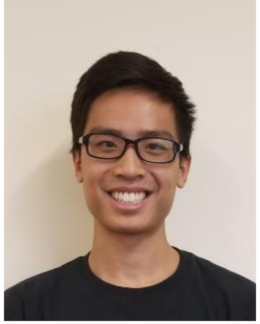
Comprehensive Design Review

Team 16
February 25, 2019

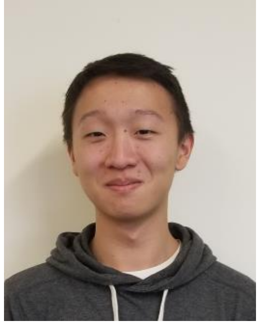
Mapper

Kelvin Nguyen
ME



Marcus Le
EE

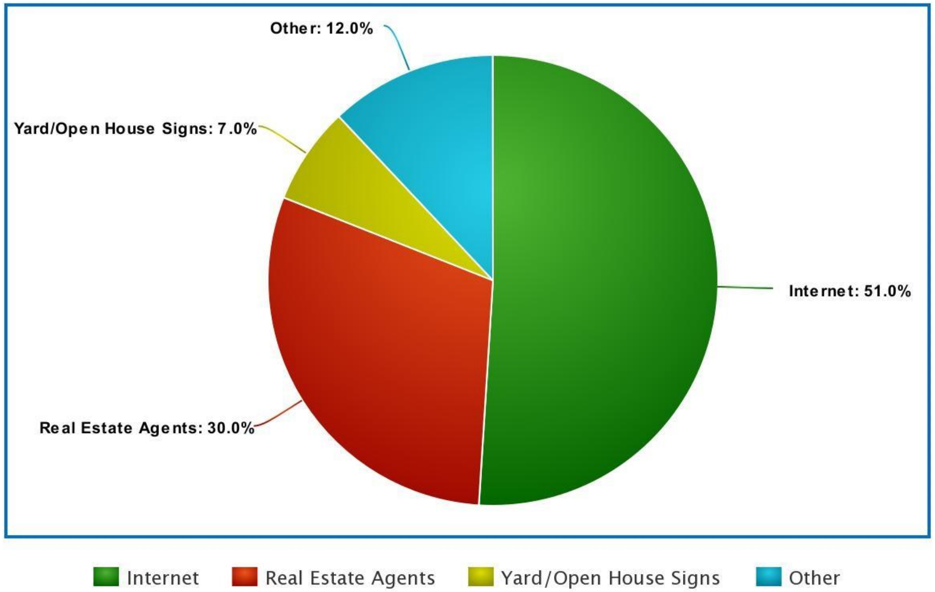
Bryan Martel
CSE



Derek Sun
CSE

Background and Motivation

- In 2017, homeowners found their new houses through:
  - Internet - 51%
  - Real Estate Agents - 30%
  - Yard/Open House signs - 7%
  - Other - 12%



https://www.nar.realtor/research-and-statistics/quick-real-estate-statistics

Goal

- Provide homeowners or real estate agents with the ability to post an updated model of the interior of their house

- Potential integration with virtual reality tours
  - Similar to an open house
  - Cater toward the younger, more technologically adept generation that will inevitably dominate the future real estate market

Method of Resolution

- A robot that utilizes LIDAR sensors to remotely navigate around the surrounding environment and produce a 3D layout of an indoor area
- A camera mounted on the robot will allow for live video feed to assist in user navigation

