Parkour:

A Parking Sharing System

Design Document

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Executive Summary

Development Standards & Practices Used

- Agile project development

Summary of Requirements

- Our application will require a dedicated frontend and backend that supports both iOS and Android applications.
- A platform will be needed that can host our server 24/7 once the application is up and running.
- The application will need to be published on the Google Play and Apple App Store so that anyone can use our app.

Applicable Courses from Iowa State University Curriculum

- COMS 227 + 228 (Object-Oriented Programming and Data Structures)
    - Knowledge of object-oriented programming and data structures are essential and will be utilized.
- COMS 252 (Linux Operating Systems)
    - Useful for setting up the VMs and hypervisor on our server.
- COMS 309 (Software Development)
    - Knowing how to research unfamiliar technologies would be very applicable to this project.
    - Utilizing Agile development practices.
- COMS 311 (Algorithms)
    - Knowledge of algorithms would be beneficial for our application's performance.
- SE 319 (Construction of User Interfaces)
    - Teaches the basics of how to design an attractive and usable user interface through a variety of languages and tools.
- COMS 362 (Object-Oriented Analysis and Design)
    - Some project management techniques would be useful such as CRC cards and knowledge of UML. This would be helpful for planning.
- COMS 363 (Introduction to Database Management Systems)
    - Gained experience with SQL and other databases. It will be useful as we develop our database and backend system.

New Skills/Knowledge acquired that was not taught in courses

- How to build an application using React Native
- Exposure to web development for mobile applications
- How to create a backend server with API endpoints using Node.js
- Utilizing VMWare Fusion to create virtual machines to host our server
- Connect and use MongoDB as a database

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1 Introduction

1.1 Acknowledgment

Outside of our own team members, Dr. Ahmed Kamal, the client who proposed this project, has been and will continue to be, a significant contributor to the overall lifecycle of the project.

1.2 Problem and Project Statement

The problem that our project hopes to solve is finding parking. In large events, such as football games or the Iowa State Fair, designated parking can be limited, expensive, and overall a hassle.

The Parking Sharing System aims to provide an alternative for finding parking at busy events or locations. This application will enable two kinds of users: to either find parking spaces, or host parking spaces. The host will be able to post a parking spot to the application. They will provide an address, size of space, time frame the space is available, and a price for that time. The guest will be able to search through the existing posts to find a spot close to the event they want to go through. All transactions will be processed through the application. Similar to ridesharing apps such as Uber and Lyft, this application is crowdsourced and will heavily rely on individuals willing to use the application to host parking spots, as well as individuals willing to use the application to find and reserve the listed parking spots. We plan to create an application that makes event parking easier, cheaper, and an overall better client experience. Because of the parking sharing idea, this application will be environmentally friendly, saving on fuel consumption.

1.3 Operational Environment

The backend server application will live on a publicly hosted server, so the frontend application can connect. The frontend application will be available through the Apple Store, and the GooglePlay Store, so it will reside on both Android and iOS devices.

Physically, the application will function at its best in large cities or local events such as concerts, football games, etc. It is not limited to specific events and large cities, but it is available wherever users can host and need to find additional parking. The application will need a large user base to make it viable. Urban and suburban areas are suitable areas because there are ample people to use the application, list their properties, and to reserve the listed spots.

1.4 Requirements

The application will depend on two types of users:

- Individuals or groups who are willing to host parking spaces
- Individuals looking for parking spaces

1.4.1 Functional Requirements

- Host User:
    - Have access to a list of reservations that contain the following information:
        - Guest Information
        - Reservation Time slot(s)
        - Vehicle license plate numbers and models
    - Securely receive payment from the guests
    - Provide a listing of their property with location and descriptions
    - Manage reservations, such as having the ability to cancel or extend reservations
- Guest User:
    - Create an account that allows them to reserve parking spots
    - Securely send a payment to the host
    - Negotiate parking prices
    - Be able to navigate easily to the host's location
- Both Users:
    - Download the application from the respective mobile device app store
    - Log into their account on the application
    - Access a list of available parking spots
    - View the available listings on a map with their respective locations

