

Parking Garage Automation

Fit-A-Lot

Rutgers University - New Brunswick: School of Engineering
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URLs:

<https://sites.google.com/site/parkinggaragesp13/home>

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Submission:

23 February 2013 via Sheldon Wong's Sakai Dropbox

Distribution of Work

- Justin Cruz
 - Assigned sections for people to work on
 - References: 2, Wills Eye Hospital Parking
 - Wrote Stakeholders
 - Wrote Valet Assistant Interface (in User Interface Specification)
 - Created Use Case Options and wrote casual descriptions
 - Wrote Full Description Use Case 2-9
 - Valet Assistant Interface User Effort Estimation
 - Wrote concept definitions and started associations definitions
- Parth Patel
 - References: 1.Driver's License Reader,3.Non-Functional Requirements
 - Non-functional requirements
 - Created System Sequence Diagrams
 - Wrote system operation contracts
 - Wrote Attribute Definitions :Valet Assistant Interface,Website,License Reader,Drivers License Reader and edited Database
- Matthew Brazza
 - Functional Requirements
 - Wrote Website Interface for Customer (in User Interface Specification)
 - Traceability Matrix
 - Domain Analysis formatting and Type for Concept Definition
 - Pieced all 3 parts together and formatted the final Report 1
- Sean Wang
 - Formatting, table of contents
 - Problem Statement
 - Created Use case diagram
 - Wrote actors and goals
 - Created traceability matrix
 - Wrote mathematical models sections
 - Gantt chart for plan of work
- Richard Bak
 - On-screen appearance requirements
 - Wrote Valet Assistant Interface
 - Wrote Valet App/Website Interface
 - Drew the domain model
- Sheldon Wong
 - Glossary
 - Helped write problem statement
 - Wrote Full Description Use Case 1 & 2
 - Edited Full Description Use Case 3-9
 - Wrote User Estimation (Not including Valet Assistant)
 - Wrote Association Definitions
 - Wrote Attribute Definition: Database

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Customer Statement of Requirements

Problem Statement

Parking garages today currently operate without any computerized system. They usually require employees to walk around and manually check the occupancy of individual spots. The owners are concerned that they are not maximizing profit due the inefficient managements of parking spots. While some parking garages already monitor occupancy using a sensor system that keeps a tally of how many vehicles enter and leave the parking structures, this implementation can be taken a step further to further increase automation and efficiency. The whole system should be able to be implemented regardless if there is an elevator with in the structure or not. It will be a flexible program that can be applied to most parking garages that utilize valets. The new system will encourage customers to make reservations online and make the parking process a hassle-free experience. The system should properly allocate the parking spot reservation to maximize occupancy within the parking structure and be able to take into account contracted reservations, confirmed reservations, and walk-ins.

Several assumptions are made in order to simplify the system. We will assume that the customer has email and SMS texting capabilities and will always be able to read their SMS messages instantly. Additionally, it is assumed that the license plate reader will always correctly read the license plate regardless if the license plate is dirty or damaged.

To use an automated system to its maximum potential, it requires a higher influx of customers, both old and new. A method to achieve this is by streamlining the process of parking a customer's car. By reducing the hassle on the customer's end, it will increase customer satisfaction and therefore increase customer retention. The parking garage can also offer several novel features to attract additional customers, such as security features, contracted parking, and reservation notifications. Additionally, the use of valets could improve customer relations by involving a human element in the automation process. However, the valet should primarily be ferrying the vehicles to their parking locations and letting the system handle the logistics of where the vehicle should be parked. Ideally, there will be a mobile application that will direct the valet to the proper parking location. This application will also allow valet employees to update the system on currently occupied or empty spots.

To streamline the initial drive in procedure, online reservations can be made and a license plate reader will read the car's license plate and determine if a previous reservations exists or a new one needs to be made. This will require less interaction for the customer while they are driving into the actual parking structure. The website will allow customers to reserve a time slot in which to park days, weeks, or even months ahead of time and the system will store this information and properly arrange parking reservations to maximize the number of reservations that can be made. Additionally, through the use of a license plate reader, the system can determine if the customer that is driving in already has a reservation or if it needs to find a vacant spot. Additionally, the system will automatically send an SMS message to the customer when their parking reservation is about to finish.

The website should have a host of features that will benefit both the customer and the manager of the parking garage. The website should allow customers to create accounts so that it can store their personal information so that they can reserve parking spots even more quickly or to even be able to make contracted reservations. The manager will also be able to access an administrative section of the site in order to set certain variables such as policies, pay rates, etc. Employees will have their own accounts to handle day to day operations in the parking garage. A customer who wants to make a reservation will not necessarily have to make an account in order to reserve a spot, but a credit card will be needed to link the customer to a reservation. The website will primarily add more convenience for both the employees of the parking garage and the customers who will be parking at that garage.

The most important feature that would be needed in an automated system would be to maximize the space in the parking structure. The reservations would need to be condensed so that there is no wasted time. The system would also need to be able to notify potential customers that there are available parkings spots and for how long they can park. The system should be able to properly handle customers who have no prior reservations and be able to determine when to know that it can not handle additional walk-ins. A database will need to be created so that the website, employees, license plate reader and the actual system can interact with each other. This way the system can track the cars (by means of the license plate reader and valet employees) that enter and leave the garage to ensure that reservation times are being followed and be updated in real time. There will be no parking sensors in place given how expensive it would be to have every parking spot equipped with one.

To maximize security there needs to be a system that can ensure that the customer receives his or her car back in the same condition. Not only will the system be keep track the condition of the customer's car, it will also ensure that the manager will not be held liable for possible damages not incurred within the garage. To accomplish this, cars will be brought to a checkpoint where six cameras will take pictures of the car from all angles before it enters the garage and right as its about to leave .With the recorded images stored in the database, the manager has a way of making sure the car that enters the garage is the same as when the car

leaves the garage. He/she will be able to dispute or verify any claims from a customer who may have believed that their car was damaged within the parking garage.

There should also be a way to track usage statistics so that parking trends can be extrapolated. By keeping a track of trends, the manager is able to get a better feel for the behaviors of his/her customers. To implement the recording of trends, a license plate reader will also be installed at the checkpoint where the cars are documented by the six security cameras. The license plate reader records the plate number and stores it in the garage's database to keep as a record. The manager can then look at the data to see how many times a certain customer enters the garage and make assumptions on frequent visitors this way. Also, by seeing how many cars enter or use the parking garage at certain times based on the data collected, the manager is able to keep track of busy times during the day as well as during the year.

There will also need to be a way so that the system can be tested to check that it works properly and that there are no design breaking bugs. A simulator will need to be created to test the system under real-world situations and conditions. This simulator will need to test that reservation made online are properly received by the system and that valet personnel can access this data using a mobile application. The simulator will also stress test the virtual parking garage to make sure that the system handles certain exceptions correctly. For example, if someone overstays and the system needs to move reservation spots around to compensate. This simulation will also provide a proof of concept of the overall system and that it works. This simulator will have several variables that can be changed, so that certain scenarios can be tested. It can change things such as: size of the parking garage (number of floors, number of spots) and the numbers of cars that enter/leave.

There are three main goals that need to be accomplished for this project. The first is that there needs to be a website that can interact with the database and be accessed by both the customers and the manager. The second is that there needs to be a mobile application that can be utilized by the employees to update the current status of the garage. The third and probably most important goal is to create an algorithm that can maximize space within the parking garage to also maximize revenue.

Glossary of Terms

Checkpoint: Spot where the valet would drive the car to for security checks before parking it within the lot.

Contracted Reservations: Reserved multiple use parking spots that are paid for by customers who require the spot for multiple days. Done by visiting the website. e.g. If the customer needs the spot everyday for work.

Confirmed Reservations: Reserved single use parking spots that are paid for ahead of time. Done by visiting the website.

Customer: Person(s) who enter the garage with either a parking reservation or looking to make a walk-in reservation.