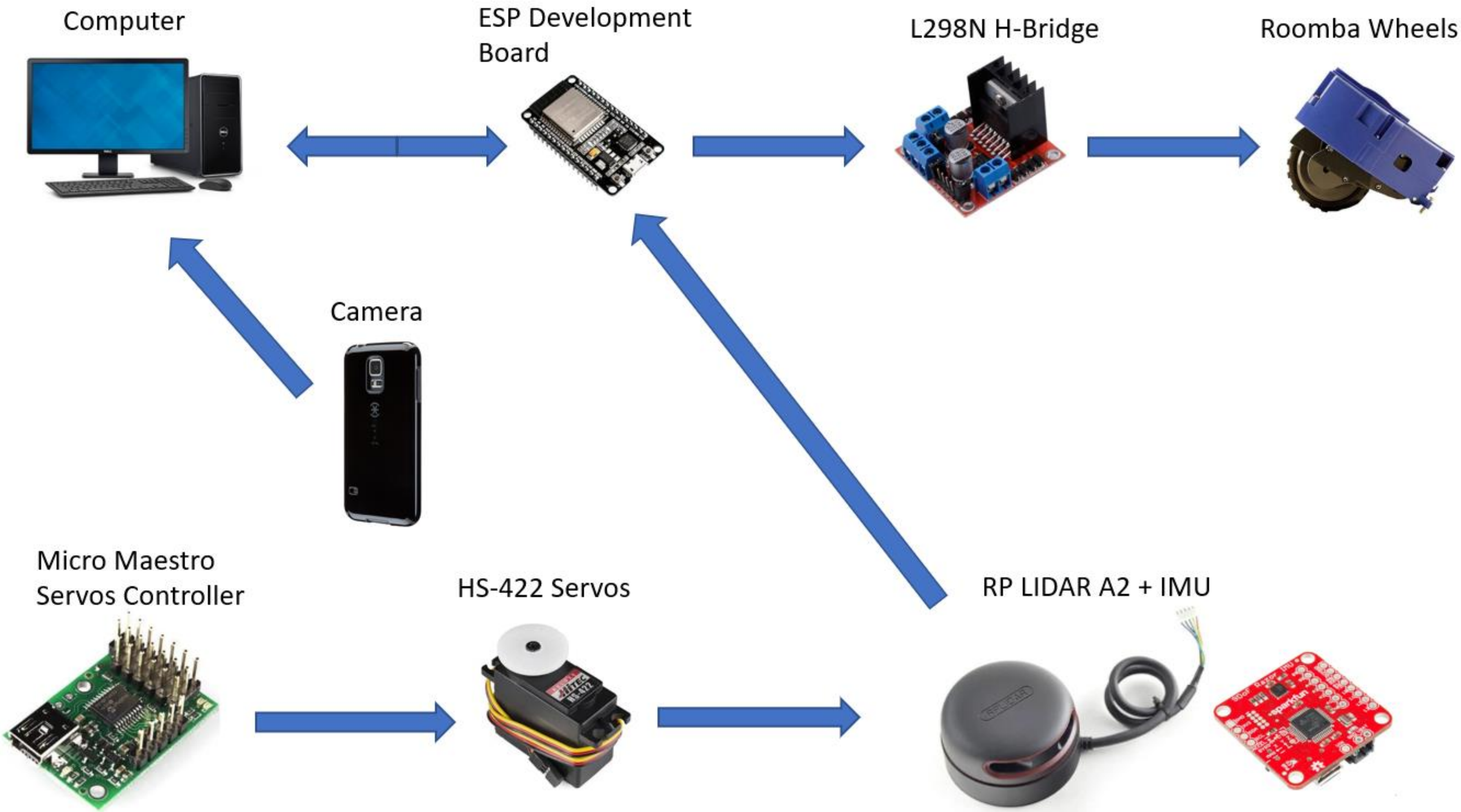
Requirements Analysis: Specifications

- Speed of up to 3mph
- Effective detection range of 15ft
- Approximately 12 pounds
- Approximately 2 hours of battery life
- Durable enough to withstand minor collisions

Requirements Analysis: Inputs and Outputs

- Input
  - LIDAR sensor data
  - Inertial measurement unit data
  - Camera data
  - User navigation control
- Output
  - Live video feed
  - Map data

