ECE 415
Preliminary Design Review
Team 26 - UPark
September 23, 2020

University of Massachusetts Amherst
BE REVOLUTIONARY™

Meet the team:

- 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

Motivation

Figure 1: Parking lots on campus requiring yearly parking permits

Figure 2: A traditional parking meter requiring loose change

Figure 3: UMass Parking Garage requiring loose change/ParkMobile

Problem Statement

Having several different payment services makes it very cumbersome for the end-user as well as the administrator to monitor these transactions. One is expected to purchase a parking permit for starters, keep loose change of quarters to pay for meters, and maybe even have a third-party app installed through which one is required to pay every time they park.

Our Solution

We intend to solve this problem of inconsistency by introducing the use of RFID transponders, similar to the EZPass, in vehicles on campus. These transponders will communicate with RFID readers at entry/exit points of parking lots and metered spots across campus and charge the users accordingly, thereby making the whole parking payment process seamless and contactless.

System Specifications

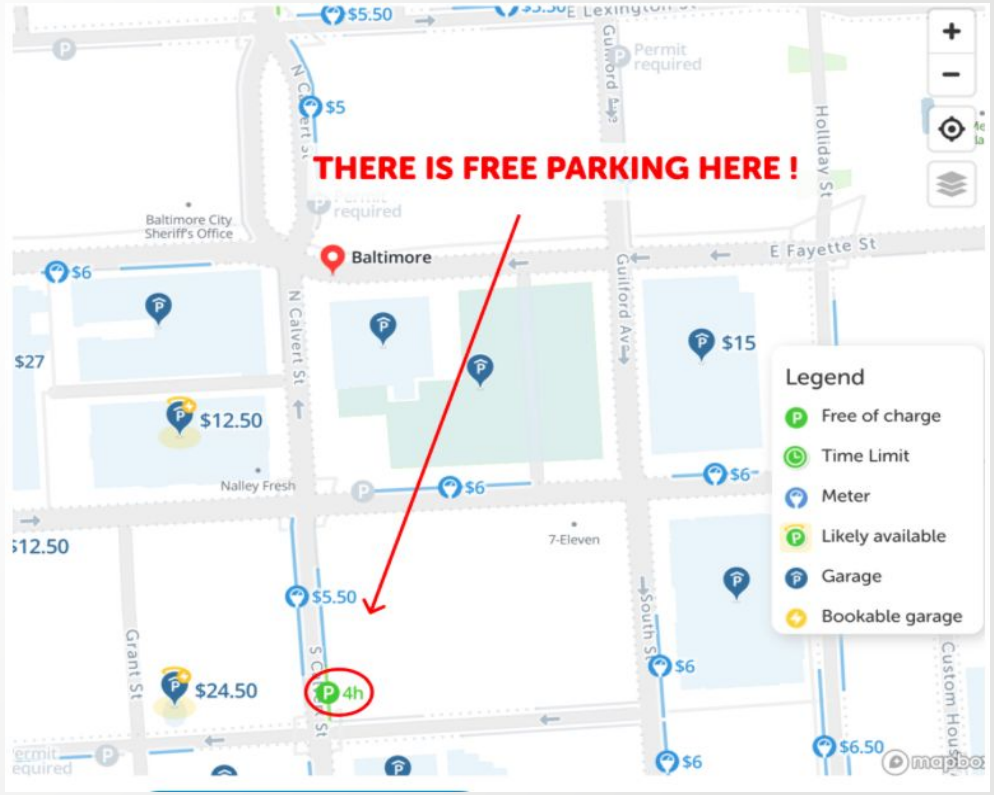
1. Must be one unified system consistent throughout the different parking spaces on campus.
2. System must automatically detect vehicles entering/exiting a parking lot with almost 100% accuracy
3. System must include a contactless payment transaction systems
4. Transaction logs and vehicle activity across 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/exit points.

Existing Products: Traditional Parking Ticket Generators

- Require you to walk up to the machine and generate a ticket every time you park
- Require you to carry loose change
- Do not resolve the issue of going contactless

Existing Products: Spotangels

- An App that allows users to locate empty parking locations
- Also allows users to make payments through the App
- Is currently only available in certain big cities around the US, and hence is impractical for use in Amherst



Existing Products: SpotHero

- Another App that allows users to locate empty parking locations
- Also allows users to reserve parking spots and make prepayments through the App
- Just like Spotangels, Spothero too is currently only available in certain big cities around the US, and hence is impractical for use in Amherst