Database: Hosted on the website, used to store customer data and parking information.

Driver's License Plate Reader: The Driver's License Reader is going to be a scanner at a checkpoint that will record the license plate number of the vehicle and store it into the system's database.

Drive-ins: Used to describe the moment a parking customer drives into the garage (at this point you don't know if they have a reservation or not).

Extension: Customers are allowed to increase the amount of time their car is in the garage, as long as there is available time slots once their time is over.

Manager: The owner of the parking garage. Heads valets and is in charge with setting the standards within his or her own garage.

Mobile Application: Used by the valets to quickly verify the reservations of customers and spot availability. Verification needed when license plate reader is unable to confirm a reservation.

No-Show: The act of missing a reservation. The manager will still collect the payment due to paying upon reservation.

Overbooking: The act of accepting more reservations than available parking spots. Typically if a spot contains a no-show, overbooking would fill that spot in order to make more money. This strategy is used to maximize profit, but isn't used in our system.

Overstay: An unavailable spot that may impede future reservations due to the customer not returning within the allotted reserved time.

Reservation: An agreement between the parking garage(company) and the customer to hold a parking spot in advance.

Registration: The action a customer takes to sign-up and enter their information into the company database. When registering before reserving, the customer is asked to input their name, phone number/email, credit card number, address, and date of birth. By registering, it allows the customer to reserve parking spots a lot faster.

Security Check Cameras: There will be six cameras placed at a checkpoint that will record the condition of the car before it enters and leaves the parking garage.

Understay: A newly vacant spot due to a customer leaving before the conclusion of their reserved time.

Valet: Employee that will provide the personal interaction with each customer. Will be using the mobile application in order to verify reservations and move the cars.

Walk-ins: Parking customers who walk into the garage without a reservation.

System Requirements

Enumerated Functional Requirements

Identifier	P.W.	Description
REQ-01	4	The system shall scan license plates
REQ-02	5	The system shall recognize registered customers via plate number
REQ-03	3	The system shall videotape the vehicle as it enters and leaves
REQ-04	2	The system should store picture of vehicle to profile upon exit
REQ-05	5	The system shall record occupied and vacant spots
REQ-06	4	The system should display information on spot availability
REQ-07	4	The system should match parking spot and keys to a ID number
REQ-08	4	The system shall allow the valet to view customer information via tablet/smartphone
REQ-09	5	The system shall allow for creation of profile on website through registration
REQ-10	4	The system shall allow valet to create a profile for walk-ins
REQ-11	5	The system shall process payments based on length of parking time
REQ-12	5	The system should allow for early payments for reservations
REQ-13	3	The system should allow for manual input in case of system failure
REQ-14	4	The system shall manage the parking garage (eg.payroll, pricing, etc.)
REQ-15	4	The system shall require registration to make reservations
REQ-16	5	The system shall allow for reservation and notify customer if non-applicable
REQ-17	5	The system shall consolidate parking spots to maximize space

		availability
REQ-18	4	The system should track tendencies within the parking at the garage
REQ-19	3	The system shall have web and mobile app integration

Enumerated Nonfunctional Requirements

Identifier	P.W.	Description
REQ-20	5	The system shall accept ‘walk-ins’, customers who have not placed a reservation.They will be given a spot depending on the vacancy
REQ-21	5	A customer may create an account online to park using the online website.They must provide the following information: 1)First Name 2)Last Name 3) A valid phone number 4)A valid email address 5)A valid credit card 6)Address 7)Date of Birth
REQ-22	4	The interaction between the valet employee and the system or the interaction between the customer and the system shall be minimal it should not take more than five minutes to complete a reservation
REQ-23	3	The data which is backed up, shall be encrypted using disk encryption software
REQ-24	5	Customers shall be able to edit their account information such as their address,add a cars information, edit a cars information.
REQ-25	4	Customers shall be able to view past transactions
REQ-26	3	When creating an account online , a customer must confirm their email address
REQ-27	5	System can be tested to check such that it works properly and that there are no bugs.
REQ-28	5	A simulator will need to be created to test the system under real-world situations and conditions. This simulator will need to test that reservation made online are properly received by the system and that valet personnel can access this data using a mobile application.The simulator will also test the virtual parking garage to make sure that the system handles certain exceptions correctly

REQ-29	5	The system shall be capable of managing customer information and the availability of parking spots
REQ-30	4	The manager will be able to login into the system to view monthly reports,payroll information,change prices for the parking garage.The manager will also be able to view the number of reserved cars and the number of walk-ins.
REQ-31	5	The system shall be consistent with the customer as well as the manager
REQ-32	3	The system should have a help page that will help customers fill in the required information to complete a reservation online
REQ-33	4	A customer may cancel a reservation an hour before reservation start time to avoid any penalty charges.
REQ-34	5	A registered customer may edit their reservation an hour before their reserved time.No change to the system can be made within an hour of their reservation.
REQ-35	5	Account information, Parking data and daily reports shall be backed up once a day, to prepare for any natural or human-induced disasters that may occur.
REQ-36	2	Recovery time shall be no greater than 5 minutes if needed
REQ-37	5	The system shall be a 100% accurate when providing customers with a parking spot if available
REQ-38	4	The system shall be incorporated with any parking garage and can be altered for parking garages with different architectures
REQ-39	5	The system shall not lose a reservation placed online line because of the system backups that take place regularly
REQ-40	3	The system should be an easy installation and shall be minimized in such a way that configuring the system for a new customer will not take more than one week

On-Screen Appearance Requirements

Identifier	P.W.	Description
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REQ-41	4	In order to make an account online, the user needs to have a device that has internet access to use the site or app. When making the account, the user must be able to input registration information, such as last name, first name, date of birth, phone number, etc.
REQ-42	4	To log into an account, the user must be able to provide his or her account ID and password
REQ-43	4	<p>To edit or delete an account, the user must be able to log into his or her account. There the user will be given the option to delete or edit the account.</p> <p>If the user selects to delete the account, a message will appear asking if they are sure about deleting it with “yes” and “no” buttons. If the user select “yes”, the message will disappear and he or she will be directed back to the home page. If the user selects “no”, the message will disappear and he or she will remain in the account page.</p> <p>If the user selects to edit the account, the text will turn into fields that will allow them to edit any of their information.</p>
REQ-44	5	<p>If the user wishes to make a reservation online, the user needs a device that has internet access to use the site or app. He or she will be asked what kind of reservation (contracted or confirmed) he or she wishes to make and how long he or she wishes to reserve for.</p> <p>If the user does not have an account, then he or she will be required to input information, such as last name, first name, date of birth, phone number etc.</p> <p>If the user does have an account, then the personal information fields on the reservation page will be auto-filled.</p> <p>When reservation is completed, the user will be asked for credit/debit card information to pay for the reservation. After the transaction has completed, the user will be given a confirmation number.</p>
REQ-45	5	To cancel or modify a reservation, the user will be asked for his or her confirmation number. The user will then be given the option to cancel their reservation or to modify any information on his or her reservation

		<p>page.</p> <p>If the user selects to cancel the reservation, a message will appear asking if the user is sure about cancelling it with “yes” or “no” buttons.If the user chooses “yes” the message will disappear and he or she will be directed back to the home page.If the user chooses “no”, the message will disappear and he or she will remain on the reservation page.</p> <p>If the user selects to modify the reservation, the text on the page will turn into fields that will allow them to modify any of the information.</p>
REQ-46	5	<p>If the valet wishes to access the valet account, he or she must be able to provide the account ID and password.On the valet account page, the first thing the valet will see is the bit map.On the bit map the valet will be able to highlight the spots and times that are occupied or vacant.</p>
REQ-47	5	<p>If the valet wishes to see the customer account/reservation information, he or she will have to select that button or link on the home page.After selecting it, he or she will be directed to another page that will ask for the customer’s reservation confirmation number.If the customer does not have the confirmation number, then the valet will have the option to input the customer’s personal information, such as his or her name, date of birth, etc.</p>