System Overview



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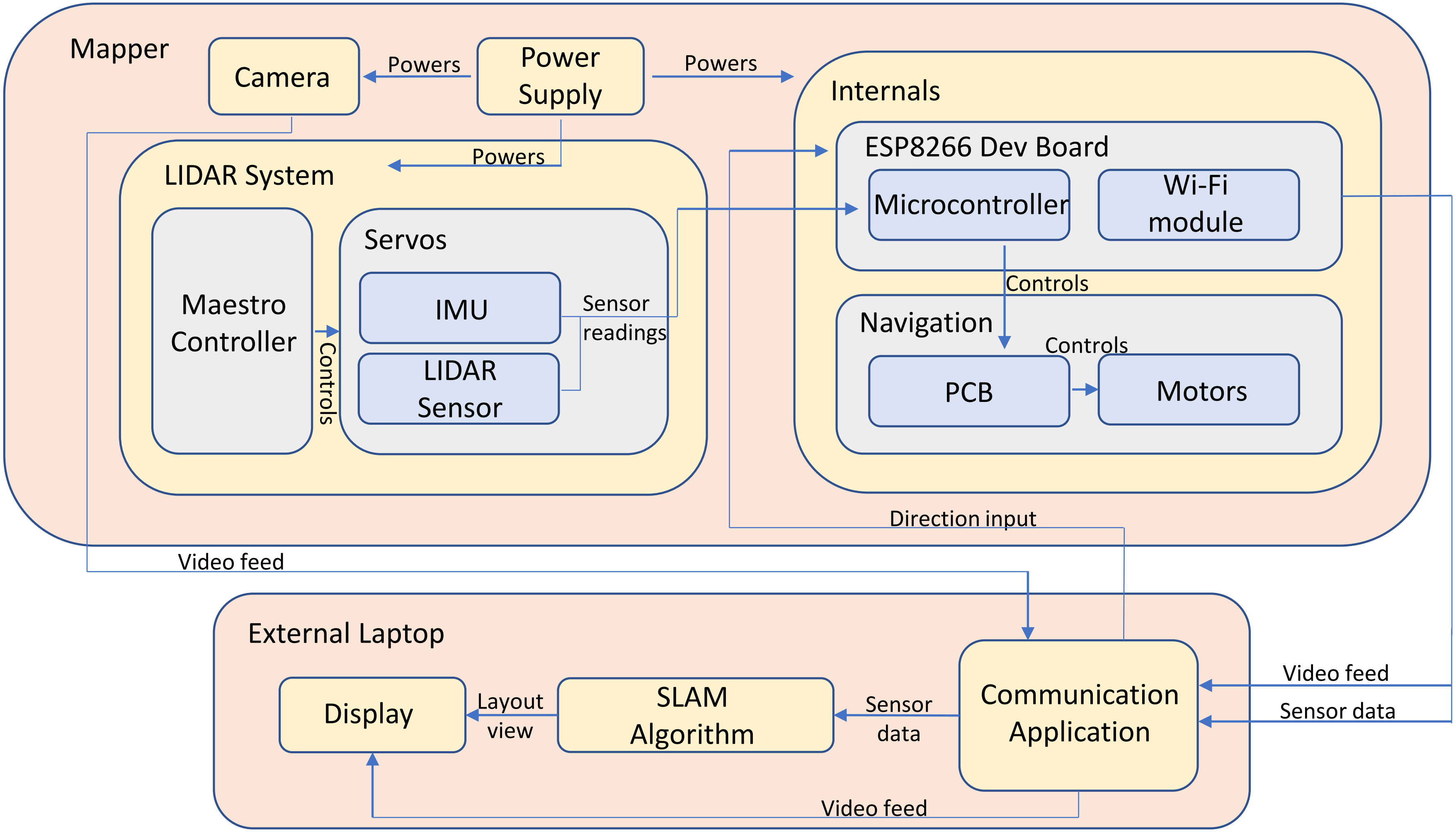

Proposed CDR Deliverables and Responsibilities

- 3D SLAM
  - Simultaneous LIDAR and IMU data input
  - Pan & tilt calibration and integration
- Functional robot
  - Mount motors to our custom robot
  - Integrate custom PCB
- Wi-Fi connectivity between robot and PC
  - Able to send navigation input to robot through Wi-Fi

Responsibilities

- Kelvin (ME)
  - Ensure functional robot, mount SLAM components, pan & tilt system
- Marcus (EE)
  - Create PCB, ensure functional robot, pan & tilt system, Wi-Fi data transfer
- Derek (CSE) & Bryan (CSE)
  - Programming 2D SLAM → 3D SLAM, Wi-Fi data transfer

Design Changes

Custom Arduino PCB → H-Bridge PCB

- Originally, Arduino PCB would handle Wi-Fi signals from the ESP8266 and send signals to the H-bridge accordingly
- It turns out that the ESP8266 has a development board that can do this exact thing
    - Eliminates the need for an Arduino
    - Creates a more compact design by reducing redundant and unnecessary hardware

