 10	
2	Ordering Time	Minutes	< 1	
3	Beverage Mixing Time	Minutes	< 2	
4	Delivery Time	Minutes	< 5	
5	Min. Capacity for Beverage Ingredients	Ingredients	> 3	✔
6	Drink Accuracy	% Target Vol.	< 5%	
7	Delivery Range	Meters	> 10	
8	Charge Lifespan	Minutes	> 90	
9	Obstacle Collisions	Num/journey	< 3	
10	Bartop Appliance Dimensions Target	cm³	< 50,000	
11	Total Appliance Cost	USD	< $1500	✔

R&D   APP   WOO

INIT   CSD   OUCH

System Breakdown
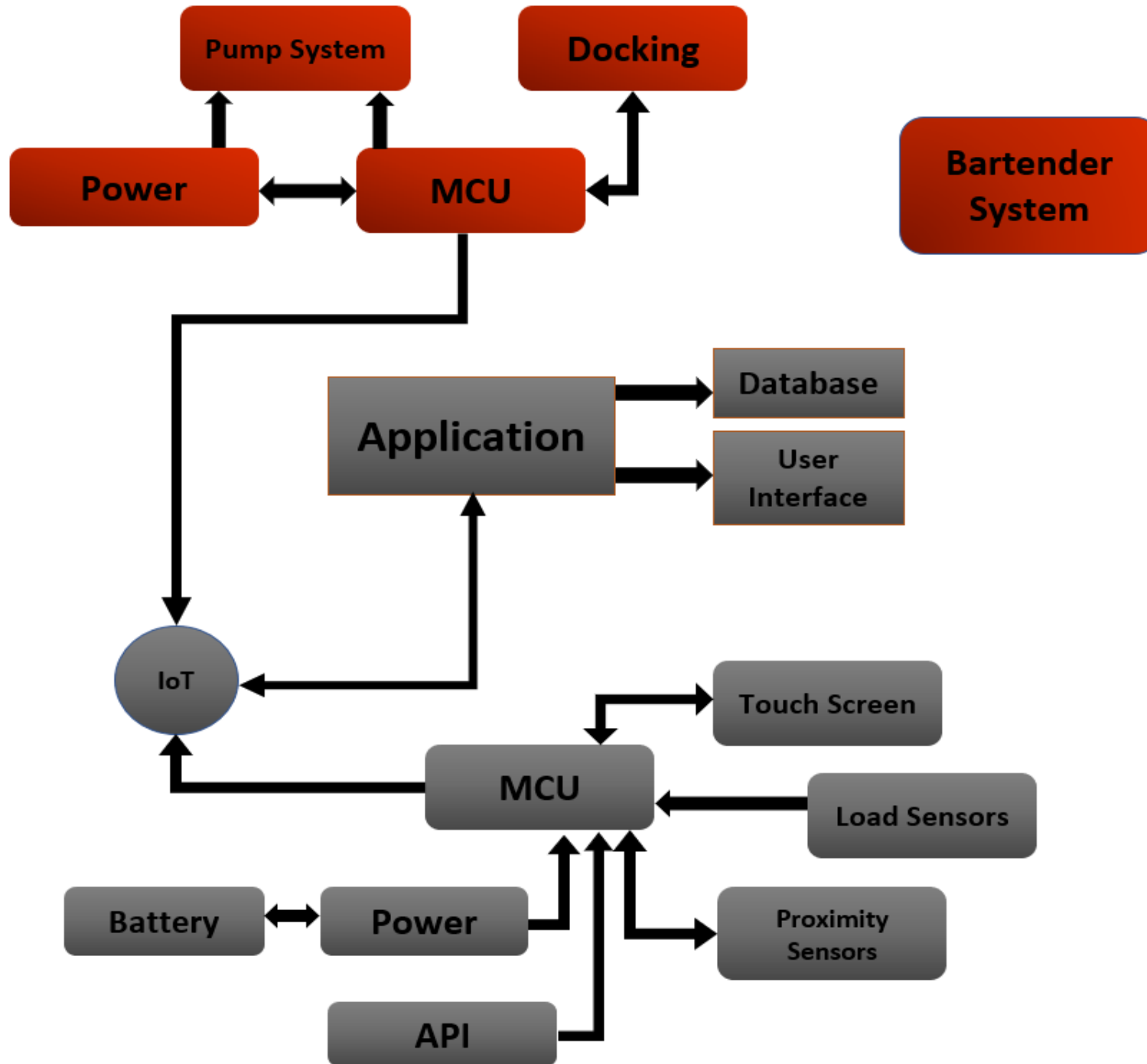
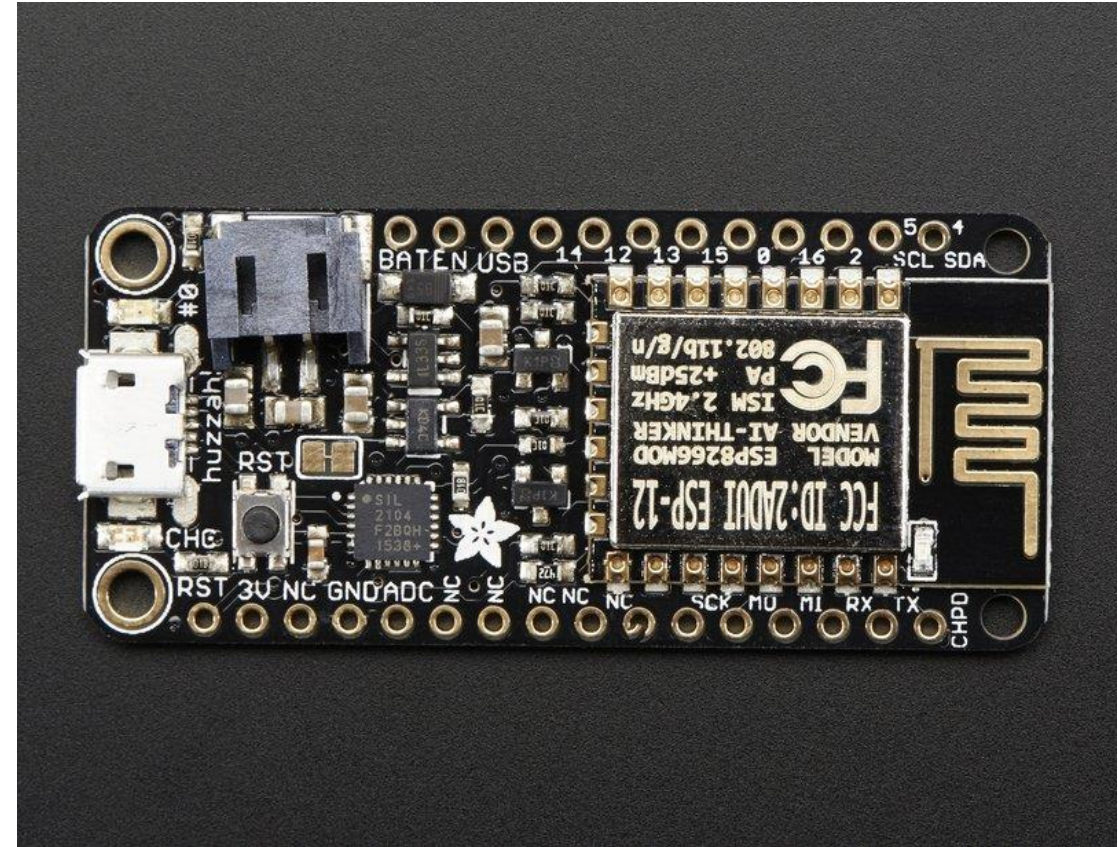# BARTENDER: Hardware

Microcontroller
- HUZZAH Feather (Adafruit)
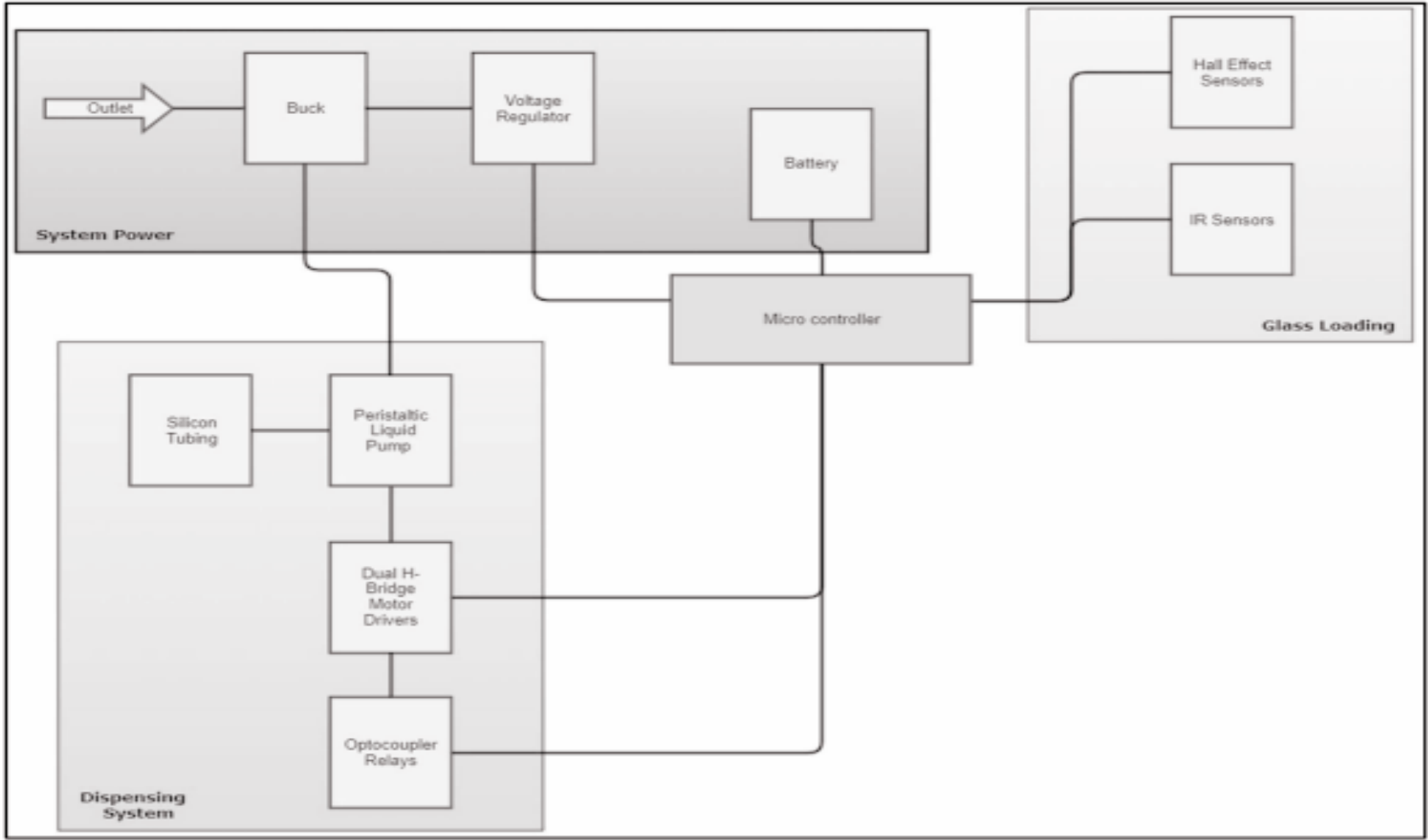- ESP8266 (Espressif)

