ECE 415
Mid-Year Design Review
Team 26 - UPark
November 30th, 2020

University of Massachusetts Amherst
BE REVOLUTIONARY™

Meet the Team (Again!)

- Rehmat Kang
  - Computer Engineering
- Belma Kondi
  - Electrical Engineering
- Nikhil Sarecha
  - Computer Engineering
- Lastone Saya
  - Electrical Engineering
- Prof. Christopher Hollot
  - Faculty Advisor

University of Massachusetts Amherst

UPark - an RFID-based Smart Parking Payment System

University of Massachusetts Amherst

Problem Statement

The UMass Campus has several methods of parking payment services. These methods expect the user to either purchase a permit, carry loose change, or even install a third-party application. Overall, these different forms of payment methods make it cumbersome for the user as well as the administrator to monitor parking transactions. There exists a more convenient way with UPark.

Our Solution

We aim to solve the problem of inconsistency by introducing the use of RFID transponders, in vehicles on campus. These transponders will communicate with RFID readers at distinctive entrances and exits of parking lots across campus and charge the users accordingly. The whole parking payment process is now seamless and contactless, and managed by a centralized parking control system which allows users to track their logs.

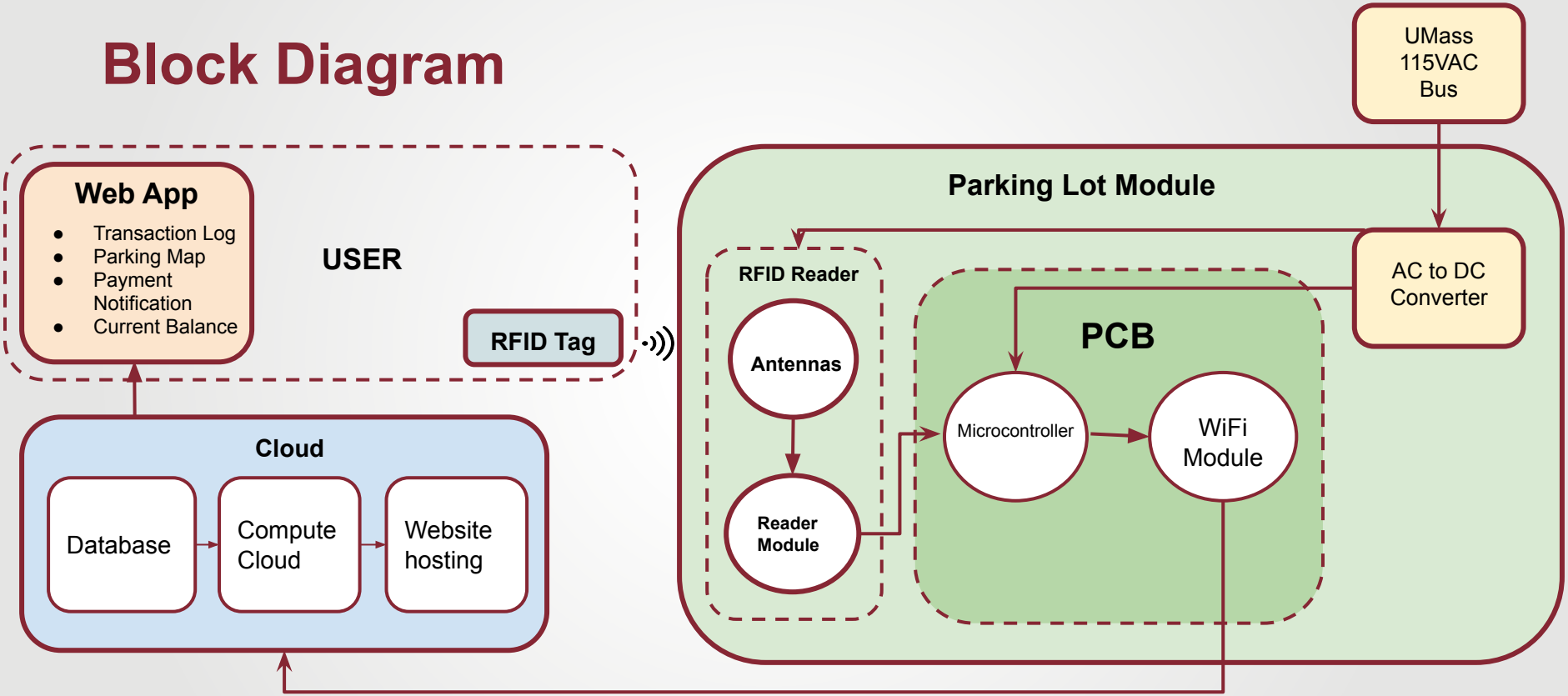
System Specifications

1. System must communicate with a centralized parking control system
2. System must automatically detect vehicles entering/exiting the parking lots with almost 100% accuracy
3. System must include a contactless payment transaction system
4. Transaction logs and vehicle activity across campus can be viewed by the administrator, UMass Parking Services, while individual user transaction logs can be viewed by the customer through a Web Application
5. System must be able to sustain extreme weather conditions between 0 ℃ and 48 ℃
6. System will draw power from the UMass 115 VAC Bus
7. As a proof-of-concept, our system will be built for parking lots with separate entry and exit points