Will now use a custom PCB as an H-Bridge to control signals sent to motor

Actual CDR Deliverables and Responsibilities

- ✓ 3D SLAM
  - ✓ Simultaneous LIDAR and IMU data input
  - ✓ Pan & tilt calibration and integration
- ✓ Functional robot
  - ✓ Mount motors to our custom robot
  - ○ Integrate custom PCB
- ✓ Wi-Fi connectivity between robot and PC
  - ✓ Able to send navigation input to robot through Wi-Fi

Responsibilities

- Kelvin (ME)
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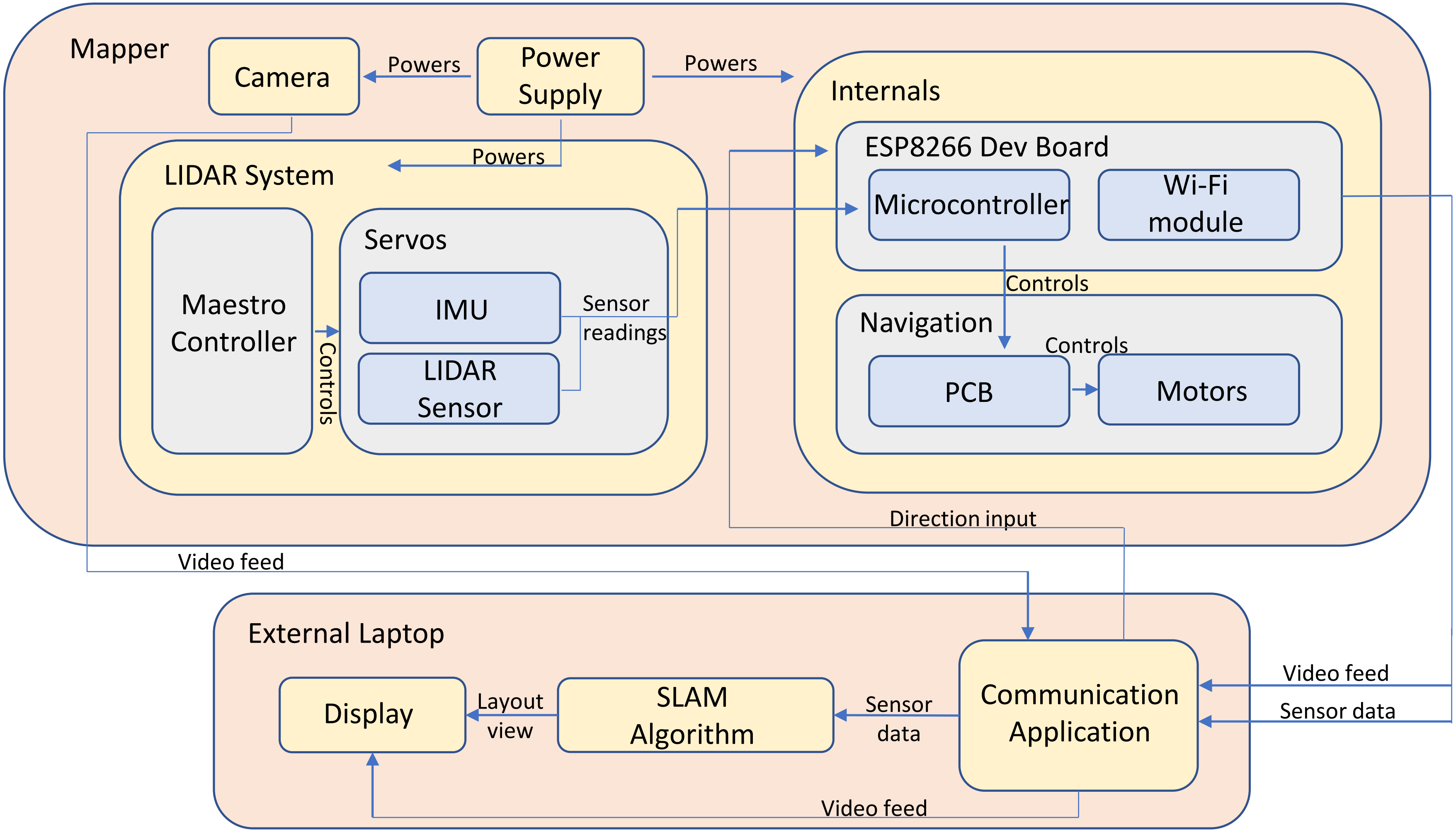
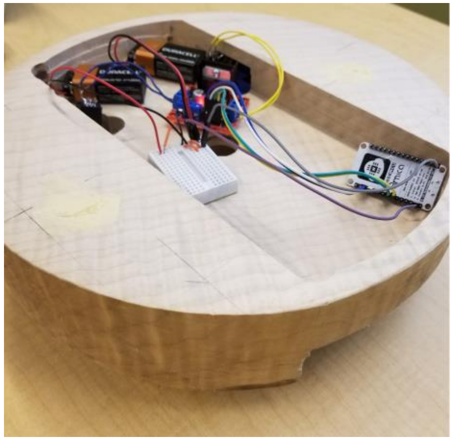