Functional Requirement Specification

Stakeholders:

This system is created for implementation in current parking garages and or lots to help parking garage owners increase profits.This system will also be of interest to people who can maintain the system.Below are examples of people and organizations who would be interested:

- Parking Garage Owners
- Valet Parking Services
- Business Enterprises
- Users - Reserved, Contracted, Walk-Ins
- Database Manager
- Business Analyst

Actors and Goals:

Actors	Goals
Manager	To manage the employees, parking garage prices, and analyze statistics
Valet	Verify customer information and park the cars
Valet Assistant Interface	Terminal for customers to input their information and time they want to park for
Customer	Make reservations and bring car to the garage.To bring in revenue.
License-Plate Reader	Read the license plate and pass the information to the system
Cameras	Take pictures of car to mark the enter/exit conditions of the car
Vacancy Display	Displays to customers if there are vacant spots within the garage
Website	Website for customers/employees to examine/change reservations and additional customer information
Database	Stores data for the website, and the parking occupancy within the garage

Use Cases

Casual Description:

UC1: Register- to register and create an account that will allow a driver to more easily make reservation.This will require the user to create an account on the internet and provide certain information.

UC2: Reserve Online- allows a driver to save a spot for a given period of time as long as there is a vacancy.

UC3: Walk-In- this allows the driver's who walk-in without a reservation to make an on- the-spot reservation by inputting the amount of time they want to stay and will allow people who walk-in with a reservation move to the park use case.

UC4: Park- to park a driver's car inside the garage.

UC5: Overstay- implements the policies on drivers who have reserved and overstayed.

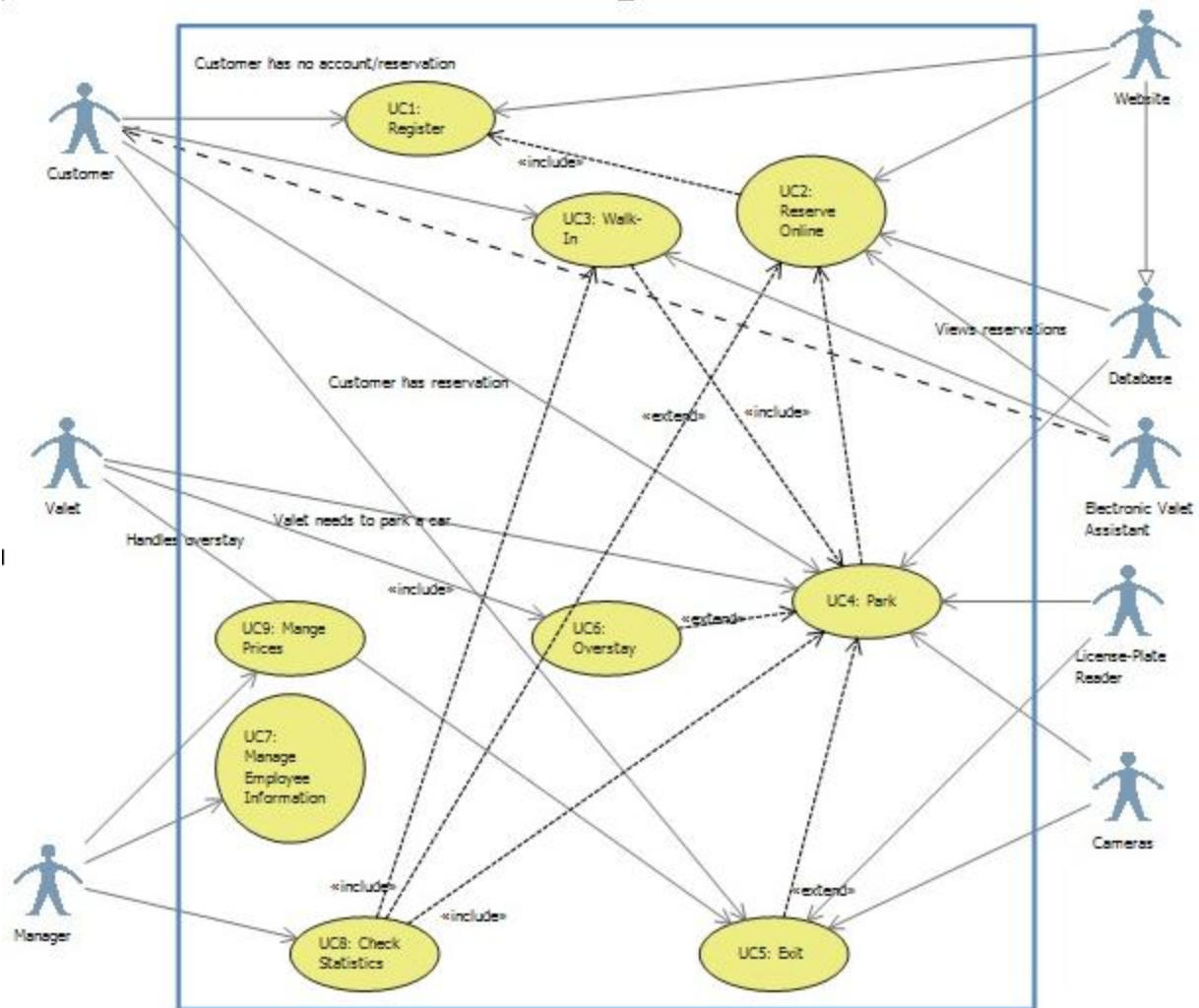
UC6: Exit- for the driver to obtain his car and notify the valet that a car must be retrieved.

UC7: Manage Prices- allows the manager to manage prices on any fees he will be charging his customers.

UC8: Manage Employee Information- allows the manager to change and update employee information and salary.

UC9: Check statistics- allows the manager to obtain statistics of how many people parked in a day and for how long.

Use Case Diagram



Traceability Matrix

	Use Cases	Register	Reserve Online	Walk-in	Park	Overstay	Exit	Mange Prices	Mange Employee profiles	Check Statistics
Requirements										
Scan license plate				x	x	x	x			
Recognize registered customers			x	x						
Take pictures of car				x	x					
Display spot availability			x	x						
Match key/parking spot					x					
View customer information		x								x
Create online profiles		x								
Create walk-in profiles		x								
Process payments							x			
Early payment of reservations			x							
Manual Input		x	x	x	x	x	x			
Require registration		x	x							
Allow reservations			x	x						
Consolidate parking spots					x					
Track Trends										x

Full-Dressed Descriptions

Use Case UC-1: Register	
Related Requirements	REQ-09, REQ-10, REQ-15, REQ-21, REQ-24, REQ-26, REQ-32
Initiating Actor	Any of: Customer, Valet
Actor's Goal	To create an account that will be stored in the database allowing for reservations for the parking lot.
Participating Actors	Website, Database
Preconditions	The system will request all the required information needed from the customer.
Postconditions	The customer's account will be stored within the database and backed up once a day.
Flows of Events for Main Success Scenario:	
-> 1.Customer/Valet accesses the website and chooses the "Register" option.	
<- 2.The system returns the display that states the required information.	
-> 3.The customer fills out the required data field.	
<- 4.The systems takes the information verifies it.	
a. If not valid, move back to 3.	
b. If valid, continue.	
<- 5.Information is stored in the database.	

Use Case UC-2: Online Reservation	
Related Requirements	REQ-07, REQ-10, REQ-11, REQ-12, REQ-15, REQ-16, REQ-31, REQ-32
Initiating Actor	Customer
Actor's Goal	To successfully reserve a spot within the parking garage.
Participating Actors	Website, Database
Preconditions	The user should be logged into his account.The system will prompt the user about their requested parking spot. It will also display whether parking is available.
Postconditions	The system will put the requested parking time into the database.
Flows of Events for Main Success Scenario:	
-> 1.User enters time that he wants to reserve.	
<- 2.System checks to see if there is an open slot.	
a. If valid spot, the system will confirm reservation.	
b. If no valid spot, the system will ask to input new time (go back to 1)	
-> 3.The system will send a confirmation email to the customer reminding the customer about the reservation.	