1.4.2 Nonfunctional Requirements

- Intuitive and simple user interface
- Allow users to update their public profile page easily
- Users should be able to upload images of the property
- Web browser application port
- Optional/Advanced settings
- Each payment should be documented with a corresponding log and receipt

1.5 Intended Users and Uses

The intended users include, but are not limited to individuals who are:

- Guests seeking parking spaces
- Hosts willing to rent out parking spaces on their property
- Administrators who will authenticate hosts and moderate posted parking spots

The intended use for the application is to provide additional parking spots during events such as visiting a city, going to work, attending a concert, or cheering at a football game. The guest wanting to attend the said event could easily pull up the app and find a nearby host so they could park nearby. The host would be able to make money by hosting their property at said event.

1.6 Assumptions and Limitations

1.6.1 Assumptions

- User (both hosts and guests) has the application downloaded on either an iOS or Android device
- Users might want to access the application on the web
- Strong network/internet connection
    - Users will have a working network and/or internet connection so they may properly use the features of the application.
- Strong user-base of drivers and hosts
    - There will be a plethora of drivers and hosts in areas of high traffic so that a user may get the most out of the application. This app will be most useful in areas with many people and where parking is an issue, like sporting events, concerts, etc. Individuals in more rural areas with less traffic are assumed to not have as many parking difficulties as those in cities and other highly populated areas.
- Drivers have a sustainable payment system set up with the app to pay hosts for parking on their property
- The host is legally entitled to use, lease or sublease the parking spot(s)
- Both drivers and hosts have read and agreed to the various terms and conditions of the application and all they entail

1.6.2 Limitations

- Regional support
    - The more popular parking apps tend to serve only a specific state or region of the US whereas a majority of the parking apps akin to what we are trying to build tend to try and support all users from any location. More often than not, a user will download a residential parking app only to find out that it features little to no

support in their area because they may not live in a busy and well-populated city like Los Angeles, New York City, or Boston.

- Available users in any given area
    - Some areas may have more hosts than guests and vice versa. This ratio is expected to vary, and there is not much that can be done about it. However, regardless of the ratio, our app will still require hosts and guests. After all, it is assumed that there will be a fair amount of hosts and guests available in most areas.
- User compliance
    - In a perfect world, the individuals who will use our app will do so after reading and agreeing to the terms and conditions. However, most users don't read a software product's terms and conditions, they simply accept without fully understanding what is being asked of them from the software. For example, drivers are supposed to arrive and leave at a predetermined time agreed upon by both parties. In the worst-case scenario, they leave their car for several days and the host has to call a towing service to remove the car. On the other side, the host may interact with the driver's car in an undesired fashion when the driver is away.

1.7 Expected End Product and Deliverables

The expected end product is a mobile application that is available on both Android and iOS, with the possibility of a web application. The application should have the following deliverables:

1.7.1 Frontend Deliverables

- Users will be able to sign up, log in, and interact with the application
- Hosts will be able to create and view their listing, along with information about users that are reserving their spaces and receive payments through the app
- Guests will be able to view parking spot listings, reserve a parking spot, and send payments to the host

1.7.2 Backend Deliverables

- A database that contains:
    - User credentials
    - Transaction history between users
    - Parking history
    - Locations of available parking spaces with associated fees

2 Specifications and Analysis

2.1 Proposed Approach

As stated in the problem statement, when attending events, it can be very difficult to find parking and at a reasonable rate. Thus, Parkour aims to provide a parking alternative where drivers can pay to park their ride within the residential borders of a host's living space, such as a driveway or front yard. The app will be released as both an iOS and Android application and will feature an intuitive, easy-to-use, simple UI so the users can worry more about a parking spot than a cluttered home page.