CDR Deliverable (Robot)

- Chassis
  - Contains motors, circuit and battery to navigate Mapper
- 3D mounts
  - Servos mount custom-made to house servos motor
  - LIDAR mount custom-made to house IMU and LIDAR
- Lid
  - Servos system with 3D mounts installed on top
  - Holds LIDAR in place



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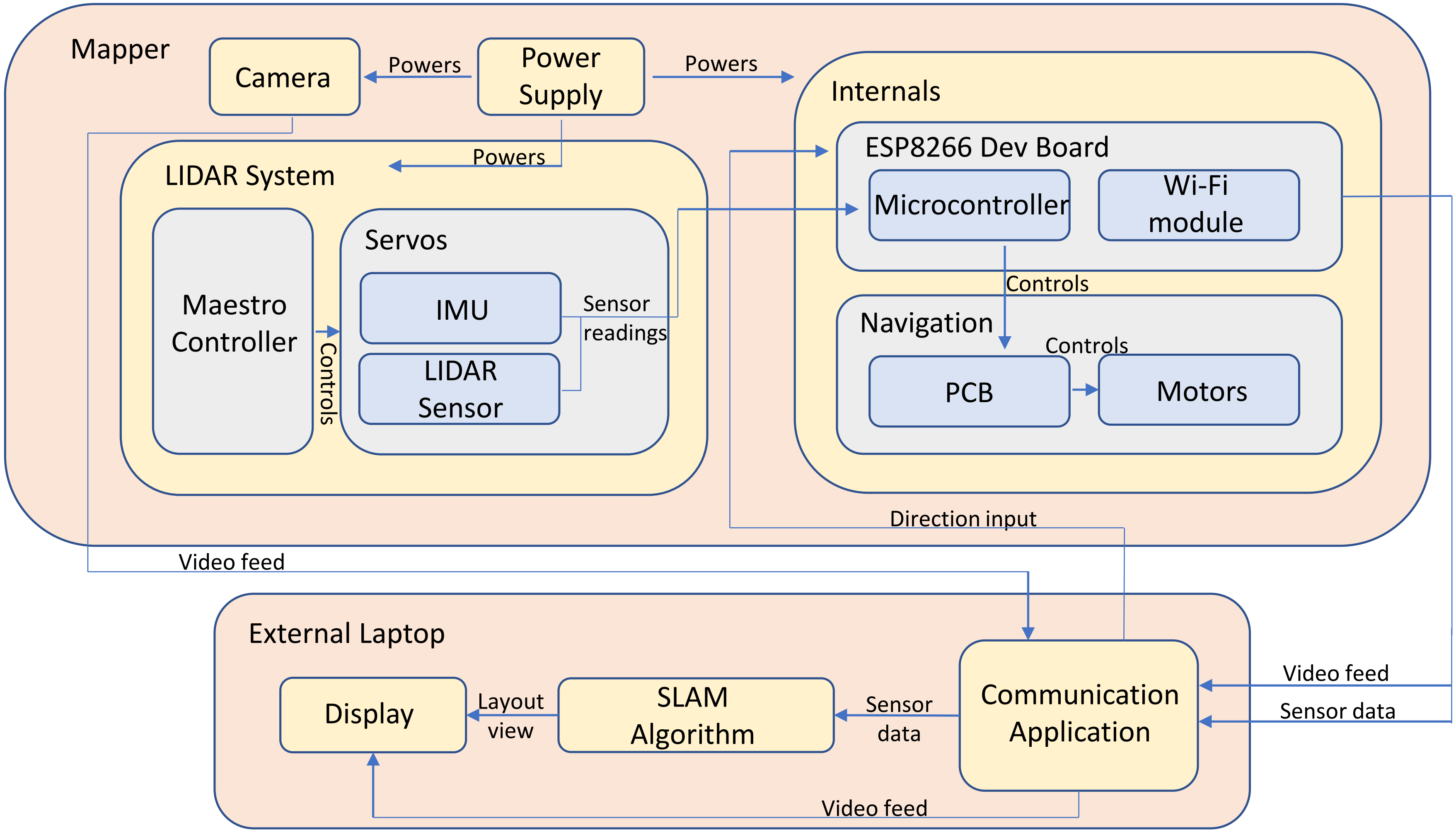
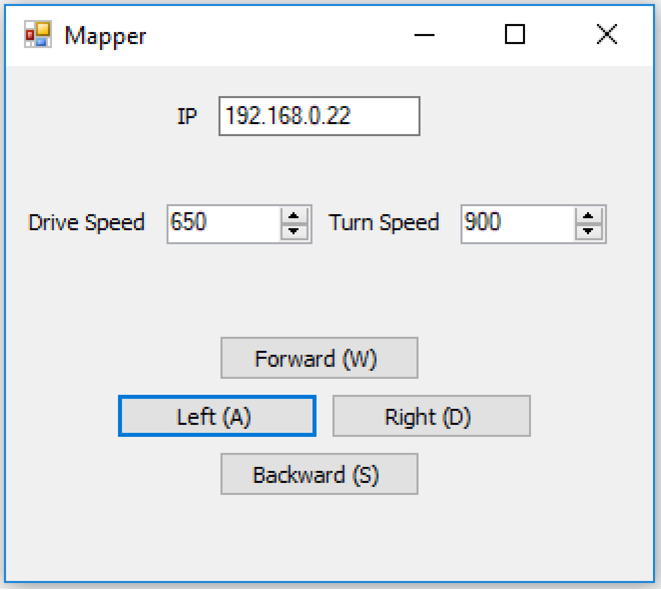