Use Case UC-2:	Online Reservation
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Related Requirements: REQ-07, REQ-10, REQ-11, REQ-12, REQ-15, REQ-16, REQ-31, REQ-32

Initiating Actor: Customer

Actor's Goal: To successfully reserve a spot within the parking garage.

Participating Actors: Website, Database

Preconditions: The user should be logged into his account. The system will prompt the user about their requested parking spot. It will also display whether parking is available.

Postcondition: The system will put the requested parking time into the database.

Flow of events for Main Success Scenario:

- > 1. User enters time that he wants to reserve.
- <- 2. System checks to see if there is an open slot.
 - If valid spot, the system will confirm reservation.
 - If no valid spot, the system will ask to input new time (go back to 1)
- > 3. The system will send a confirmation email to the customer reminding the customer about the reservation.

Use Case UC-3:	Enter Garage
Related Requirements:	REQ-01, REQ-02, REQ-03, REQ-04, REQ-07, REQ-08, REQ-10, REQ-20
Initiating Actor:	Customer
Actor's Goal:	To reserve a block of time in the garage to park their car.

Participating Actors: Customer, Database,
License Plate Reader, License Card
Reader, Valet Assistant

Interface

Preconditions: There is an open lot
inside the parking garage that the
customer can park in.

Postconditions: The car will have a
spot reserved in the garage.

Flows of Events for Main Success Scenario:

-> 1.The customer drives up to the entrance gate
and presses the start screen.
<- 2.The license plate reader reads the license and
the system finds a reservation
that is associated with the customer.
● If found the screen will display “Verify
information then proceed to the valet
ahead.”
(Proceed to number 9.)
● If not found, the screen will ask for time
the customer would like to stay, while
showing the maximum time they will
allowed to stay.
(Continue to next step.)
-> 3.The customer inputs the amount of hours and
minutes he would like to stay.
<- 4.The systems verifies a valid input.
● If valid, it will go to the next screen and
ask for phone number
● If not valid, it will go back to number 3.
-> 5.The customer enters valid phone number.
<- 6.The systems verifies a valid input.
● If valid, it will go to the next screen and
ask to input driver’s license.
● If not valid, it will go back to number 5.
-> 7.The customer enters driver’s license into
driver’s license reader.
<- 8.The systems extracts information
<= 9.The system signals the user to proceed to the

next station to park.

Use Case UC-4:	Park
Related Requirements:	REQ-04, REQ-07, REQ-08
Initiating Actor:	Customer
Actor's Goal:	To park the customer's car in the garage.
Participating Actors:	Valet, Database, Cameras, Valet Assistant Interface
Preconditions:	The user has a reservation created (walk-in or online).
Postconditions:	The car will be parked in the garage.
Flows of Events for Main Success Scenario:	
-> 1.The customer drives up to the cameras.	
<- 2.Valet notifies user to leave keys in the car and go.	
-> 3.Valet triggers cameras to take photo of cars in six different angles.	
<- 4.Pictures are stored in the database.	
-> 5.Valet confirms security check is done.	
<- 6.System notifies valet on valet assistant interface where to park	
<- 7.Valet parks the car.	
-> 8.Valet verifies he parked the car by pressing button on app.	
<- 9.Database is updated.	

Use Case UC-5:	Overstay
Related Requirements:	REQ-08,REQ-11,REQ-14,REQ-29
Initiating Actor:	System
Actor's Goal:	To follow the policies on overstays
Participating Actors:	System, Database
Preconditions:	The customer has overstayed.
Postconditions:	The car will be removed or reservation is extended.
Flows of Events for Main Success Scenario:	
-> 1. System updates database as soon as the customer overstays	
<ul style="list-style-type: none"> • System will know because the car has not exited 	
<- 2.The valet is notified about an overstay.	
-> 3.The valet will follow policies on the overstay	
<ul style="list-style-type: none"> • If the customer has overstayed and the parking lot is full then the car will be towed • If the customer has overstayed and the parking lot is not full ,then the customer will simply be overcharged and the reservation will be extended 	

Use Case UC-6:	Exit
Related Requirements:	REQ-04, REQ-07, REQ-18

Initiating Actor:	Customer
Actor's Goal:	To obtain and return the car to the customer.
Participating Actors:	Valet, Database, Valet Assistant Interface
Preconditions:	The customer has requested his car and has fully paid.
Postconditions:	The car will be removed from the garage.
Flows of Events for Main Success Scenario:	
-> 1.The customer requests for the car and pays.	
<- 2.The valet will obtain the car and driven to the customer.	
-> 3.License Plate reader sees the car leaving.	
<- 4.Database is updated and car is returned.	

Use Case UC-7:	Manage Prices
Related Requirements:	REQ-30
Initiating Actor:	Manager
Actor's Goal:	To change the prices associated with the parking garage.
Participating Actors:	Database, Website
Preconditions:	The manager is logged in with his account.

Postconditions: The prices will be changed and updated.

Flows of Events for Main Success Scenario:

- > 1.Manager selects “Manage Prices”
- <- 2.The website will move to the page that allows the manager to change prices.
- > 3.The manager changes the prices online and confirms the change.
- <- 4.The database is updated with a time stamp recording when the change occurred.

Use Case UC-8:	Manage Employee Information
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Related Requirements:	REQ-30
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Initiating Actor:	Manager
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Actor’s Goal:	To change employee information like salary or personal information.
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Participating Actors:	Database, Website
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Preconditions:	The manager is logged in with his account.
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Postconditions:	The employee information will be changed and updated.
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Flows of Events for Main Success Scenario:
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- | |
|--|
| <ul style="list-style-type: none">-> 1.Manager selects “Manage Employee Information”<- 2.The website will move to the page that |
|--|

allows the manager to manage employee information.