Dispensing Recipe
- Peristaltic Pumps (Adafruit)
- Silicon Tubing (McMaster-Carr)
- Opto-Coupled Relays (Songle)
- DC Motor Driver (Texas Inst.)
- 74HC4051 8-Channel (Texas Inst.)

Docking/Alignment Check
- HC-SR04 UltraSonic Proximity (ElecF)

INIT — R&D — CSD — APP — OUCH — WOO

BARTENDER: Design

BARTENDER: Firmware

Connect to IoT Hub
- DHCP IP assignment (WiFi)
- Connect to broker & subscribe to data topics (MQTT)

Readiness Checks (Loop)
- Validate container alignment with nozzle (ADC)

Dispensing Recipe
- Receive beverage order (MQTT)
- Sequential pump action (PWM)
- Release for delivery (MQTT)

R&D

APP

WOO

INIT

CSD

OUCH
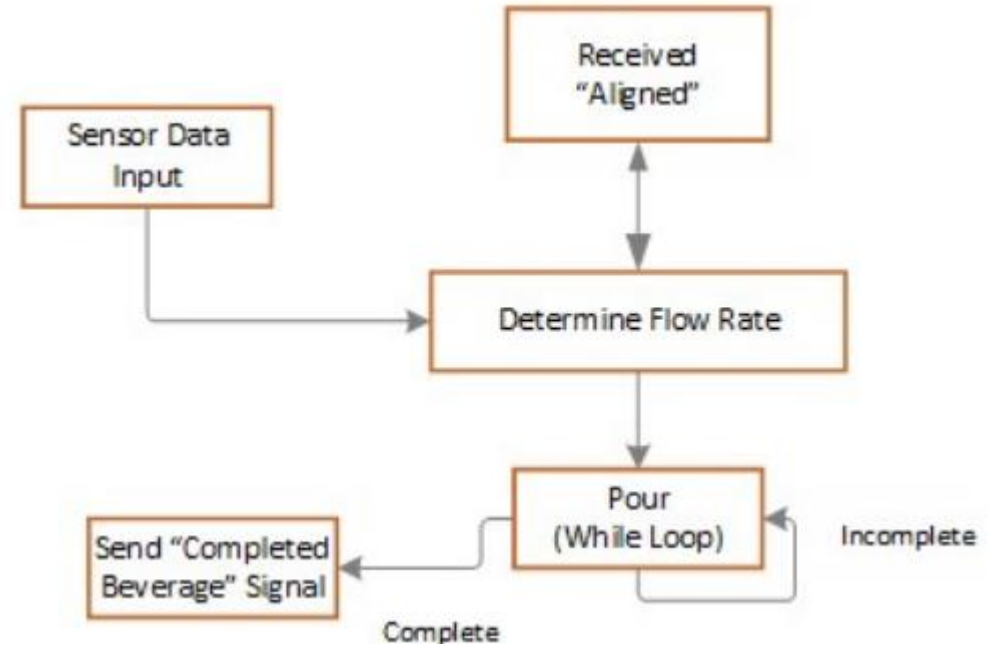
BARTENDER: Status

(Breadboard) Prototype/Firmware
- Power, relays, & motor drivers **OK**
- Connection to WiFi & MQTT **OK**
- Pump control via PWM **OK**
- Arbitrary recipe fulfillment via serial **NO**
- Pump control via MQTT **NO**
- ...

PCB Design
- Module schematics & footprints **OK**
- SMD component vendor sourced **OK**
- Initialized schematic **OK**
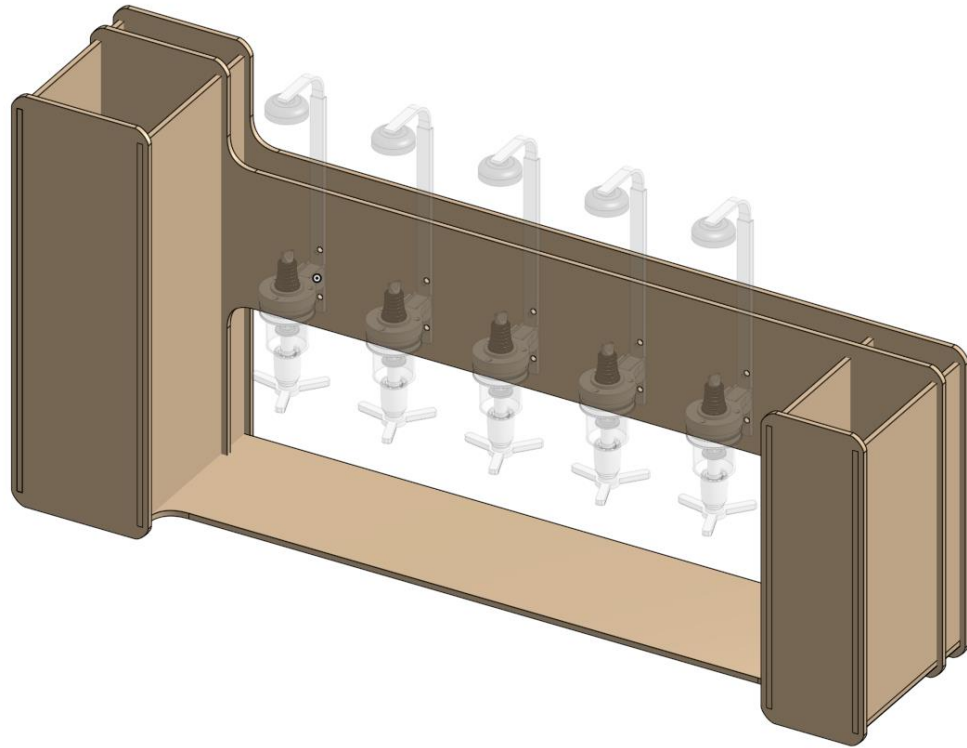- Initialized layout **NO**
- ...

R&D   APP   WOO

INIT   CSD   OUCH

BARTENDER: Status

Structural
- CAD for base components **OK**
- MVP CAD prototype **OK**
- Components sourced/ordered **OK**
- Initial structure manufacturing **NO**
- Initial structure validation **NO**
- ...

Overall Integration
- MQTT tags pre-defined **OK**
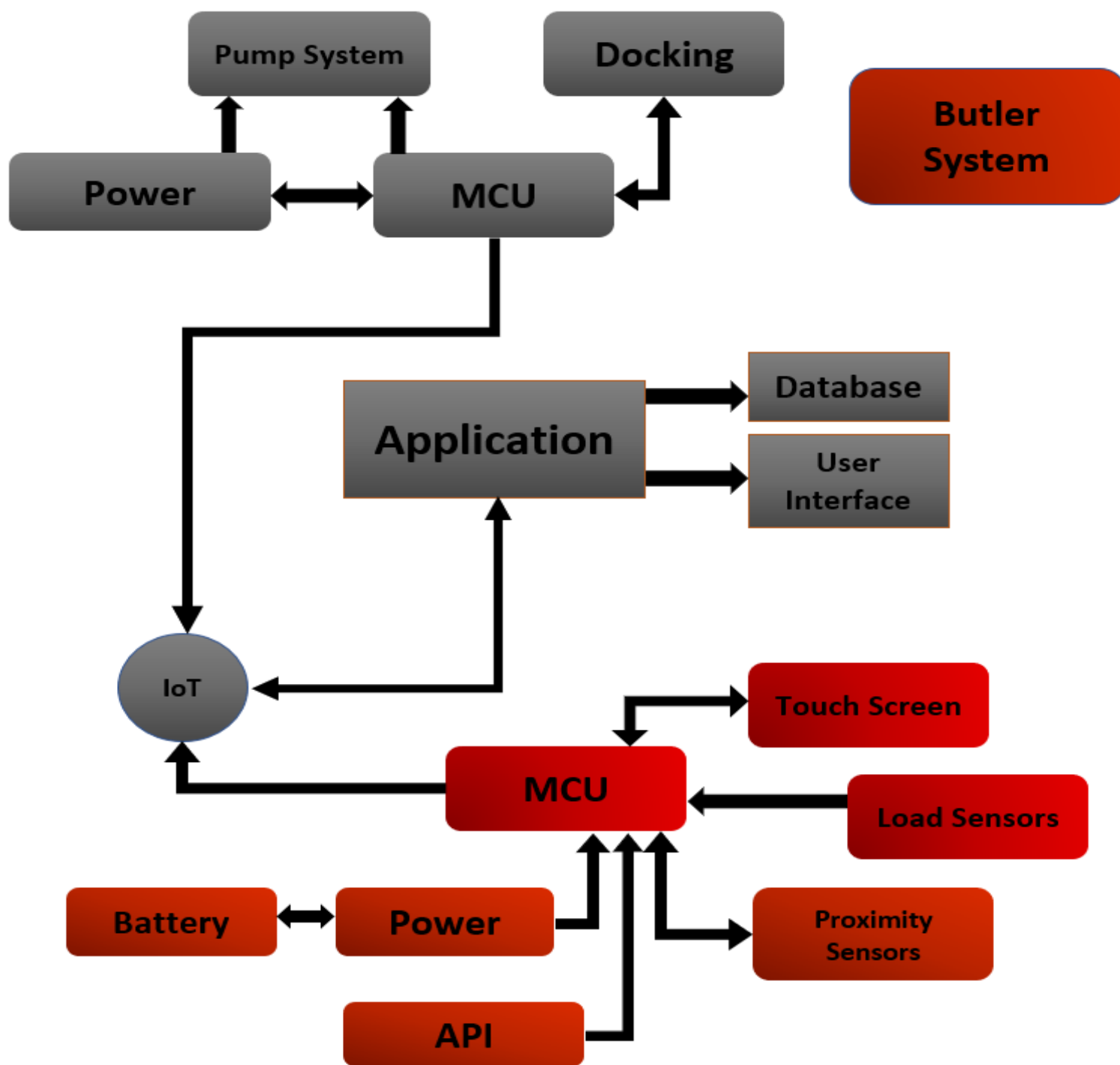- MQTT tags validated, live demo **OK**
- ...