After meeting with the client, the team received the research paper on which the application is based. The only stipulation was that this project would be 100% software. A full list of requirements is available in section 1.4. Additionally, see section 3.2 for more details on the proposed technologies that will be utilized.

2.2 Design Analysis

2.2.1 Frontend

- **React Native**: The team has chosen to develop the frontend using React Native, an open-source mobile application framework. It is used to develop mobile applications for Web, Android, iOS, and Microsoft's Windows. It provides developers to access native platform capabilities using React, a JavaScript library created and maintained by Facebook.

2.2.2 Backend

- **Node w/ Express**: The team has chosen to develop the backend using Node.js because it is a very popular backend language to run on servers. There are plenty of resources for team members who are unfamiliar with Node and the Express library, a widely-used web application framework for Node.
- **Database**: The team has chosen to use MongoDB as the database because it is a popular choice among Node and Express.js developers and there exists many resources and community support. Since it is also a cross-platform document-oriented database program, it doesn't rely at all on the manipulation of relational data such as MySQL, which oftentimes presents a steep learning curve for developers.

2.2.3 Other technologies

- **VMWare Fusion**: This is the hypervisor that's used for creating virtual machines on the backend server. (See 3.2 for more details)

2.3 Development Process

Our group has chosen to follow the agile methodology as per the agile manifesto established in 2001 (https://agilemanifesto.org/iso/en/principles.html). Routine meetings and frequent testing will be implemented for the application. This also includes frequent collaboration with our client to ensure that his needs as a client are being met and the timeline that he has set forth is being followed.

With the help of the agile methodology, we will cycle through a process of planning, executing, and evaluating that includes continuous team and client collaboration to ensure that the final version of every deliverable is as satisfactory as possible. As a team, we will most likely rely on the agile process framework of Scrum which features frequent daily stand-ups and bi-weekly sprints. Since the development of this application will not be done in the environment of a standard paying 8-hour/day software company, stand-ups will be held a minimum of once per week so everyone can get caught up and on the same page as everyone else. Sprints will be roughly around one week to two weeks depending on the difficulty and size of the task at hand so that there is ample opportunity to discuss our recent advancements with the client for any immediate feedback.

2.4 Conceptual Sketch

Below are conceptual sketches for several different screens inside of the application. Since these are conceptual these screens could change by the end of the project.