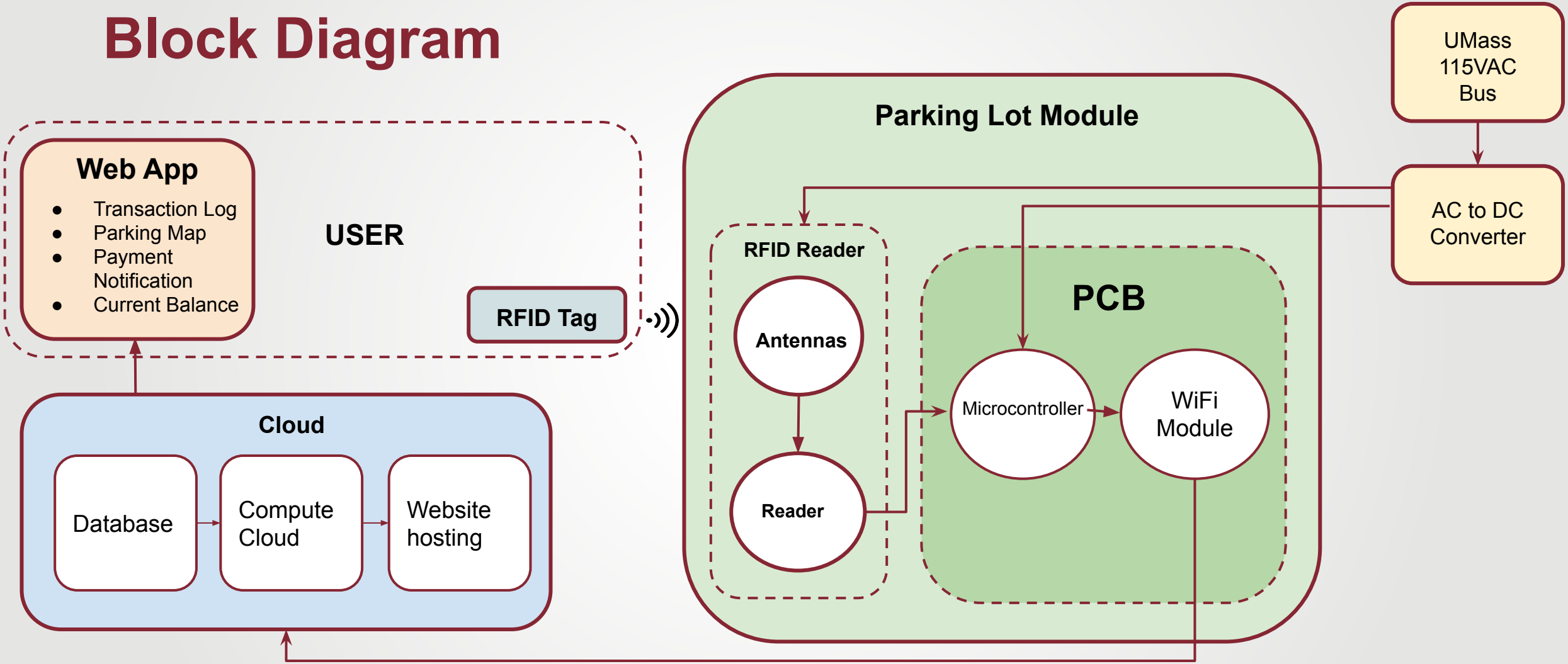
Existing Products: ParkMobile

- A leading app that helps users locate empty parking spots in garages as well as metered spots
- Works in 350+ cities
- Still requires you to make a payment every time you park
- Although available in Amherst, it covers a very small portion of the campus, hence is still very impractical

Illustration

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



Preliminary Design

RFID Transponder (Passive)

UHF RFID Transponder (mounted in vehicle)

RFID Reader (Active)