THE BARTENDER

LATEST 3D MODEL

INIT   R&D   CSD   APP   OUCH   WOO

BUTLER: Hardware

Motorized Platform
- Create 2.0 (iRobot)

Navigation "Firmware"
- Raspberry Pi 4.0 + Raspbian Lite
- IR photodiode (Generic)
- TAL221 Load Cell (HTC-Sensors)
- HX711 24-Bit ADC (Avia)

Structure
- ¼" MDF (HomeDepot)
- Aluminum T-slot (8020 Inc.)

R&D APP WOO

INIT CSD OUCH

BUTLER: Design
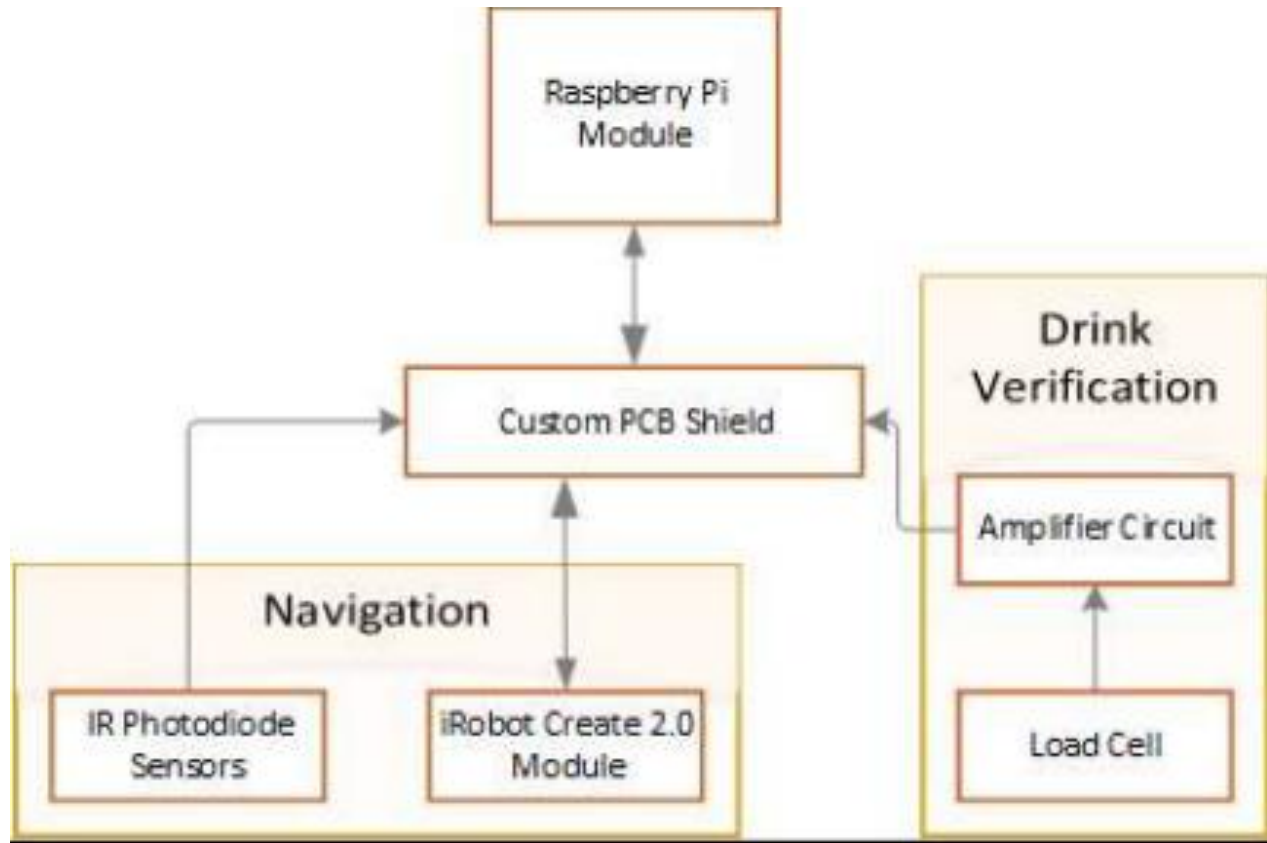
BUTLER: Firmware

Navigation
- Line following with PID controller
  - IR Sensors
  - Raspberry Pi + Python
- Built-in docking feature

Cup Detection (Override Interrupt)
- Load cell monitoring

Communication with MQTT
- Start/End Navigation
  - Docking at endpoints
- Cup Presence + Empty/Full
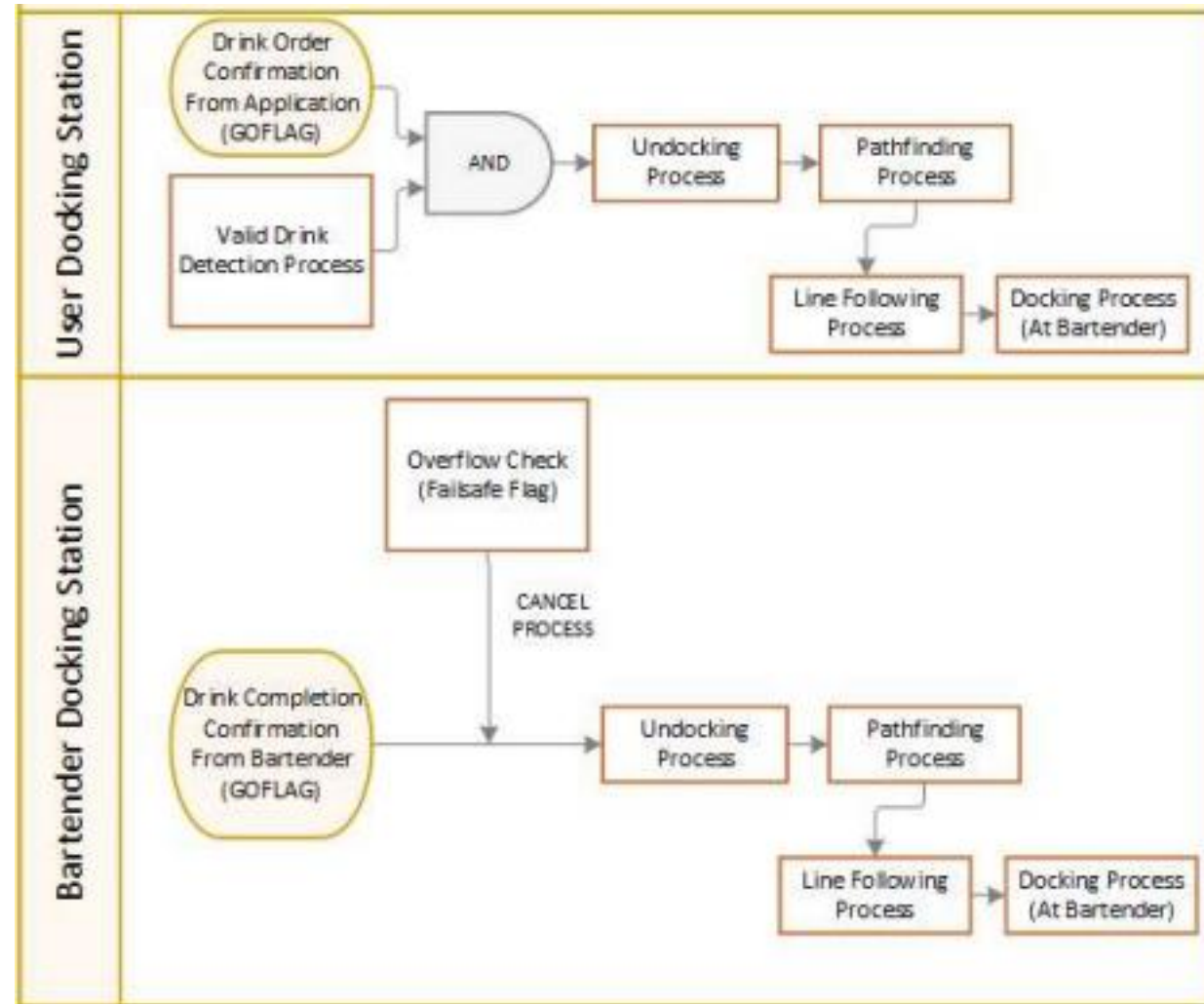
BUTLER: Status

(Breadboard & Pi) Prototype/Firmware
- Load cell sensor validation **OK**
- IR sensor validation **OK**
- iRobot serial interface motion control **OK**
- iRobot motion control via Python **OK**
- iRobot preset path & docking **OK**
- IR sensor array integration via Python **NO**
- ...