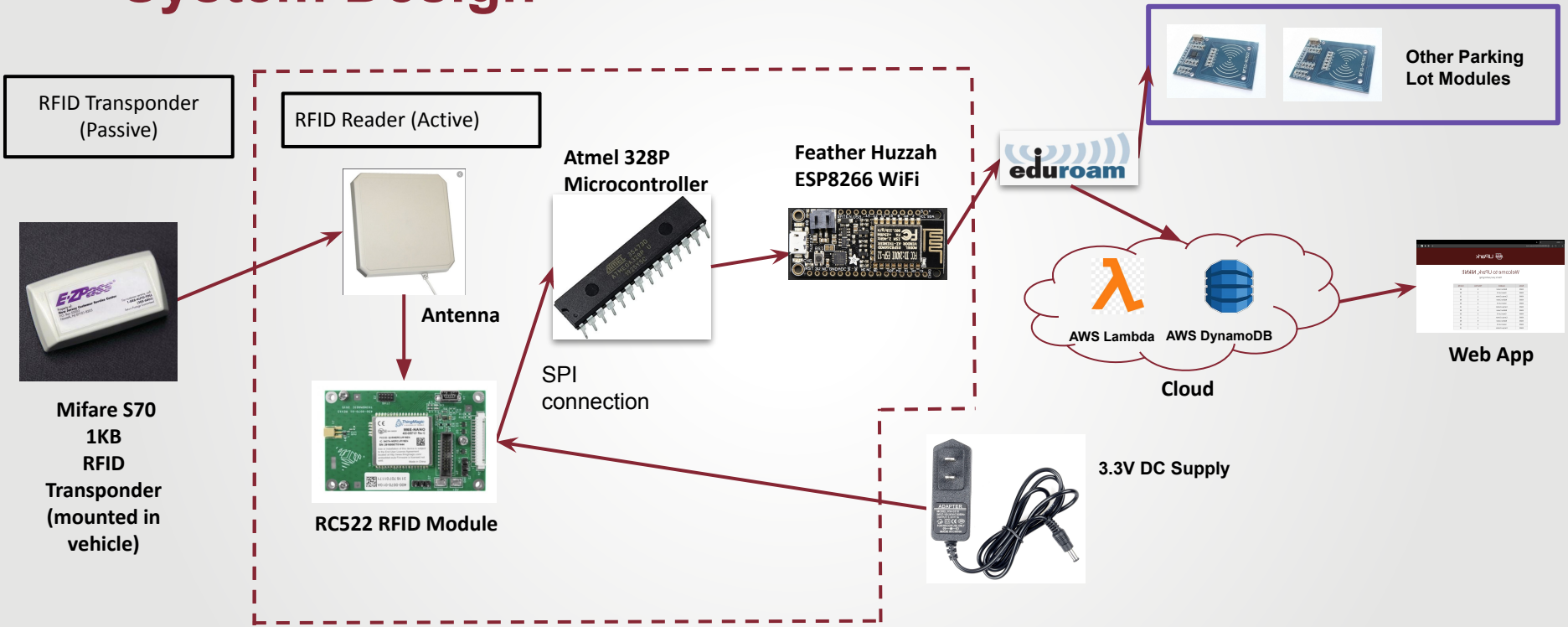
Illustration Of UPark

Represented above are the different entry and exit points of a parking lot. An RFID Reader installed at this location will detect RFID tags, embedded in the UMass Parking Stickers in vehicles entering/exiting to activate a clock timer accordingly, which will calculate the cost. Users will not have to stop at the entry point to generate a ticket or be required to pay for parking manually.