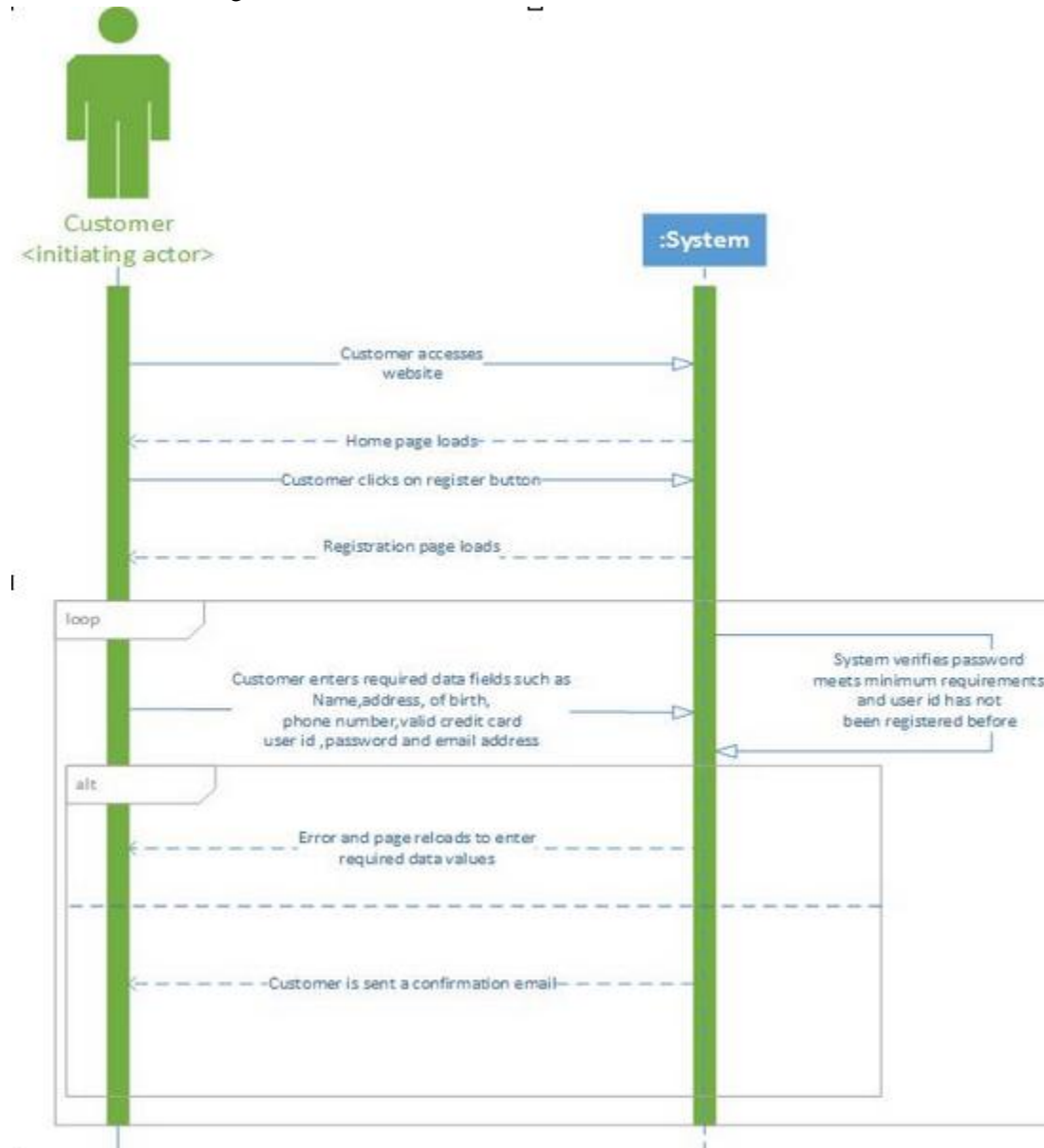
-> 3.The manager changes the employee information online and confirms the change.

<- 4.The database is updated with a time stamp recording when the change occurred.

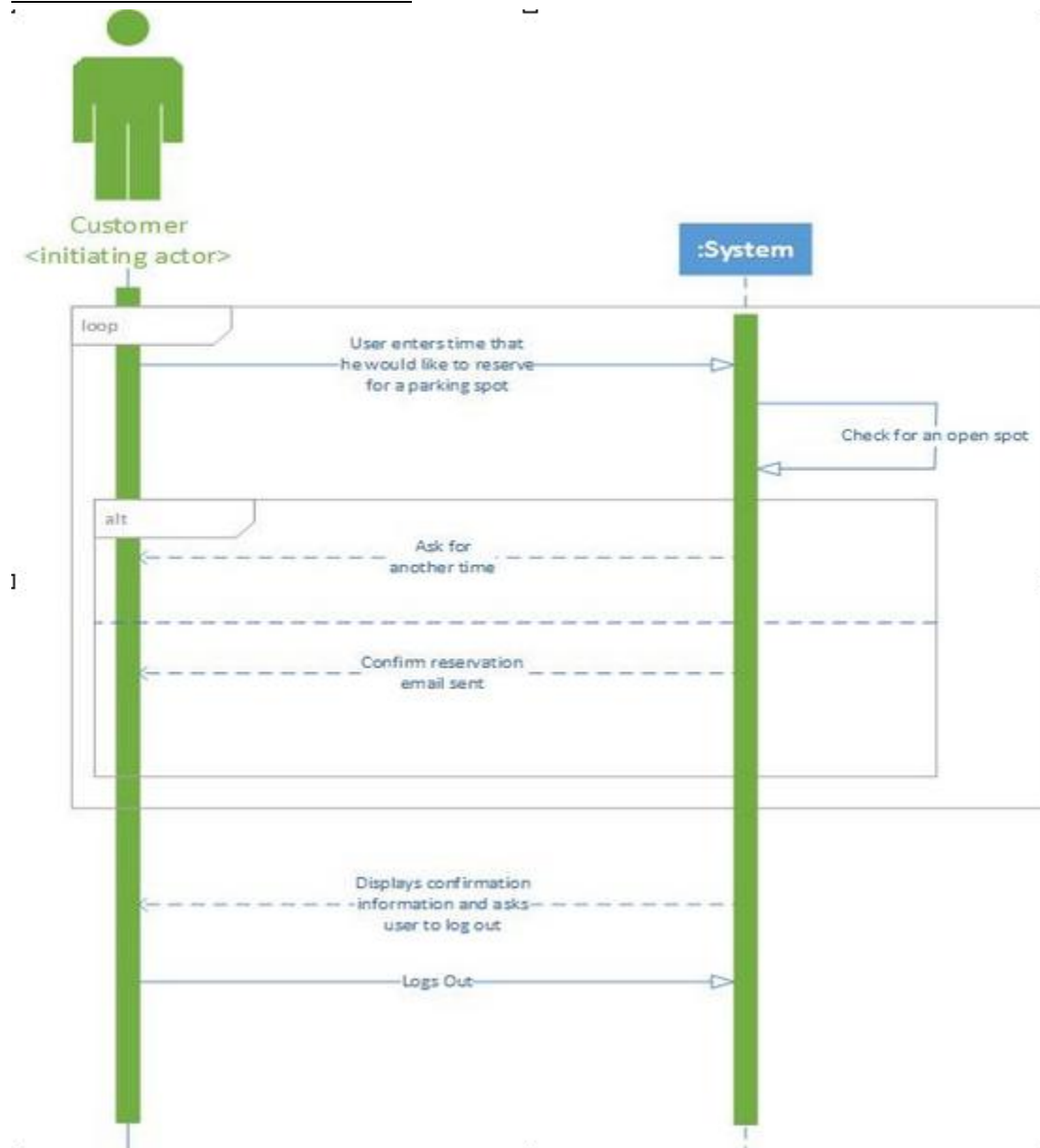
Use Case UC-9:	Check Statistics
Related Requirements:	REQ-30
Initiating Actor:	Manager
Actor's Goal:	To view statistics of the parking garage.
Participating Actors:	Database, Website
Preconditions:	The manager is logged in with his account.
Postconditions:	The parking garage statistics are provided to the manager.
Flows of Events for Main Success Scenario:	
-> 1.Manager selects "Check Statistics"	
<- 2.The website will move to the page that allows the manager to view parking garage statistics.	