PCB Design
- Module schematics & footprints **OK**
- SMD component vendor sourced **OK**
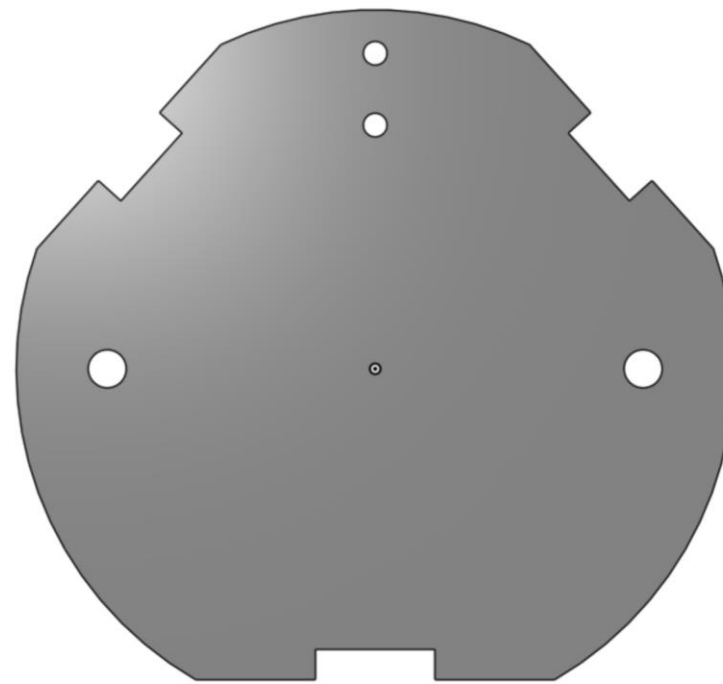- Initialized schematic **NO**
- Initialized layout **NO**
- ...

R&D   APP   WOO

INIT   CSD   OUCH

BUTLER: Status

Structural
- CAD for base components **OK**
- MVP CAD prototype **OK**
- Components sourced/ordered **OK**
- Initial structure manufacturing **NO**
- Initial structure validation **NO**
- ...

Overall Integration
- MQTT tags pre-defined **OK**
- Transition development to Pi **OK**
- MQTT tags validated, live demo **OK**
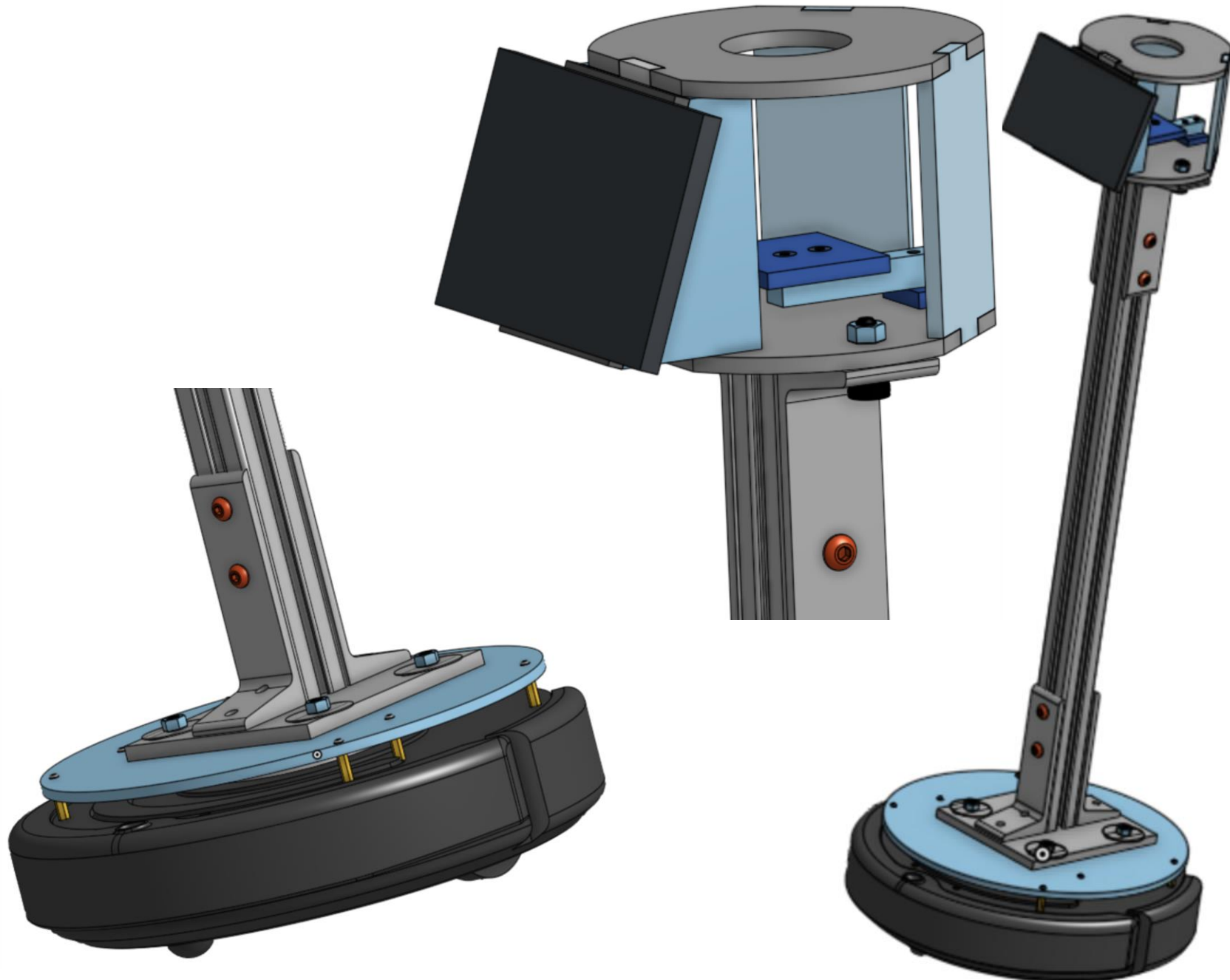- ...
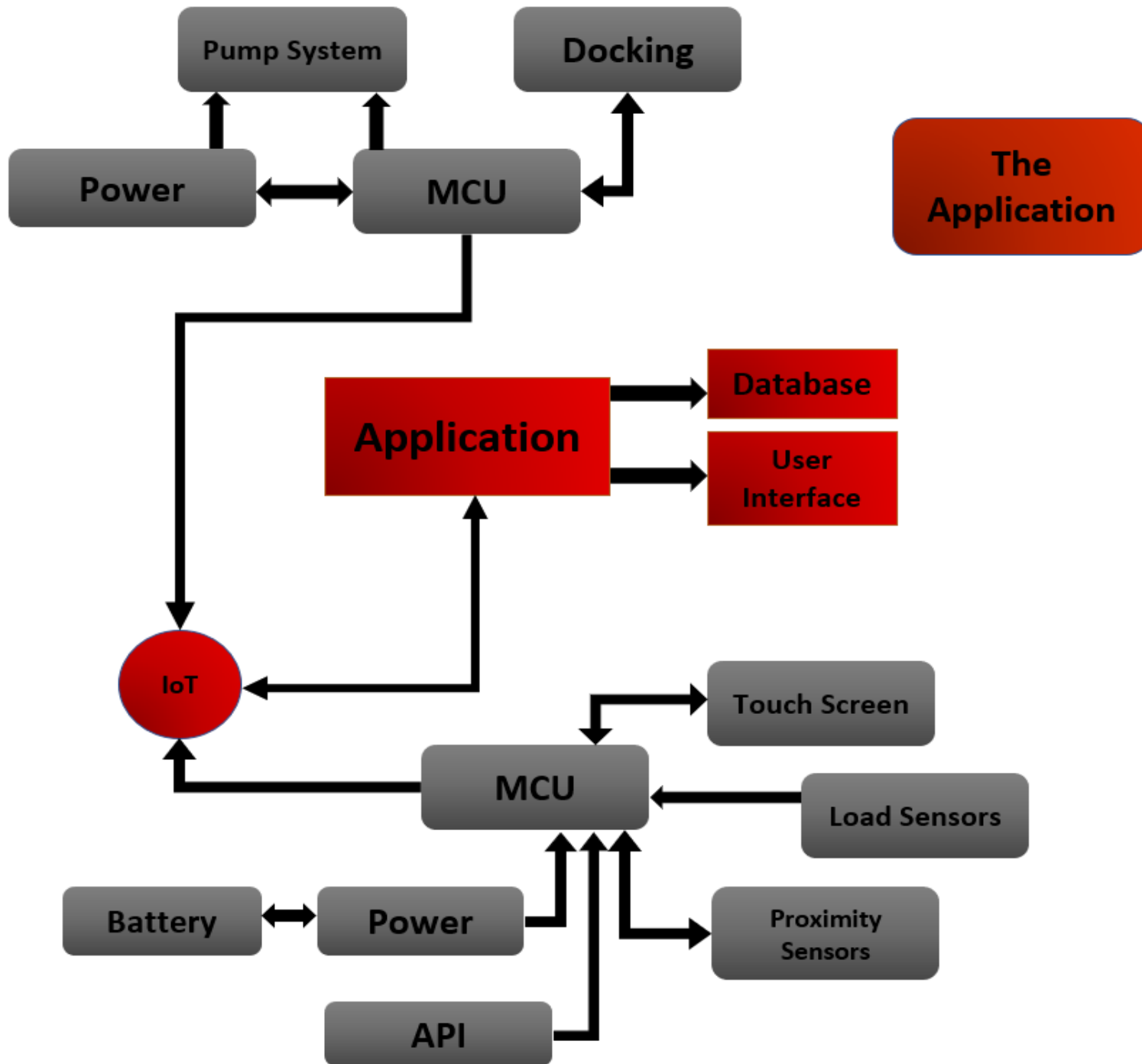