CDR Deliverable (Wi-Fi Connectivity)

- Configure a network
- ESP chip, auto connects to the network on startup
- Computer connects to the same network
- PC Application can then communicate through the network to ESP8266
- Able to send robot movement controls through PC application to ESP8266
- Accepts WASD keyboard input
  - W = Forwards
  - A = Rotate left
  - S = Backwards
  - D = Rotate right

CDR Deliverable (Wi-Fi Connectivity)

- On startup the ESP8266 searches for the network pre configured within the RC_Mapper file and establishes a connection
- PC client sends UDP messages to the IP defined in the UI through port 4320
- Robot movement speeds can be changed using the drive and turn speed parameters



CDR Deliverable (Wi-Fi Connectivity)

- ✓ Wi-Fi connectivity between robot and PC
  - ✓ Able to send navigation input to robot through Wi-Fi

- Next steps:
  - Send LIDAR and IMU data through ESP8266 development board to PC
  - Transition from Arduino libraries to C

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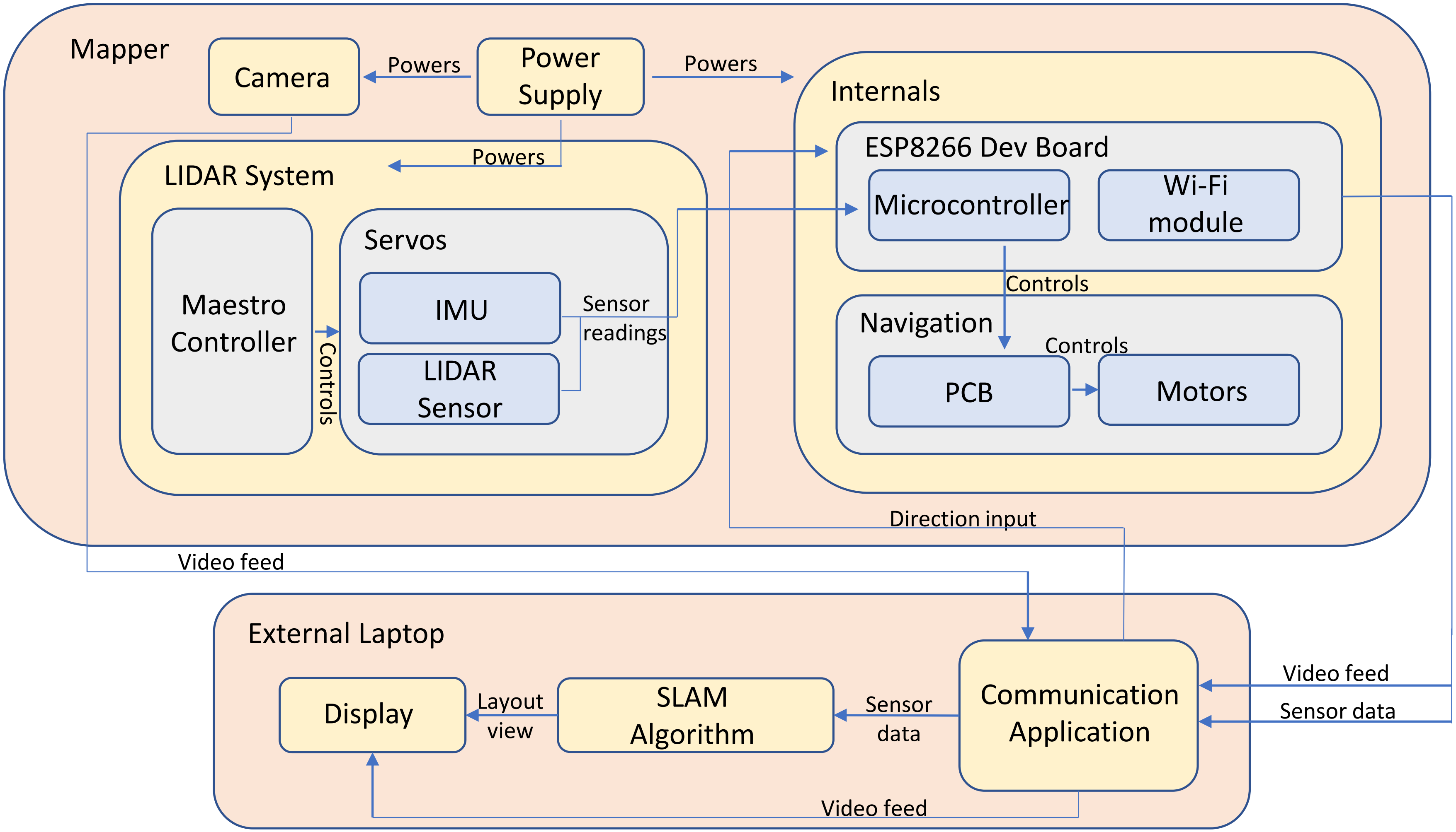


CDR Deliverable (3D SLAM)

RPLIDAR A2 → rplidar ROS package

- read RPLIDAR raw scan result using RPLIDAR's SDK
- convert to ROS /scan messages
- record /scan messages to a rosbag

SparkFun 9DoF Razor IMU → razor_imu_9dof ROS package

- read IMU sensor data
- convert to ROS /imu messages
- record /imu messages to a rosbag

CDR Deliverable (3D SLAM)

ROS /scan and /imu messages → Google Cartographer node

- node processes data with Cartographer SLAM algorithm
- scan matching and IMU data to generate local submaps
- local submaps merged to global map
- 2D SLAM while gathering points in all directions for 3D map

Output

- Rviz
  - Live point cloud
  - Local and global map
- Meshlab
  - Full point cloud
  - Generated mesh

CDR Deliverable (3D SLAM)

Open Source

- Cartographer libraries
- ROS packages/nodes
- RPLIDAR A2 SDK

Our contributions

- LIDAR ROS integration
- IMU calibration and ROS integration
- LIDAR and IMU compatibility with ROS Cartographer package
- ROS configurations