Figure 1. In app map screen

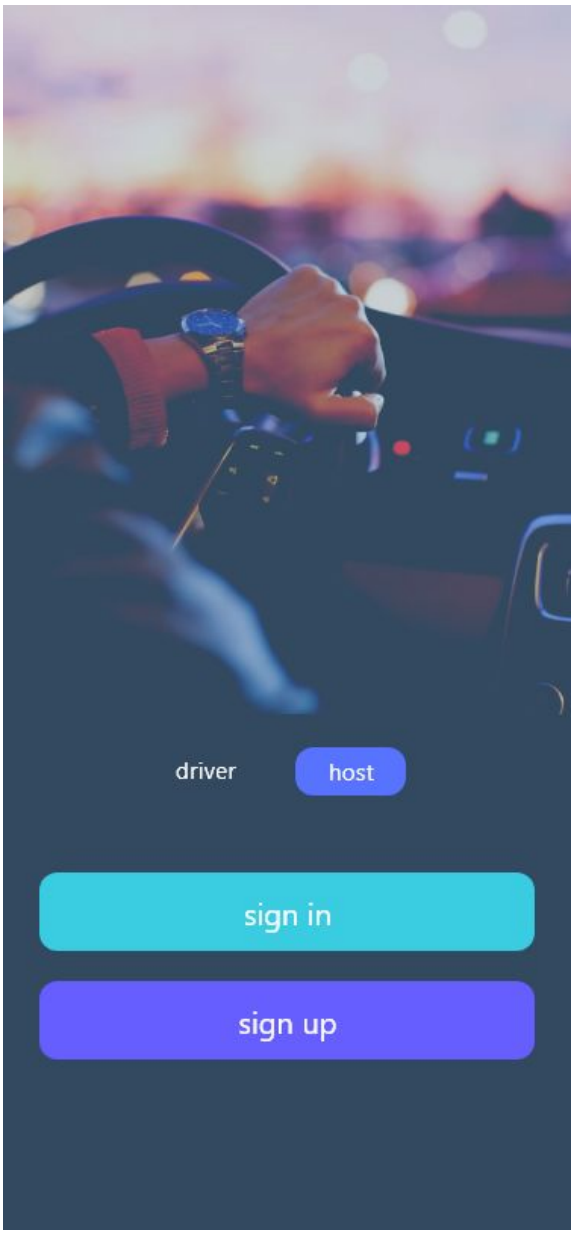


Figure 2. In app splash screen

On the left is another proposed idea for the view of the map. The sketch on the right is a toggle between driver and host along with the ability to sign in or sign up as the highlighted individual.