INIT   R&D   CSD   APP   OUCH   WOO

THE APPLICATION

Block Diagram Highlight

APPLICATION: Building Blocks

Operating System / Environment
- Linux Raspbian Lite (bare bones)
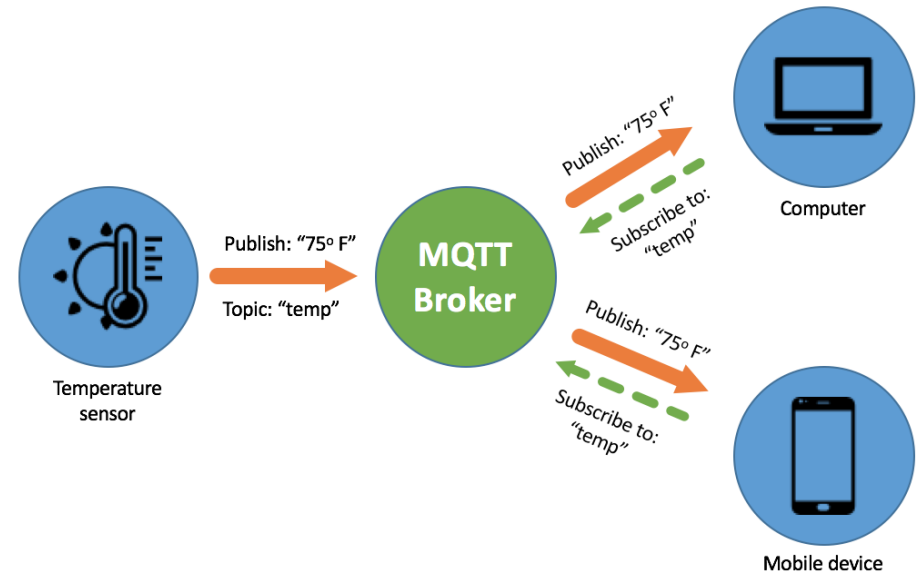
"Internet of Things" Platform
- Eclipse Mosquitto (MQTT)

Persistent Database
- SQLite3

Programming Language
- Python 3.7.4
  - PyQT5 (GUI) lib
  - Paho (MQTT) lib
  - Sqlite3 lib

Temperature sensor — Publish: "75° F" Topic: "temp" → **MQTT Broker** → Publish: "75° F" / Subscribe to: "temp" → Computer; Publish: "75° F" / Subscribe to: "temp" → Mobile device

APP: Status of Backend Env.
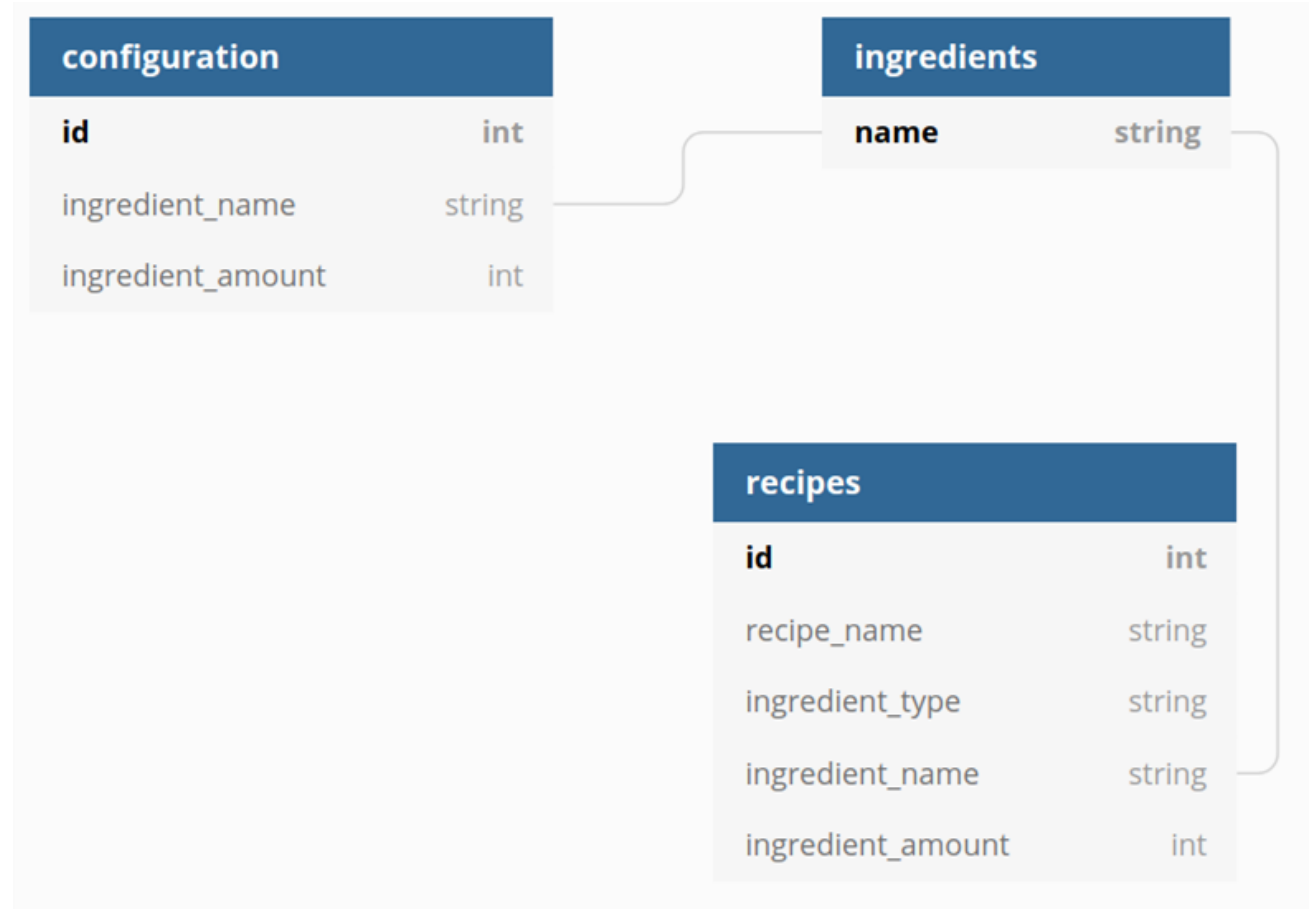
Operating System & Runtime Environment
- Flash OS, strip to OS bare essentials, enable GPIO functions **OK**
- Install Python, libraries, configure Git repos **OK**

MQTT Broker Configuration
- Install, enable service, configure for maximum QoS **OK**
- Validate errorless machine-to-machine data transfer between subsystems **OK**

SQL Database Configuration
- Install, enable service **OK**
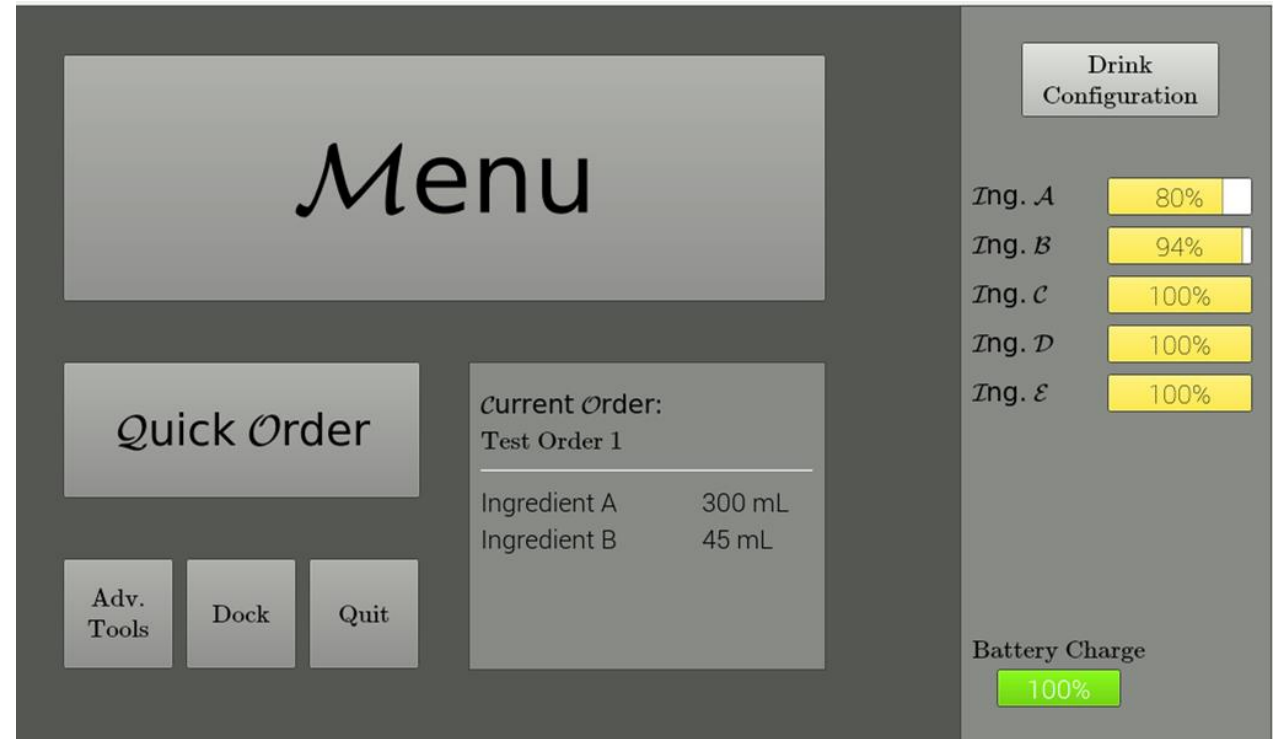- Format tables, populate tables with basic entries, validate core query structures **OK**

configuration	
id	int
ingredient_name	string
ingredient_amount	int

ingredients	
name	string

recipes	
id	int
recipe_name	string
ingredient_type	string
ingredient_name	string
ingredient_amount	int

INIT   R&D   CSD   APP   OUCH   WOO

APP: Status of GUI

Graphical User Interface
- Formalize visual design & generate UI basis files from development toolkit **OK**
- Translate/Port to Python & PyQT5 **OK**
- Link basic button functionalities
  i.e. "exit all processes" **OK**
  i.e. confirmation dialogues **OK**
- Instantiate primary Window & actions **OK**
- Instantiate menu shell & actions **NO**
- ...