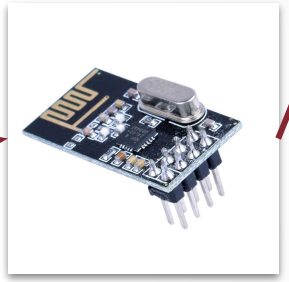
Laird S902PL Antenna

ThingMagic Nano Carrier UHF RFID Module

UART connection

Atmel 328P Microcontroller

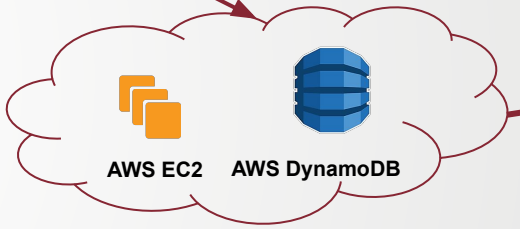
2.4 GHz WiFi Module



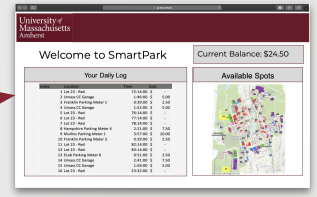
3.3V DC Supply

eduroam

Other Parking Lot Modules

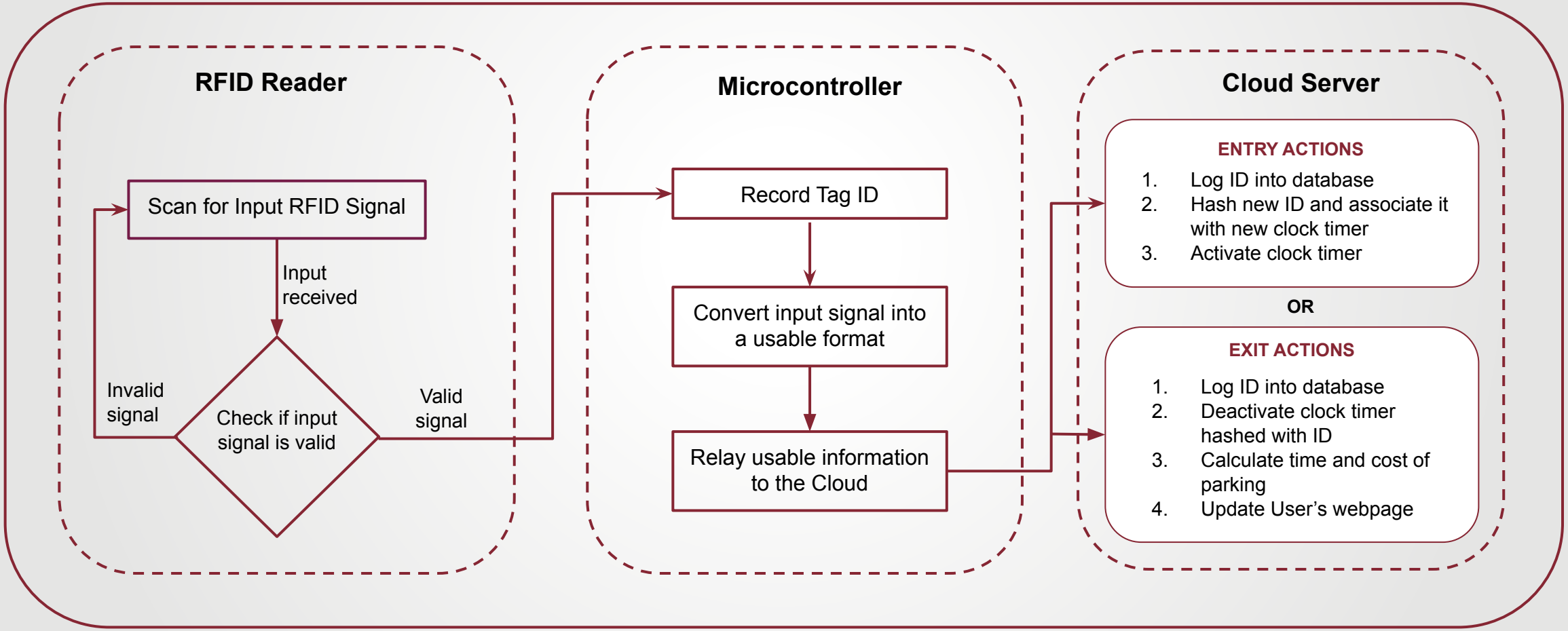


Cloud



Web App

Software Diagram



Primary 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

MDR Deliverables (1)

Subsystem: **RFID Reader and Microcontroller**

Participants: **Belma and Lastone**

Equipment:

- RFID Reader, Antennas and Tags
- Microcontroller

Belma and Lastone will demonstrate successful communication between RFID tag and microcontroller. When an RFID tag is in proximity to the reader, the microcontroller will turn on an LED. It will then record the unique ID of the tag, as well as record the time the tag was detected.

MDR Deliverables (2)

Subsystem: **Server Software and GUI**

Participants: **Rehmat and Nikhil**

Equipment:

- Microcontroller
- 2.4GHz WiFi Module
- Cloud Platform

Rehmat and Nikhil will present a working microcontroller and server software that will be able to transmit tag data stored on microcontroller to the Cloud server via Eduroam. This tag data will be logged on our cloud platform's database management application. Logged information will be used for backend processing such as calculating time spent in the parking lot and cost of parking, and will be presented on the GUI on the user's end.

Gantt Chart

Names	Tasks	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
		9/27/20 - 10/3/20	10/4/20 - 10/10/20	10/11/20 - 10/17/20	10/18/20 - 10/18/24	10/25/20 - 10/31/20	11/1/20 - 11/7/20	11/8/20 - 11/14/20
Lastone	Research/place order for compatiable antennas for RFID module							
	Configure the RFID module with antenna and tag							
	Set up power supply							
	Connect configured RFID module with microcontroller							
Belma	Select RFID tag compatiable with RFID module and antenna							
	Ensure the RFID can detect the tag when its in proximity							
	Connect configured RFID module with microcontroller							
Rehmat	Set up Web Server							
	Interface Microcontroller with WiFi Module							
	Build raw GUI							
	Ensure packets get delivered from tag to Wireless sever							
Nikhil	Set up Web Server							
	Set up a database management application on the web server							
	Build raw GUI							
	Generate test input file to trigger time and cost calculation							
	Display triggered action on GUI							

Budget

Component	Estimated Cost
RFID Module [ThingMagic Nano Carrier Board]	$290
Custom PCB	$10
Design Fabrication Components	$20
Antenna	$120
WiFi Module	$7
Microcontroller	$30
RFID Tags	$20
Analog to Digital Converter	$8
Total	**$505**

Stretch Goals

- Use data collected from several RFID readers across campus to locate empty parking spots and present to users on the GUI in real-time.
- Implement a function to check whether or not a vehicle using a parking lot is allocated to that lot, and if not, inform UMPD/UMass Parking Services accordingly.
- Use a single RFID reader with directional antennas to detect both entering and exiting vehicles.

Questions?

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