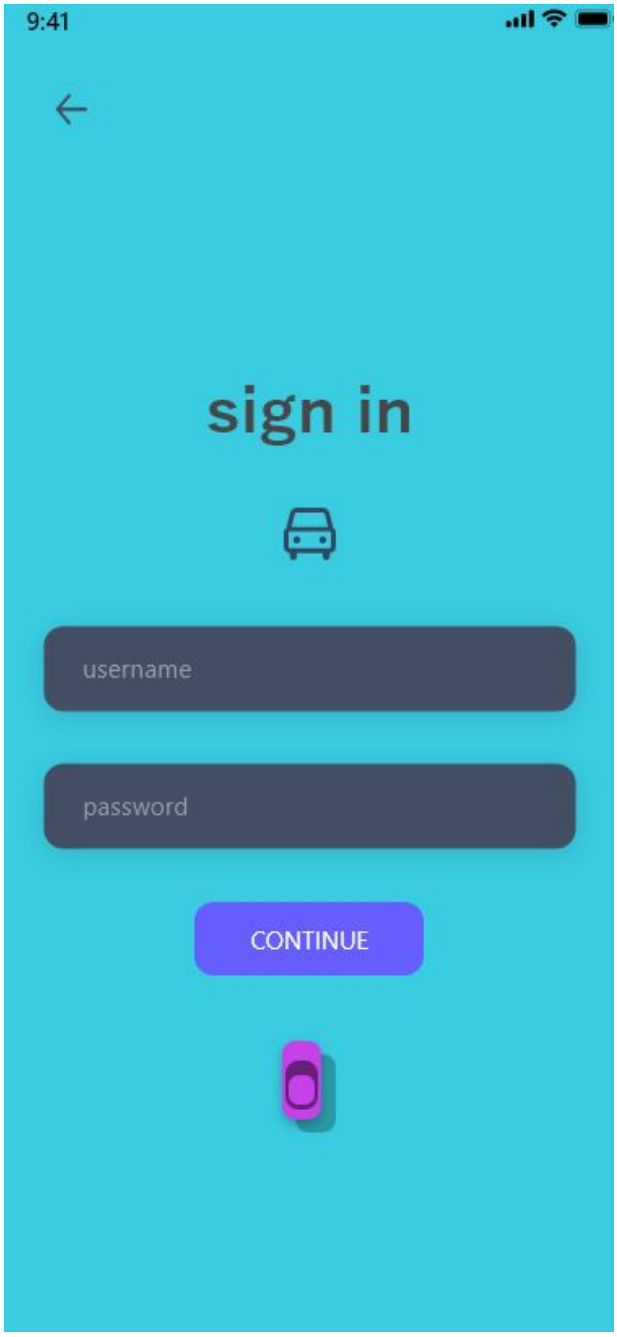


Figure 3. In app sign in page

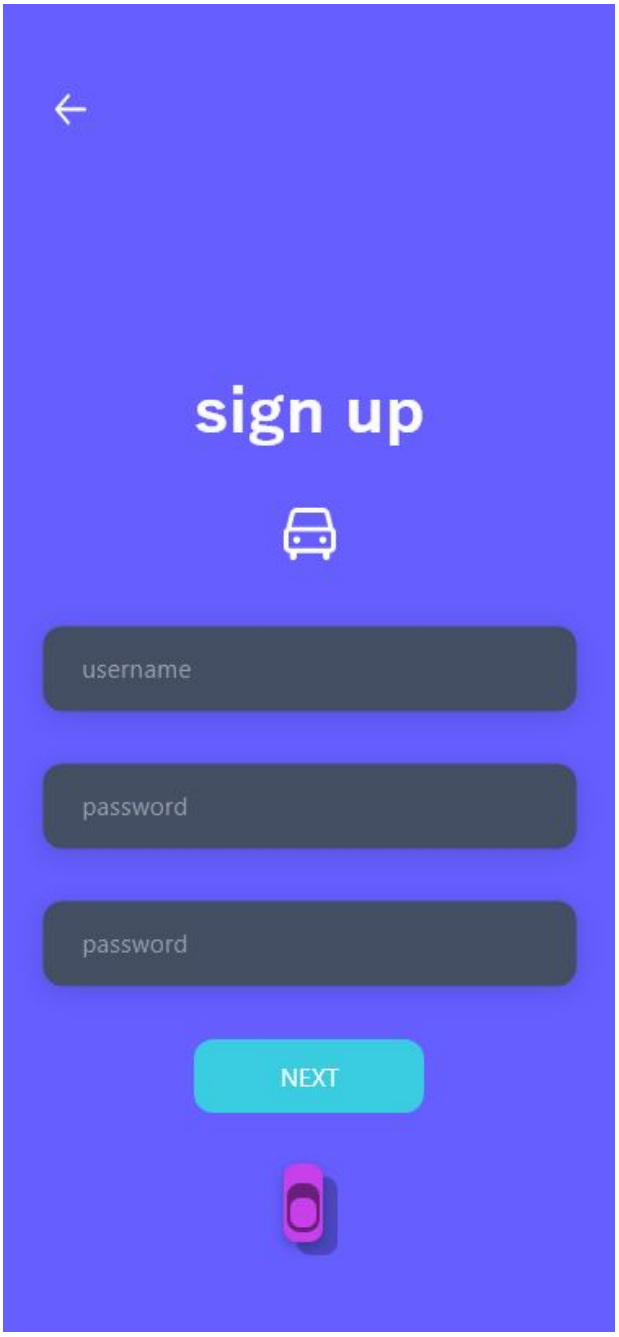


Figure 4. In app sign up page

These two sketches are the basic sign in and sign up pages.

3 Statement of Work

3.1 Previous Work and Literature

One similar iOS application in comparison to this project is Prked. This app was very similar to our idea, but it was very barebones in terms of functionality. It was posted at the very beginning of the spring semester. The application, despite frequent updates, continues to be very buggy and is unusable at this point in time.

We are basing our project on the paper “Collaborative-Aware Intelligent Parking System for Green and Smart Cities based IoT” that is written by our advisor. It has not been published yet but describes the parking system as it relates to game theory and optimization.

3.2 Technology Considerations

Since the project will be made up of two separate mobile applications (iOS and Android), our team wanted to find a technology solution that would enable us to create one application that could be exported to be used on Android and iOS. Therefore, we will be using React Native to develop the frontend. Ionic was also considered but React was ultimately chosen because of the better performance, its popularity in corporate environments, and community-supported codebase which features plenty of development resources and third-party libraries/frameworks.

The front end application will be connected to a single backend hosted on a web server. The team has not committed to one language, but plans on using some variant of Typescript that is good for a large number of concurrent users. The backend will also be connected to a database to securely store information needed for our application. Like the backend technology, the team has not committed to a single database language, although technologies like MySQL, MongoDB, Postgresql are all being considered.