Core Logic
- Send/receive data from MQTT **OK**
- Send/receive data from SQLite **OK**
- Live GUI refresh on data updates **OK**
- Subsystem management logic **NO**
- ...

Drink Configuration

Menu

Ing. A 80%
Ing. B 94%
Ing. C 100%
Ing. D 100%
Ing. E 100%

Quick Order

Current Order:
Test Order 1

Ingredient A   300 mL
Ingredient B   45 mL

Adv. Tools   Dock   Quit

Battery Charge
100%

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APPLICATION: GUI Breakdown

- Link to menu window
- Quick order last order
- Basic system information and options
- Ingredient inventory

Main Window

Shutdown confirmation

- Small display of current ingredient inventory
- Core Change button
- Return link to main window

Menu Shell

Custom Drink Core

- List of known ingredients
- Quantity input requests for each ingredient

- List of available drinks and their components

Menu Core
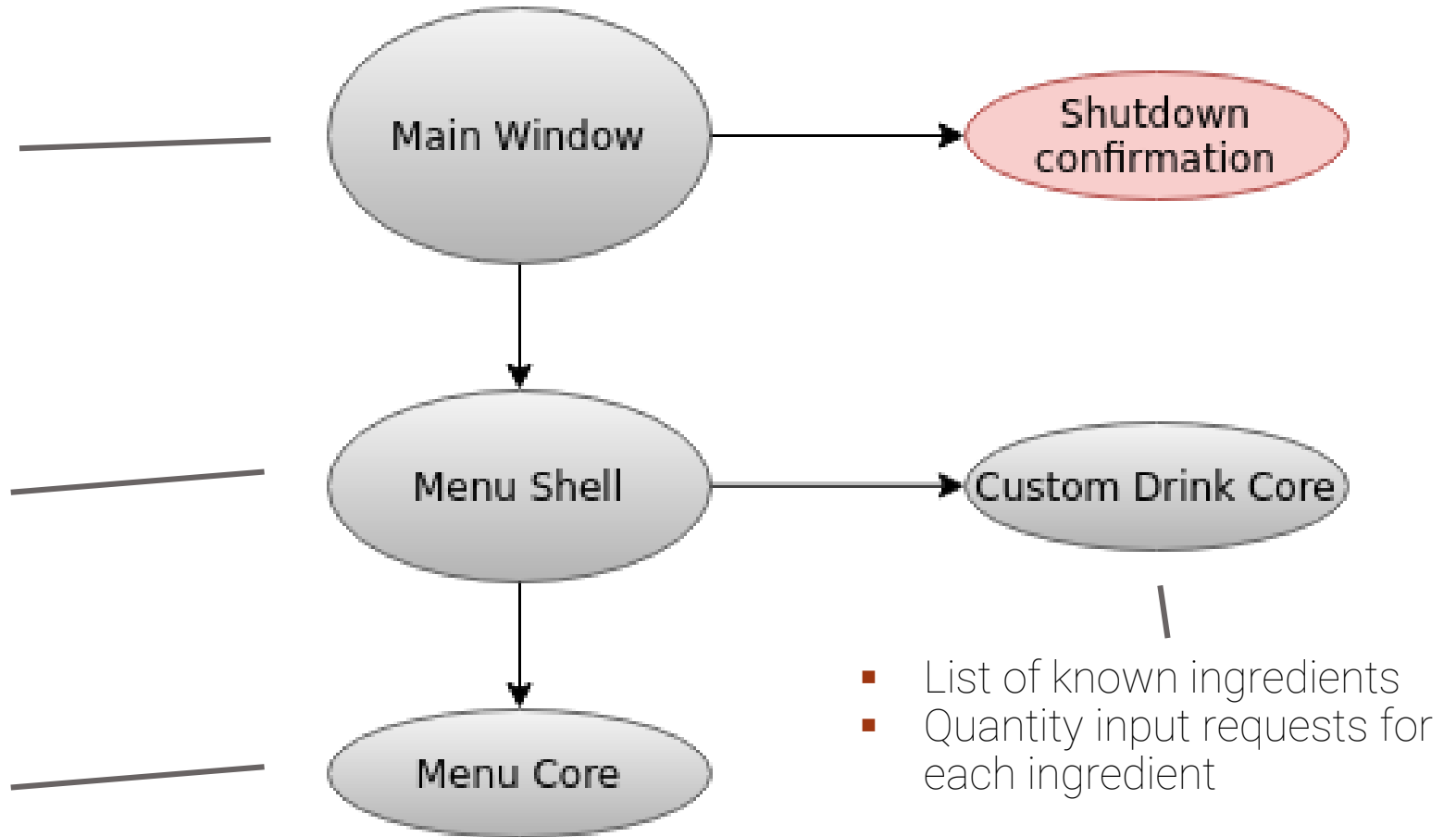
APPLICATION: State Diagram

Idle State: Lack of user input or relevant system processes

Primary Window: Constantly checks various system states

Menu Window: Queries SQL database to offer relevant information to the user

Dispatch Order: Received confirmation from user. Initiates Butler movement.