System Sequence Diagrams

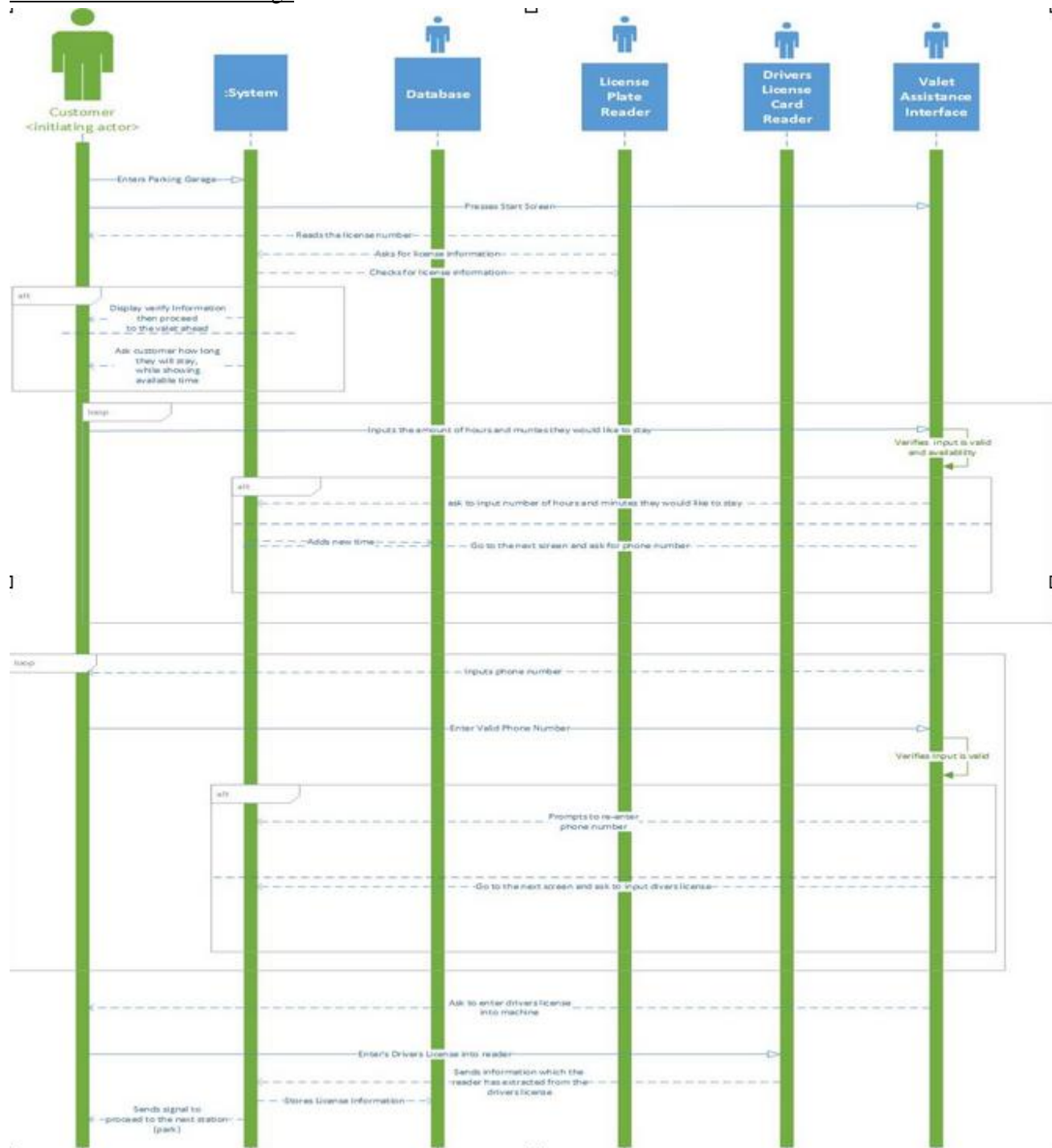
Use Case UC-1: Register



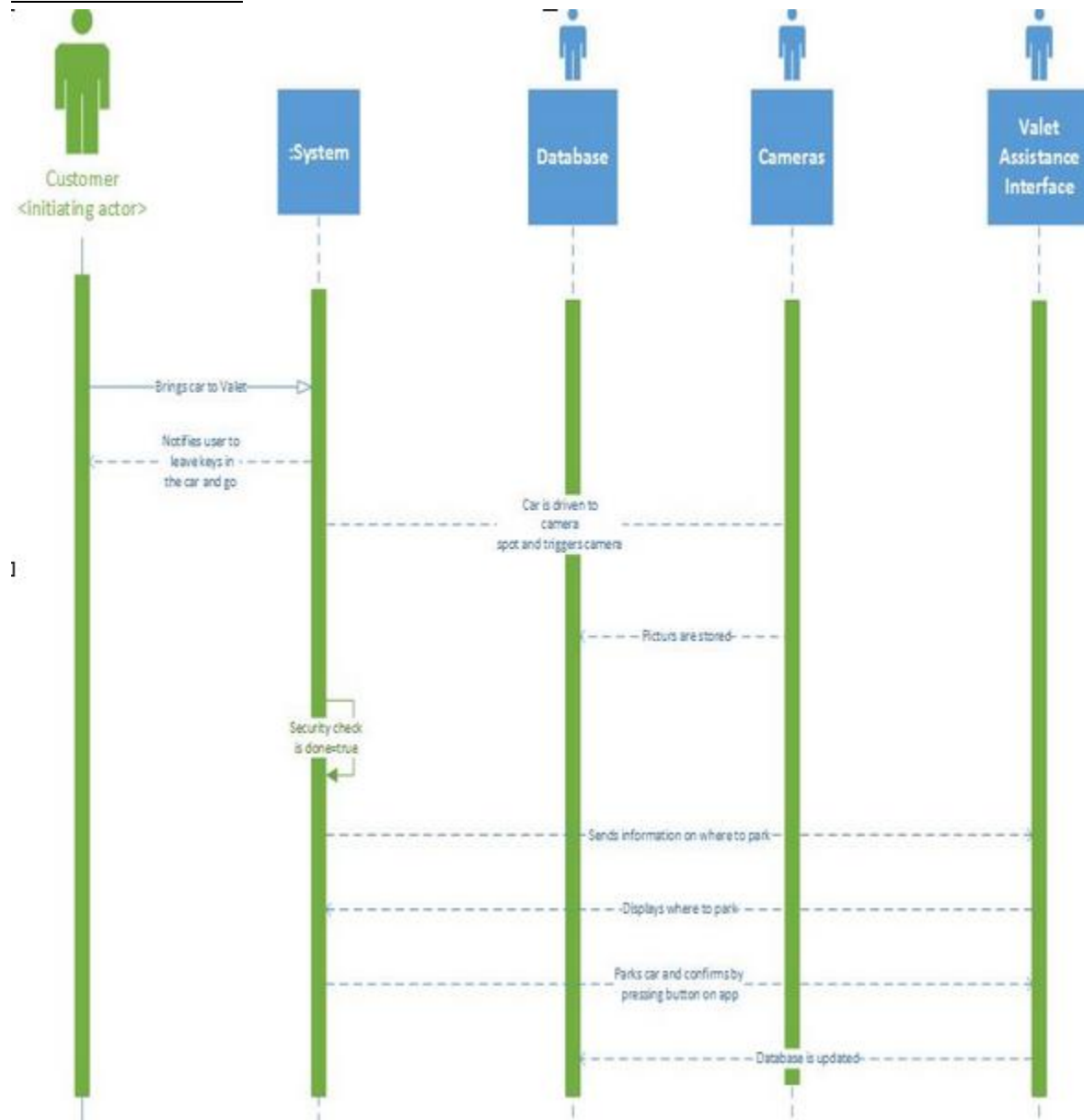
Use Case UC-2: Online Reservation



Use Case UC-3: Enter Garage



Use Case UC-4: Park



User Interface Specification

Valet Assistant Interface:

- 1 Customer touches start button to begin. The screen will show whether or not the lot/garage has vacancies with the longest interval at which he or she can stay, and a question asking of the customer has a reservation and two buttons “Yes” and “No”.
 - a If the customer does have a reservation, he or she will have to hit “Yes” and it will go to a screen with a field, digital keypad, and a “Back” button. The customer will use the keypad to input his or her confirmation number and then hit the “Confirm” button. If the customer hit “Yes” by accident they can hit the “Back” button.
 - b If the customer hits “No”, there will be a new message asking them for how many hours he or she wishes to stay, and for his or her phone number. There will also be two input fields under each questions and a “Confirm” button at the bottom. To input the correct information into their respective fields, the customer will have to tap the correct field and a digital keypad will appear. Once the customer is done, he or she can hit the “Confirm” button. If the customer hit “Yes” by accident, he or she can hit the “Back” button to go back.
- 2 Once the “Confirm” button is hit, the assistant will send them to another screen that will ask them to scan their driver’s license for confirmation.
- 3 There will be another assistant at the exit. Once again the customer will be asked to touch the screen to start. They will be asked to scan their driver’s license so the system can find the correct vehicle.