VMWare Fusion will be used as the hypervisor for creating and managing our virtual machines. These virtual machines will be configured to automatically host our servers on startup. Once these VMs are configured, we will export them, deploy them on a hypervisor and ensure they are communicating with our application correctly. We will modify and maintain these VMs throughout the course of our project.

3.3 Task Decomposition

Our project is divided into a mobile (frontend) application, paired with a backend server that we will make requests to get user information and other stored data that might need to be stored in

a database. Since we will have two separate projects going, the team will split up and simultaneously develop the front and backend.

3.3.1 Frontend Tasks

- Initialize the skeleton React-Native Project
- Sign up page
    - Establish a connection to the backend server
    - Make post request to the server to create user
    - Receive a response from the server
    - Create the user interface
- Login page
    - Make a post request to the backend server
    - Receive a response from the server
    - Create the user interface
- Home Page
    - Create the user interface for the screen the users first see after logging in
- Navigation Bar/Menu
    - Create the component that allows users to navigate the application quickly
    - Create placeholder links for all of the future pages that will be added to the application
- Profile Page
    - Make a get request to the server to retrieve the user’s information
    - Receive a response from the server with the user info
    - Create the user interface for the profile page
    - Fill out the user page with the information
    - Add an edit profile link in the profile page
    - Add a profile picture and the user's name on the top of the navigation bar/menu?
- Payment Page
    - Connect the application to the chosen payment APIs
    - Create the user interface
    - Send post to the server to log the payment occurred
- Post Parking Space
    - Send post request to the server to store the new parking space
    - Receive a response from the server
    - Create the user interface to post a parking space
- List Available Parking Spaces
    - Send a get request to the server
    - Receive a response from the server
    - Create the user interface for the page
    - Display the spaces retrieved from the database
- Reserve Parking Space

    - Make a post request to the server to modify the number of spaces on the backend
    - Receive a response from the server
    - Add a payment element to pay immediately
    - Create a user interface to reserve a parking space
- Show the Parking Spaces on a Map
    - Make a get request to the server to get available spots in the loaded area
    - Use a map API (Google/Apple/Maps) to show the map
    - Plot the locations on the map
    - Provide directions to the selected parking location
- Create optional settings

3.3.2 Backend Tasks

- Initialize a skeleton Node.js project
- Setup a database to be used with the project
- Connect the backend server to the database
- Create a user model to be used in the database
    - Include the obvious items such as username, email, and password
    - Also include profile information
- Create a User Signup API endpoint in the backend
    - Create the needed GET, POST, PUT, DELETE requests
    - Encrypt user information
- Create a User Sign in API endpoint in the backed
    - Create the needed GET, POST, PUT, DELETE requests
    - Decrypt and verify user login
    - Send back if the user successfully logged in
- Create a Receipt API
    - Create a model to store Receipt objects
    - Create the needed GET, POST, PUT, DELETE requests
    - Store the receipts in the database, link the receipts to users through their ids
- Create a model for the spot locations
    - Include address, and maybe coordinates
- Create a model for a listing
    - Include user that posted the listing
    - Include pricing and stipulation information
    - Include the location object
- Create the Parking API
    - Create the needed GET, POST, PUT, DELETE requests
- Create additional query options

3.3.3 Administrative/Misc Tasks

- 491
    - Publish Design Document Version 1
    - Publish Design Document Version 2
    - Publish Design Document Version 3
- 492
    - Prepare project poster
    - Present the project

3.4 Possible Risks and Risk Management

There are many risks associated with this application. An early risk was how to securely handle payment information. We mitigated by deciding to use a third party API to set up payment through a well-established company. Users will be given the option of using Google Pay, Apple Pay, PayPal, Venmo, or Amazon Pay. This helps our consumers to use a familiar payment method and it helps our team by not having to worry about huge security risks.