Order Processing: Constantly monitors Butler and Bartender processes until end of delivery.
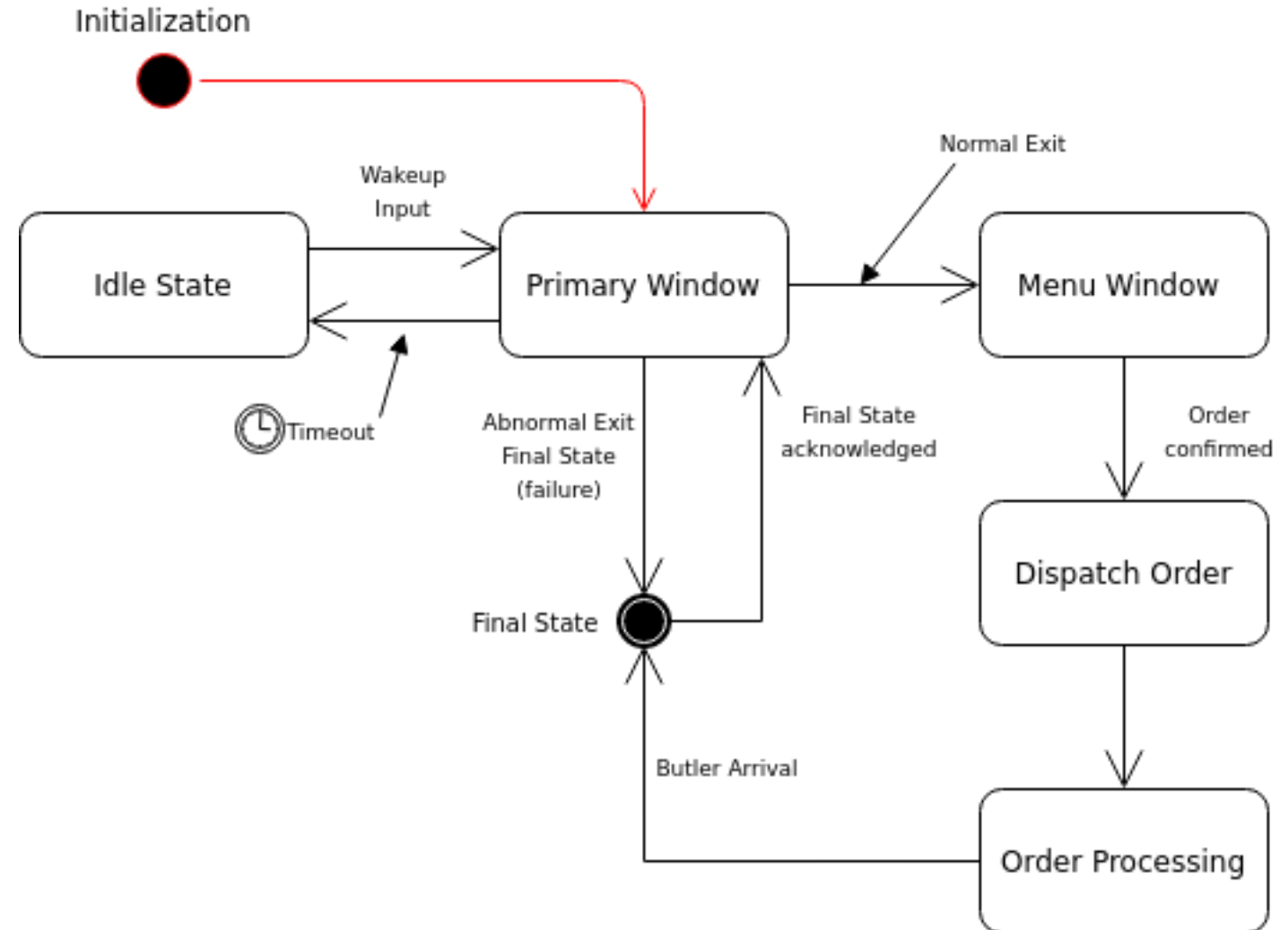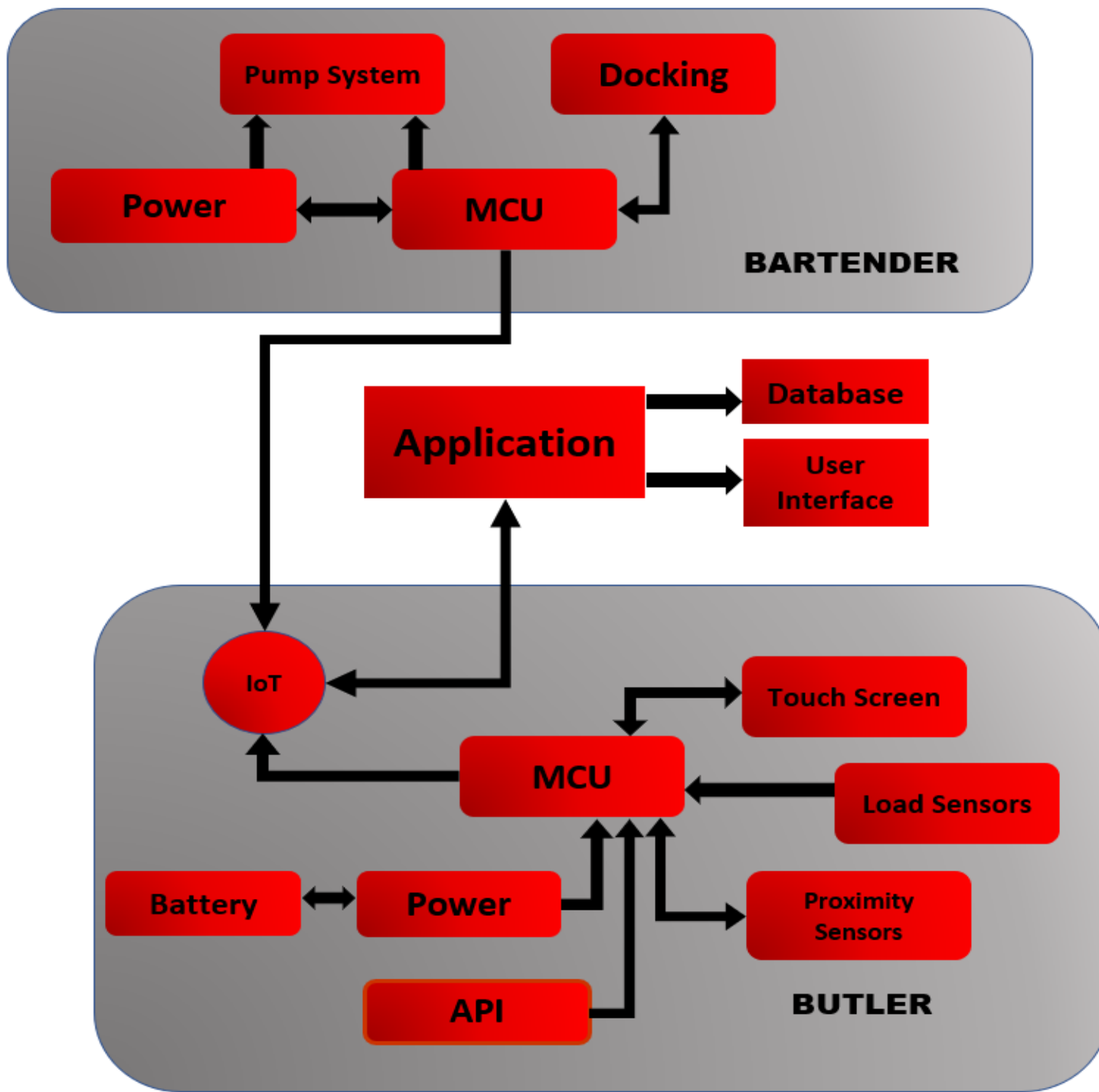
OVERALL SYSTEM SUMMARY

& Notes on Integration

Challenges to Overcome

Simultaneous Development Timelines (& Overall System Integration)
- Radically distinct, individually complex subsystems
- Maintaining alignment for concurrent/dependent development goals

Team Experience
- Steep learning curves for CAD software &
- Lack of familiarity with sensor libraries, programming languages = addtl hours spent
- ...

Conflicting Considerations Approaches
- Optimum Functionality vs.
- Manufacturability/Deployability vs.
- Aesthetics/Ergonomics

R&D   APP   WOO

INIT   CSD   OUCH

Health and Safety Standards
- Food Safety - NSF/ANSI 25
  - The purpose of this standard is to establish the minimum food protection and sanitation guidelines

- Drinking Water - NSF/ANSI 61
  - the standard that covers drinking water system components

- Fire Safety and Emergency - NFPA
  - the fire safety standard that provides symbols used to effectively communicate fire safety, emergency, and associated hazards information.

Digital Standards

- Wireless Communication - IEEE 802.11

- MQTT v5.0 standards - ISO/IEC PRF 20922

RELEVANT STANDARDS
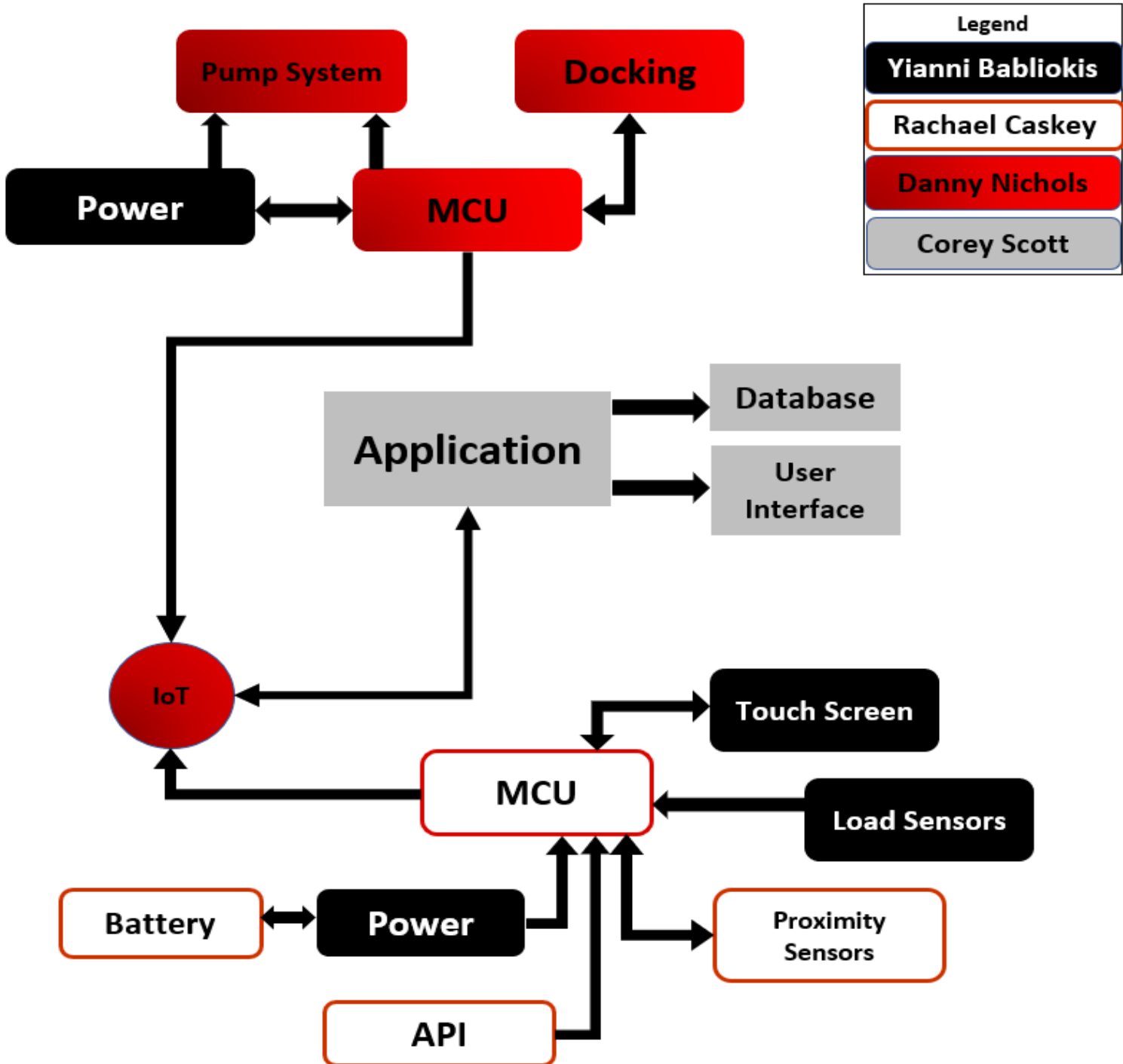
SYSTEM DIAGRAM

Responsibilities Highlight

ADMINISTRATION:
Roles & Responsibilities

Main: ✓   Assisted: 🤖

Task	Pump System	Bartender MCU	Internet of Things Platform	Application	User Interface	Database	Butler MCU	Butler Proximity Sensors	Butler API	Butler Battery System	Butler Power System	Bartender Power System	Butler Load Sensors	Butler Touch Screen
Yianni Babiolakis							🤖	🤖	🤖	🤖	✓	✓	✓	✓
Rachael Caskey							✓	✓	✓	✓		🤖	🤖	🤖
Danny Nichols	✓	✓	✓	🤖	🤖						🤖	🤖		
Corey Scott		🤖	🤖	✓	✓	✓	🤖							