Valet APP/Website Interface:

- 1 Valet inputs valet account ID and password in respected fields. If not successful in entering correct information, the user will remain on the same page and will have to try until the right information is inputted. If user is successful, he/she will be directed to a new page. The page will contain a list of reservation information and a link that says “Customer Information”. The reservation list will contain the confirmation number, license plate number, the time interval, the space number, and some information about the customer.
- 2 To view details on a customer, the valet will select the link that says “Customer Information” which will direct him/her to another page. The new page will show another set of fields, which will ask for the customer’s personal information.

- a If the information inputted is correct, the user will be directed to a new page that displays the customer's information. The page will display the customer's information, such as name, date of birth, license plate numbers, etc.
- b If the user wishes to exit the page, he/she can select the "Back" button and she/she will be redirected to the main valet page.

Customer Website Interface:

- 1 User visits website homepage
 - a If the user has an account, he/she may log-in.
 - i He/she may log-in if he/she can provide the account ID and password
 - b If the user does not have an account, he/she may create one
 - i He/she may register if he/she provides last and first name, email address, date of birth, home address, phone number, etc.
 - c If the user selects log-out at any given time, he/she will be redirected to the homepage with his/her account logged-out
- 2 User will have ability to edit or delete account once logged-in
 - a If the user selects to delete, they will be prompted with a confirmation message first, then action will be enacted
 - b If the user selects to edit, the account profile page will go from static, to editable and will save changes once user clicks the save button
- 3 Users will have ability to reserve parking
 - a If the user has an account, they will be asked to log-in and the reservation page will be auto-filled in the background.
 - b If the user does not have an account, they will be asked to submit information similar to that of registration (see preliminary figure 1.1)
 - c Once all information is submitted, either manually or automatically, the user will be asked to submit credit-card information to finalize reservation
 - d Once reservation is finalized, the user will be given a confirmation number
- 4 Users will have ability to cancel or modify reservations
 - a The user will be asked for his/her confirmation number
 - b Once number is inputted correctly, user is asked if he/she wishes to cancel reservation or modify reservation
 - c If the user selects to cancel, they will be prompted with a confirmation message first, then action will be enacted
 - d If the user selects to modify, the reservation information will be displayed and editable and will save changes once user clicks the save button

FILL-A-LOT

HOMERESERVATIONSACCOUNTREGISTRATIONLOG-OUT

SPOT POLICY

When reserving a spot at the Fill-A-Lot Automated Parking Garage, be aware that all reservations must be acted on within a half hour of requested starting time. Any time not used at end of reservation will be credited back to your account.

MORE INFO.

RESERVE A SPOT

USE THIS FORM TO RESERVE A SPOT

First Name *

Last Name *

Email Address *

Telephone Number *

Start time *(eg. 1:30pm or 13:30)

End time *(eg. 1:30pm or 13:30)

SUBMIT

ACCOUNT INFORMATION

Figure 1.1 shows a user reserving a spot without an account. It also captures some of the other features such as viewing account, logging-out, and registration.

User Effort Estimation

The Valet Assistant Interface minimizes the amount of strokes a customer has to use by using one stroke to start the parking process; using a keypad to type on average 3 strokes for number of hours and minutes the user would like to stay; 9 strokes for the phone number; and 1 stroke using the driver's license reader to obtain information.

Registering an account on the website keeps the amount of clicking to a minimum. It an average of 15-20 keypad strokes for the First and Last Name; 10 strokes for the phone number; average of 15-20 strokes for email address; 14-16 strokes for the credit card number; 10-20 strokes for the address; and 8 strokes for entering the birthdate; and 1 stroke to confirm..

Reserving a spot online minimizes the amount of strokes by using 1 stroke to start the reservation; 1 stroke to select "Register" or "Already have an account"; average of 3 strokes for number of hours and minutes the user would like to stay; 9 strokes for the phone number, 14-16 strokes for the credit card number; 1 stroke for completing; and 1 stroke for confirmation.

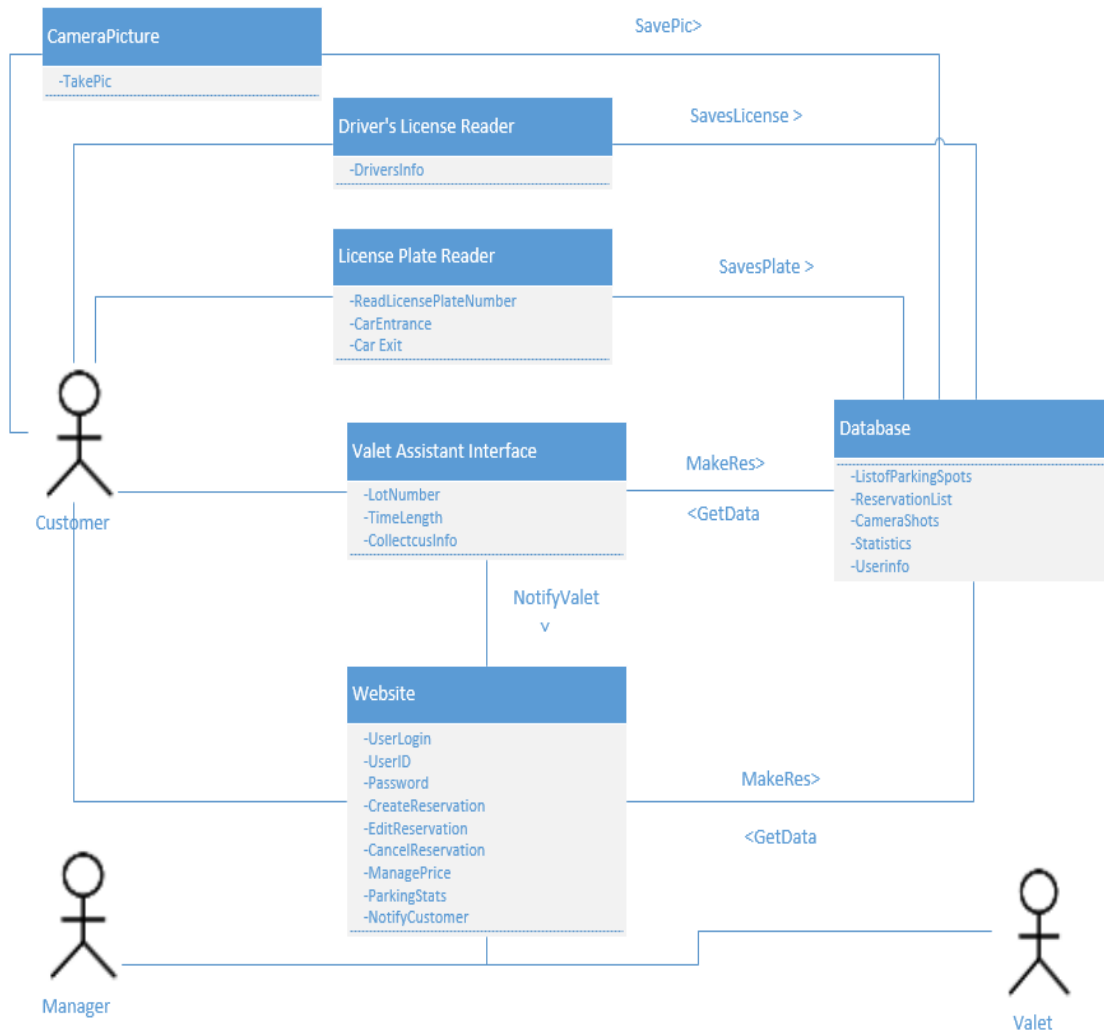
The manager can access the database to find out logistics and trends with minimum amount of strokes by first using 1 stroke to select the administrator option; an average of 10-30 strokes depending on the login information; 1 stroke to select data type, then depending on what the manager selects, the amount of strokes are different:

- Manage Prices (1 stroke to select the option; 1 stroke to select either "Adjust/ Hour rates", "Adjust Possible Deals", or 1-2 strokes to select other options; 4-8 strokes to enter/adjust prices.)
- Manage Employee Information (1 stroke to select the option; 1 stroke to select type of Employee; 1 stroke to select the Employee, 1 stroke to select "Employee Data" or "Manage Pay". If Employee Data, 1 or 2 clicks to browse data. If Manage Pay, 5-6 strokes to enter pay amount and 1 stroke to confirm.)
- Check Statistics (1 stroke to select the option, 1 stroke to choose what type of trends to observe; 1-2 strokes to analyze the statistics in the database; 1 stroke to exit the option)

After the manager is complete with their action, it takes 1 stroke to log out.