The second big risk is the liability that is associated with having vehicles. There will have to be very strict language in our terms and agreements for users of the application to absolve us from any fault if there is an accident or theft of service. Currently, instructions for owners are being devised if, for whatever reason, a vehicle is left at their parking spot longer than the agreed-upon time.

The next risk that our team has thought through is how to verify users. This would be to keep all users accountable and safe while using our product. The plan is to ask for personal information such as a driver's license number for the owners. We will also ask for the license plate number and other identifying information about the car from the renters, so an owner can verify that the correct vehicle is parked in the agreed-upon spot.

The last and most recent risk associated with this project is COVID-19. There is a lot of uncertainty about how we will be able to communicate with the team as well as work on documentation, development, and testing online. Currently, we all have access to the internet for communication, but we will need to continue to work together to overcome any and all issues that crop up during this project.

3.5 Project Proposed Milestones and Evaluation Criteria

Proposed Milestone	Evaluation Criteria
Meet with the team and client.	Team meets together and with the client

Gather requirements.	Team meets with the client to get an idea of their vision for the application, and the team meets with one another to discuss proposed requirements
Research possible technologies to develop the application and come to a decision on them.	Team researches backend and frontend technologies to use to develop the application, and the technologies are chosen.
Finish the first iteration of the Design Document.	The team successfully turns in the Design Doc v1 with all of the needed sections filled in before the due date.
Generate a list of tasks based off of the requirements gathered previously.	The team has a list of tasks to follow during development that are uploaded to the git project tracking tool
Finish the second iteration of the Design Document.	The team successfully turns in the Design Doc v2 with all of the needed sections filled in before the due date.

3.6 Project Tracking Procedures

Our team will work in an agile environment to track our procedures. We meet weekly to discuss what goals have been met and how the team is keeping up with the timetable that we have built to finish all tasks in time. We divide work up into manageable weekly sprints to ensure high morale and effective communication. Our team will be using GitLab tracking to manage our progress throughout this project. We will be working with GitLab over other project tracking systems because all team members are already familiar with how to use it.

3.7 Expected Results and Validation

Our application must be able to:

- Successfully allow a guest to download the app to their mobile phone.
- Allow said guests to either host or find nearby parking spaces via the app.
- Provide a reservation to the host saying the guest wishes to park at their location
- Allow the host to verify the guest and their identity and set certain guidelines for said guest.
- Securely exchange and validate payment between host and guest
- (More to be added possibly)

4 Project Timeline, Estimated Resources, and Challenges

4.1 Project Timeline

First, our team will do research on what technologies and options that are available to us. We had the choice of either doing an API or building a new app from the ground up.

First Stage (January 2020 - March 2020)

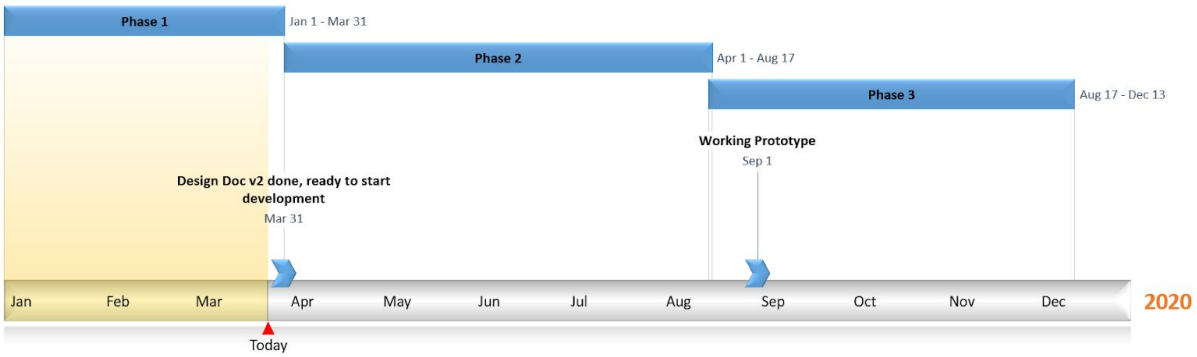
- Familiarize team members with one another
- Work on Design Document
- Gather requirements
- Research technologies for frontend/backend