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Bartender/Butler Schedule

Bartender	Week 5/6 (Feb 14th)	Week 7/8 (Feb 28th)	Week 8/9 (Mar 13th)	Week 10/11 (Mar 27th)	Week 12/13 (Mar 10th)	END (to April 17th)
PCB Design	●—					
MVP CAD Design	—●———●					
MVP Assembly	●—●———●					
MQTT Control/Data Flow	●—●——					
Soft Integration	●———————	●———●				
PCB Integration		●——●——————●			
Overall System Testing		●—————————●	●———●	
Aesthetic Mods		●——————●———————●		
Demo Setup			●————————	●———●	
Final Documentation				●———	●———●

INIT   R&D   CSD   APP   OUCH   WOO
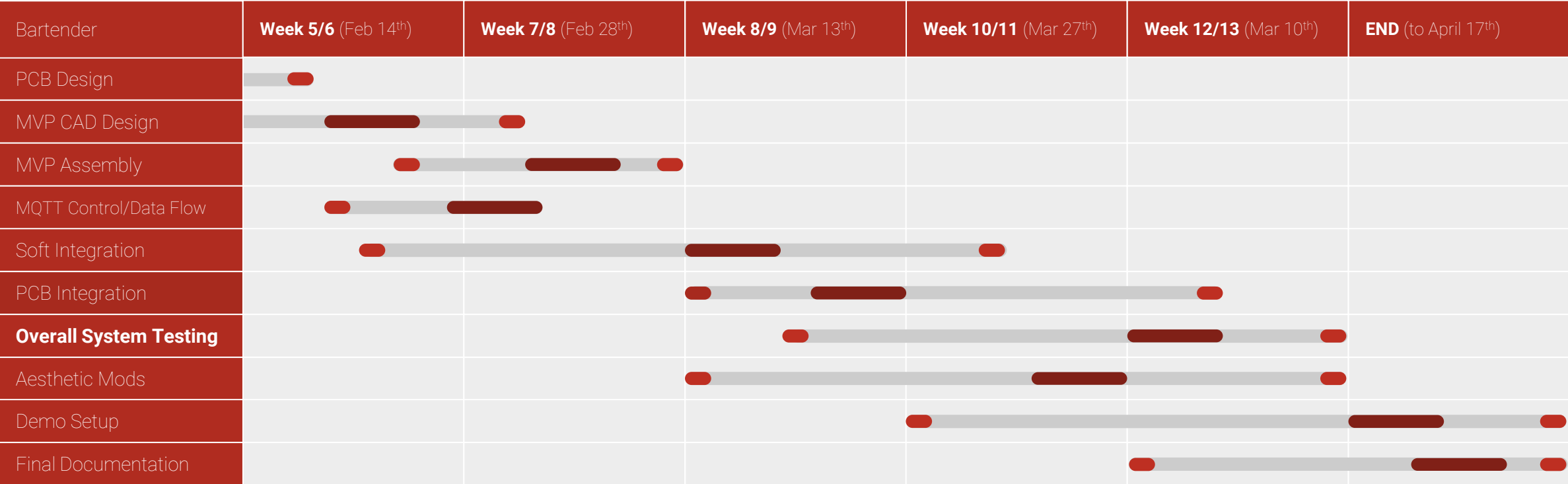
Application (Integration) Schedule

Bartender	Week 5/6 (Feb 14th)	Week 7/8 (Feb 28th)	Week 8/9 (Mar 13th)	Week 10/11 (Mar 27th)	Week 12/13 (Mar 10th)	END (to April 17th)
Optimize SQL DB Layout						
MVP GUI Windows						
Bartender Control/Stats						
Butler Control/Stats						
Overall Control Integration						
Overall System Testing						
GUI "Beautification"						
Demo Setup/Practice						
Final Documentation						
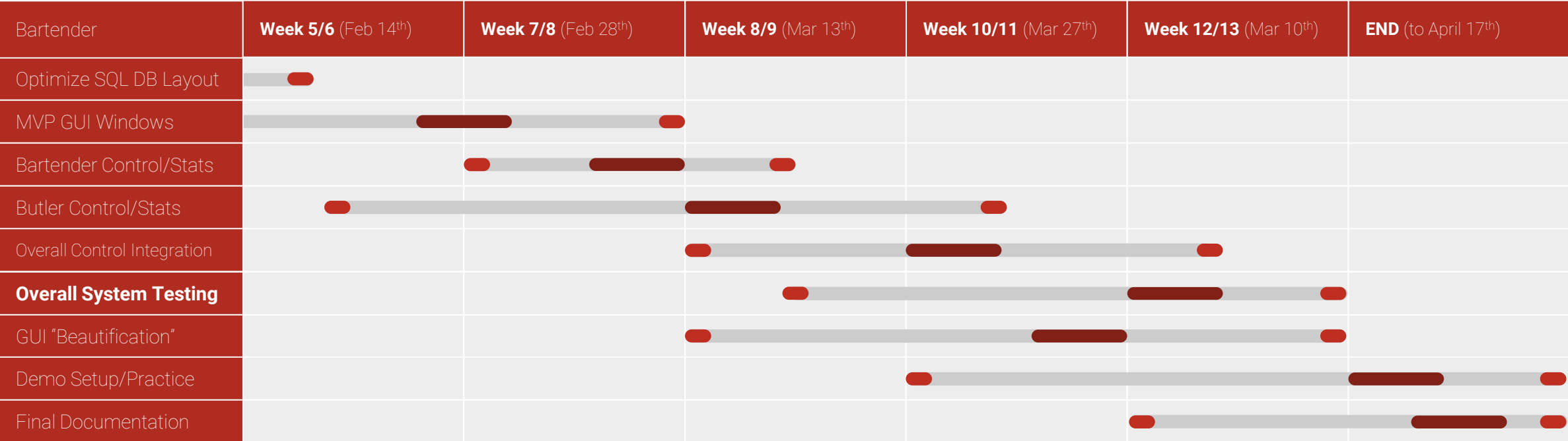
INIT   R&D   CSD   APP   OUCH   WOO

Budget
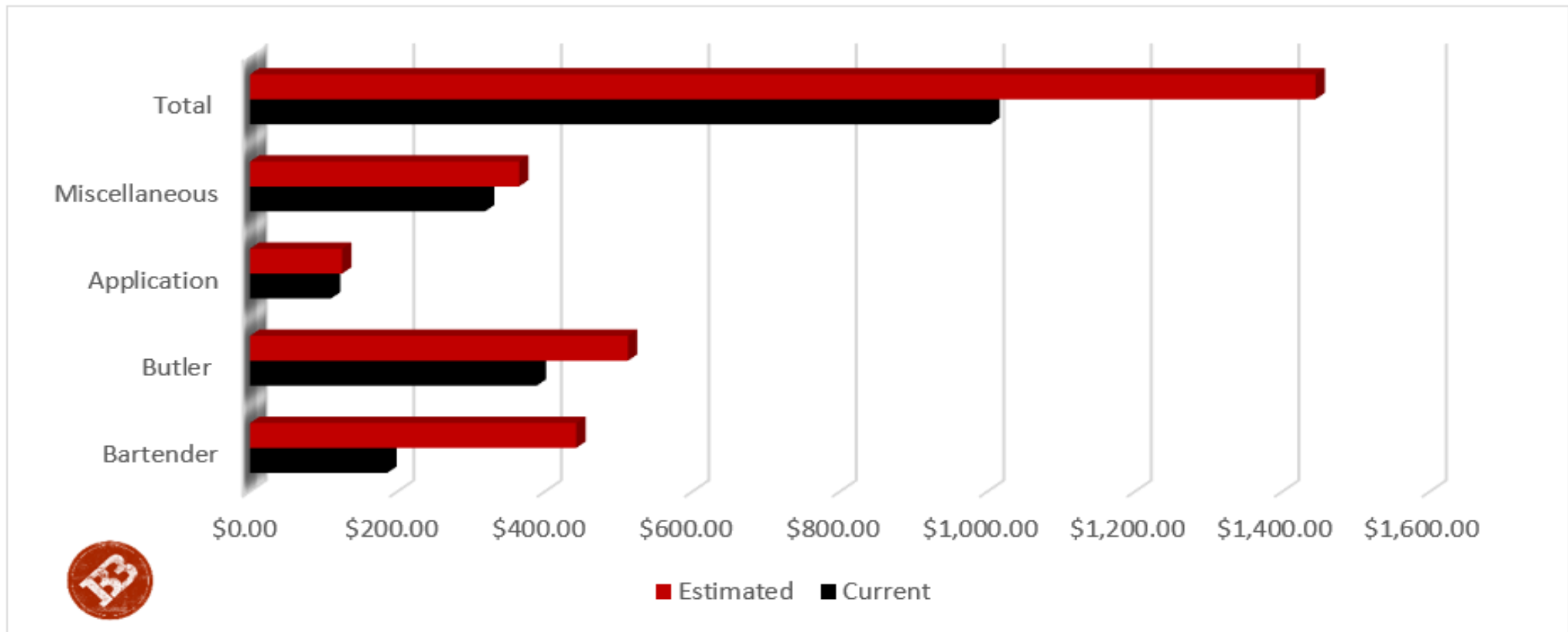
ADMINISTRATION: Progress Percentage

Bartender
- Construction
- Firmware
- Design
- Overall

(0% to 100%)

Butler
- Construction
- Firmware
- Design
- Overall

(0% to 100%)

Application
- Graphical Interface
- Back-End Logic
- Overall

(0% to 90%)

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