Demo

What we plan to bring to FPR

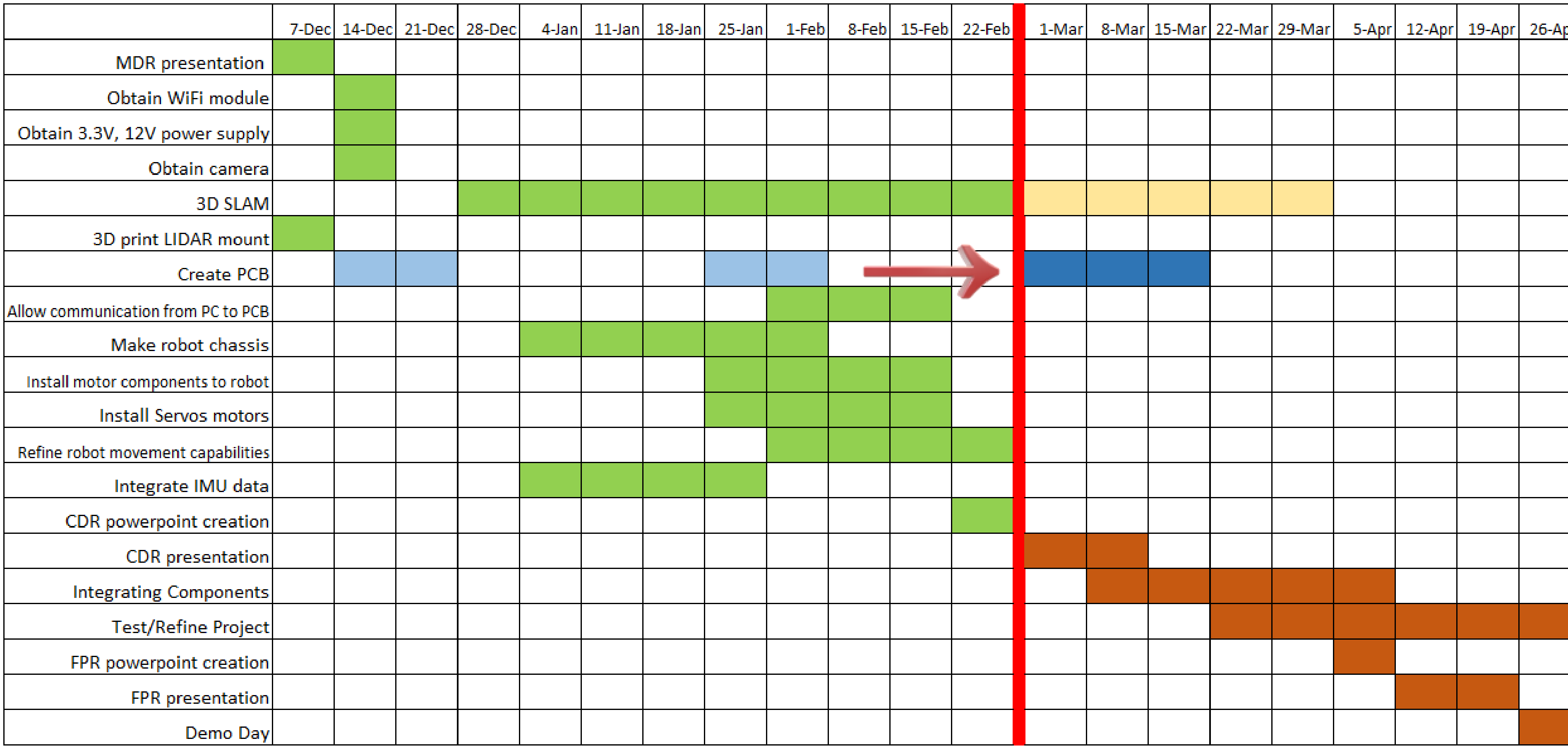
Mapper completed

- Wireless maneuverability of robot
  - User controls sent through Wi-Fi to Mapper
  - LIDAR and IMU sensor data relayed back to PC
  - Camera feed sent back to PC
- 3D SLAM
  - 2D map generated and viewable in Rviz
  - Point cloud viewable in Meshlab
  - Mesh generated from point cloud
- Component integration
  - Functional PCB integrated into Mapper
  - All hardware and circuitry fits neatly in Mapper

What we plan to bring to Demo Day

- Completed Mapper on display
- Video that shows Mapper fabricating 3D model of a room
  - Perspective of robot
  - Current map that is being created
  - Marker that shows where the robot is relative to the room

Schedule



Marcus Kelvin Derek+Bryan All

Questions?