Second Stage (April 2020 - May 2020)

- Work on implementing application
- Create APIs on backend for app to interface to
- Create iOS and Android applications
- Connect MongoDB DBMS with backend server
- Establish a working connection between server and apps
- Implement all important features for applications

Third Stage (August 2020 - End of Project)

- Fix bugs and refactor code design
- Create a working prototype
- Recruit users for testing purposes
- Test application for football games in the fall
- Implement security features for server and applications
- Implement other miscellaneous features in applications
- Continue to improve reliability and efficiency of applications



4.2 Feasibility Assessment

By December 2020, this project should be a full stack mobile application anyone can download and use off of the Apple or GooglePlay store. The applications frontend should be refined, easy to use, and professional. The backend should process API calls quickly, and securely.

Realistically the team believes that all of the functional goals are attainable by the above date. The team expects there could be issues with verifying homeowner's identities and proving they own the property they are listing, but large scale applications like Airbnb do not do this type of check so the team will find a solution as more important function requirements are finished.

4.3 Personnel Effort Requirements

Task	Description	Time (hours)
Research frontend and backend technologies	The frontend technology would need to allow for a fast, high performing UI for a mobile application. Our backend will need to store user and application data.	20+

Research payment options	Payment processing and handling options for users and	10
Come up with solutions on handling user interactions	Handling interactions that might pose as a liability, such as parking for longer durations than allocated.	10
Learn respective frontend/backend's syntax, framework or language.	This will depend on individual experience with the chosen languages/frameworks we are working with. Most of us may not be familiar with these languages, so we need to familiarize ourselves with it first.	15
Construct frontend UI	Develop an easy to use UI for the mobile app.	70
Construct backend server	Develop a backend server that would communicate with the frontend and store user/app data.	50
Frontend + Backend testing	Ensure that frontend and backend are both communicating properly	15
Frontend and backend debugging	Check for bugs within the application.	40
Creating Virtual Machines and configuring them with our backend.	Setting up a virtual machine to host our server. Configuring and ensuring the backend server works within the VM with our frontend.	30
Deploying the VMs to a hypervisor	The virtual machines will need to be deployed to a hypervisor.	5
Configuring the server(s) to work with the virtual machines	Once we finish finding the servers and setting up the virtual machines.	10+
Beta testing	Testing of the application in our local environment,	30

	ensuring the behavior works.	
Deploying application to the Google Play/App Store	Publishing the app could take time, depending on how each store processes their apps.	7-14 days
Live testing	Once all the servers and applications are deployed, we can test it with a live group of users if possible.	20

4.4 Other Resource Requirements

No additional resources.

4.5 Financial Requirements

A few financial requirements include:

- Server costs
- Cost of publishing our app to the Google Play and App Store
- Verification API costs

From an economic standpoint, the project will have to include the functionality to carry out monetary transactions for the users of the two mobile applications. To facilitate these transactions, all of which cost developers a tiny fee per, integrations with popular payment options like PayPal will be needed. Also, the integration of software like Google Maps will eventually cost us a small fee to use because more often than not, companies charge based on the number of calls to their APIs. Second, the cost of publishing our app to the Google Play Store for Android devices includes a one-time fee of $25. On the other hand, Apple charges a yearly fee of $299 for a group of developers to publish their app to their App Store. Lastly, we will be using servers for hosting purposes. For now, we are only concerned with hosting our product in Iowa, so our server costs will be next to nothing. However, if we ever choose to expand our scope to accompany other regions of the country and/or the world, we will be subjected to much higher server costs.

(Everything past here is tentative, per Canvas)

5 Testing and Implementation

5.1 Interface Specifications

5.2 Hardware and software

5.3 Functional Testing

5.4 Non-Functional Testing

5.5 Process

5.6 Results

6 Closing Material

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