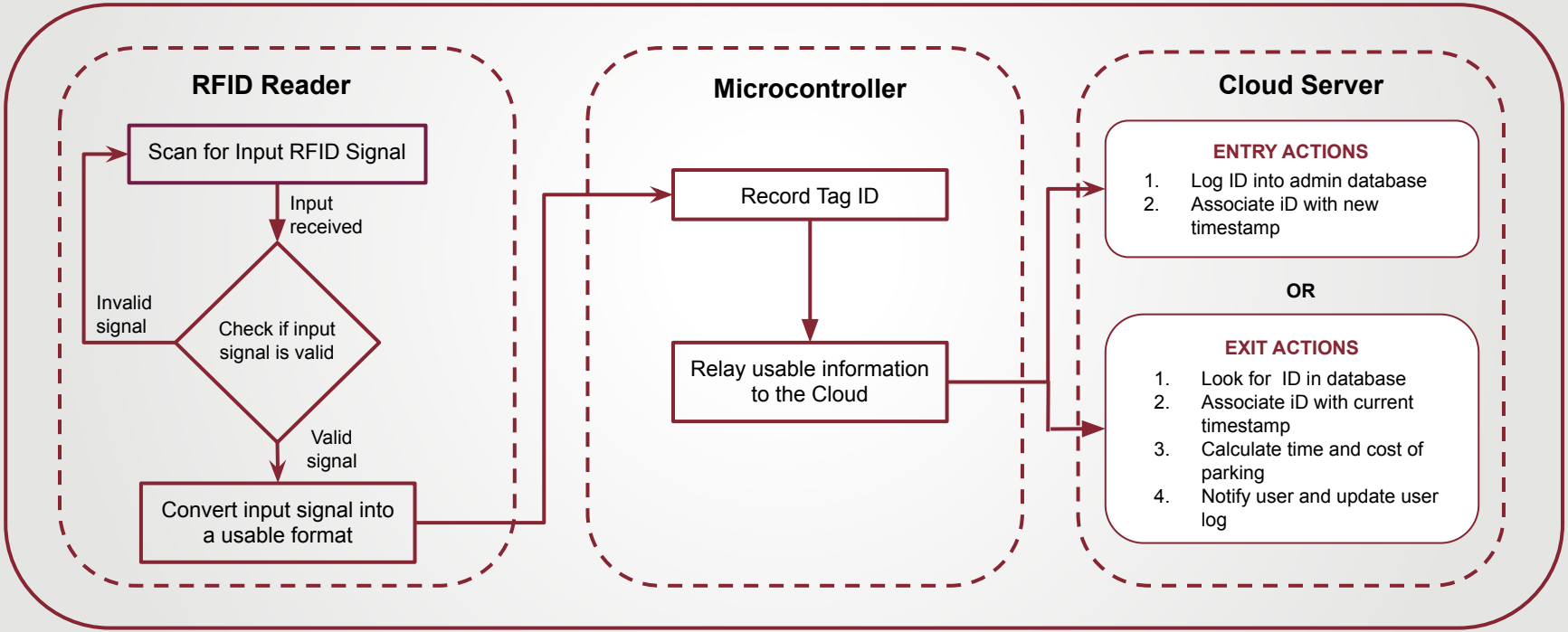
Block Diagram



System Design

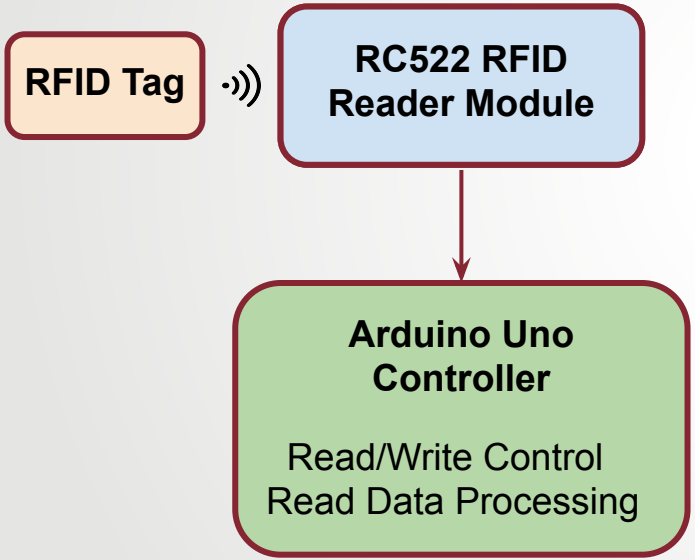


Software Diagram

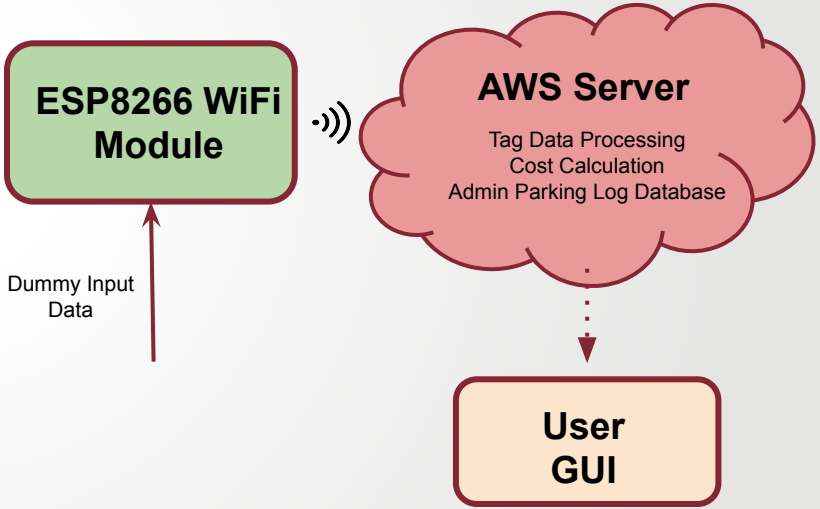


MDR Prototype

Prototype 1: Belma and Lastone



Prototype 2: Nikhil and Rehmat



MDR Accomplishments: Belma and Lastone

Goals Promised & Delivered:

- Successful communication between RFID tag, reader and microcontroller
- Microcontroller turns on an LED when an RFID tag comes in proximity to the reader
- Microcontroller records unique tag ID

MDR Components: Belma and Lastone

- Arduino Uno
- Arduino IDE
- RC522 RFID Reader
- RC522 Tags

Future Components:

- Longer range UHF RFID Reader (TBD)
- Longer range UHF RFID Tags
- AC To DC Converter
- Antenna

MDR Accomplishments: Nikhil and Rehmat

Goals Promised & Delivered:

- Successfully programmed WiFi module to communicate with AWS server
- Successfully transmitted dummy input signals generated in the microcontroller, to be stored on AWS database
- Processed incoming data to calculate user parking cost and notified user using an AWS notification service
- Built a static GUI web page displaying user's name and parking log activity

MDR Components: Nikhil and Rehmat

- **ESP8266 WiFi Module**
  - Programmed to transmit test RFID data to AWS server endpoint

- **Cloud Infrastructure - Amazon Web Services**
  - AWS IoT Core: Receives sensor information from ESP8266 WiFi module over the internet and processes it to be used for AWS Services
  - AWS DynamoDB: Database to display and manipulate all parking logs
  - AWS Lambda: Compute engine to calculate cost of parking and notify user
  - AWS SNS: Notification service to notify user of their parking logs via text messages/email in real-time

- **GUI**
  - Static webpage built with HTML, CSS and Javascript

MDR Demo:

Belma and Lastone

MDR Demo:

Nikhil and Rehmat

CDR Deliverable

- **End-to-end integration of the two subcomponents to perform the entire cycle of operations for a vehicle entering and exiting a parking lot:**
  1. Prototype will be able pick up an incoming RFID signal
  2. The incoming RFID signal will be sent over to the RFID Module, and then to the microcontroller
  3. Microcontroller will parse through the tag data and send it through the WiFi module over to the Cloud server to log into database
  4. Database will determine entry or exit based on previous data log and calculate parking time and cost accordingly
  5. The calculated cost will be reflected on admin database and user's GUI profile in real time

Primary Responsibilities for CDR

1. **End-to-end integration of the two subcomponents to perform the entire cycle of operations for a vehicle entering and exiting a parking lot**
   - (Entire team)
2. **Transition from RC522 to a longer range UHF RFID Module**
   - (Belma)
3. **Have PCB designed and tested**
   - (Lastone)
4. **Optimize cloud infrastructure for lower-latency performance**
   - (Rehmat)
5. **Build a functional GUI interacting with AWS**
   - (Nikhil)

Hardware Plans for FPR

- **Transition to a higher range UHF RFID Module. Potential options include:**
  - ThingMagic M6E Nano Carrier
  - ThingMagic Micro LTE Carrier
  - Sparkfun M6E Nano Carrier
- **Design and test PCB. Components include:**
  - Atmel ATmega 328P microcontroller
  - ESP8266 WiFi module
  - DC voltage converter (if needed)

Project Management: Responsibilities

- **Lastone Saya - Altium Lead**
  - RFID Reader and Microcontroller
- **Belma Kondi - Budget Lead**
  - RFID Reader and Microcontroller
- **Rehmat Kang**
  - Microcontroller and WiFi Module
- **Nikhil Sarecha - Team Coordinator**
  - Web Server and GUI

Project Expenditures (Current & Projected)

Current Expenditures	Cost
RC522 RFID Module	$0
RC522 RFID Tags	$0
WIFI Module	$0
Arduino Uno Microcontroller	$0

Projected Expenditures	Cost
UHF RFID Module	$200
UHF Tags	$50
Antenna	$20
Custom PCB	$10
Analog to Digital Converter	$8
Total	**$288**

Project Management: Gantt Chart until CDR

Names	Tasks	February	February	February	February	March
		Week 1	Week 2	Week 3	Week 4	Week 5
Lastone	Finalise and ourchase UHF RFID Reader					
	Design PCB with Belma					
	Enable sleep mode					
Belma	Configure UHF RFID reader with microcontroller and tag					
	Set up antennas with RFID reader					
	Help Lastone with PCB					
Rehmat	Receive tag data directly from MCU					
	Parse through incoming data to obtain Tag ID					
	Optimize latency issues on AWS					
Nikhil	Implement API gateway					
	Build a functional GUI interacting with AWS					
	Implement user functions such as login, live parking map etc.					
	Make final touch-ups and cosmetic changes to GUI					

Thank You!

Any Questions?

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Output of Arduino Uno Serial Monitor