Domain Analysis

Domain Model:



1 Concept Definitions (D-doing; K-knowing; N-neither)

Responsibility Description	Type	Concept Name
To check if the incoming customer has a reservation	K	License Plate Reader
To collect information incase the customer has no reservation	D	Valet Assistant Interface
To show the outside how many parking spaces are left	D	Outside parking sign
To obtain customer information and make customer online reservations	N	Website
To manage the prices of fees related to the parking garage	D	Website
To manage employee information and statues	D	Website
To obtain parking lot number and key storage number	N	Valet Assistant Interface
To notify the manager that a customer has overstayed	D	Database
To notify the customers about their overstay	D	Website
To signal to the database that the car has left the parking garage	D	License Plate Reader
To analyze and observe parking garage statistics	K	Website
To park the car into the lot	D	Valet
To obtain the car out of the lot	D	Valet
To obtain pictures of the condition of the car before it comes in	D	Camera
To collect information from the drivers license	D	Drivers License Reader

2 Association Definitions

Concept Pair	Association Description	Association Name
License Plate Reader \longleftrightarrow Database	License Plate Reader sends license number of the car to the database. The database then stores it within its memory for future use.	SavesPlate
Valet Assistant \longleftrightarrow Database	Valet Interface notifies the database that something either needs to be verified or edited. (e.g Whether or not a customer reserved a spot, or changing customer information. The database then retrieves the information and sends it back to the interface for use.)	MakeRes
Camera \longleftrightarrow Database	The camera takes pictures of the car and sends them to the Database. The database then stores the images within memory for future use.	SavesPic
Website \longleftrightarrow Database	The website accepts reservations from customers and sends the details to the database. The database stores the parking reservation and details within its memory for future use. The website may also pull information (such as customer or reservation information) from the database.	SaveRes, GetData
Valet Assistant Interface \longleftrightarrow Outside parking sign	The database will possess knowledge of the spots remaining within the facility and send that information to the outside parking sign. The parking sign will receive the information and display it outside.	ShowTime
Manager \longleftrightarrow Database	Manager requests data from the database via the website (e.g Employee Information, Trends). The database returns the requested data to the manager for managerial use.	GetData
Driver's License Reader \longleftrightarrow Database	Driver's License reader sends driver's license of customer to database. The database then stores it within its memory for future use.	SavesLicense
Valet Assistant Interface \longleftrightarrow Website	Valet Assistant Interface notifies the website that a walk-in reservation has been made, or a customer with an existing reservation has arrived.	NotifiesValet

3 Attribute Definitions

Concept	Attributes	Attribute Description
Database	ListofParkings pots	Record of all the parking spots in the garage and who is parked where and for how long, accessible by the valets
	ReservationList	List of all the reservations made within the parking garage.
	CameraShots	
	Statistics	All the pictures of the cars that enter into the parking garage are stored
	Userinfo	Contains parking garage information e.g monthly reports,employ ee information
		Contains customer information such as name,address, drivers license number,phone number

Valet Assistant Interface	LotNumber	Parking lot number where the customers vehicle has to be
	TimeLength	parked.
	KeyNumber	Longest length of time a walk-in customer can stay at the present moment
	Collectcustinfo	Key storage number where the key must be stored
		Collects customer information when they have entered the garage
Website	UserLogin	Request for username and password
	Userid	Customers userid
	password	password used to login
	Createreservation	Creates reservation for the customer
	Editreservation	
	CancelReservation	Change reservation

		time
	ManagePrice	Customer may cancel reservation
	ParkingStats	Manager must be logged in and can edit prices for parking spaces
	NotifyCustomer	Webpage to view parking garage statics such as reports , no. of spots occupied,no. of spots empty
		Notify customers if they have overstayed and how time they have left
License Plate Reader	ReadLicensePlateNumber	Reads the customers license plate to verify if they have a reservation or if they are a walk-in
	CarEntrance	
	CarExit	Notifies the database that the

		car has entered
		Notifies the database that the car has exited
Drivers License Reader	DriversInfo	Extracts information from the drivers license
Camera Picture	TakePic	Picture is taken of car to ensure safety of the car

4 Traceability Matrix

Priority Weight	Use Case	Customer	Valet	Electronic Valet Assistance Interface	Cameras	License Plate Reader	License Reader	System	Website	Database
29	US-1								X	X
35	US-2								X	X
31	US-3	X		X		X	X			
10	US-4		X	X	X					
18	US-5							X		X
10	US-6		X	X						X
4	US-7								X	X
4	US-8								X	X
4	US-9								X	X

System Operation Contracts (Responsibility Description):

Operation	Register
Preconditions	<ul style="list-style-type: none">• The customer does not have an account• Username is between $5 \leq x \leq 20$ characters• Username has not been registered• Password is $x > 8$• Name, Address, Phone number, Drivers License Number will be inputted to complete registration
Postconditions	<ul style="list-style-type: none">• Account is successfully created and stored into database

Operation	Online Reservation
Preconditions	<ul style="list-style-type: none">• The user should be logged onto his account• The required time for the customer should be available• If the required time is not available then the customer will have the option of choosing another time.• Payment must be completed
Postconditions	<ul style="list-style-type: none">• The reservation will be completed and added to the database

Operation	Enter Garage(a) (Contracted Reservation/Confirmed Reservation)
Preconditions	<ul style="list-style-type: none">• License plate reader has scanned the license plate• Database has found a reservation• Customer will have verified information
Postconditions	<ul style="list-style-type: none">• Customer will be forwarded to the park area

Operation	Enter Garage(b) (Walk-Ins)
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n	
Preconditions	<ul style="list-style-type: none"> ● License plate reader has scanned the license plate ● Database has not found a reservation ● Customer has created a reservation on the spot ● Customer has inputted a valid phone number ● Customer has inserted drivers license into the drivers license reader to extract information
Postconditions	<ul style="list-style-type: none"> ● Customer will be forwarded to the park area

Operation	Park
Preconditions	<ul style="list-style-type: none"> ● Customer has successfully completed a reservation ● Customer has driven up the cameras ● Customer has left keys with valet ● Pictures are stored on the database ● Valet has confirmed security check
Postconditions	<ul style="list-style-type: none"> ● Car has been parked in the garage

Operation	Overstay(a)(The parking lot is full)
Preconditions	<ul style="list-style-type: none"> ● Customer has stayed beyond their reserved time ● System has updated database on overstay
Postconditions	<ul style="list-style-type: none"> ● Customers car will be towed

Operation	Overstay(b)(The parking lot is not full)
Preconditions	<ul style="list-style-type: none"> ● Customer has stayed beyond their reserved time

	<ul style="list-style-type: none"> • System has updated database on overstay
Postconditions	<ul style="list-style-type: none"> • Customers reservation has been extended and the customer has been overcharged

Operation	Exit
Preconditions	<ul style="list-style-type: none"> • Customers has requested his car • Customers has successfully paid • License plate reader has scanned the car leaving • Database has been updated
Postconditions	<ul style="list-style-type: none"> • Customer exits with car

Operation	Manage Prices
Preconditions	<ul style="list-style-type: none"> • Manager has logged on with his account • Manager has selected the manage prices page on the website • Manager has updated prices and confirmed the price change • Database has been updated with a timestamp
Postconditions	<ul style="list-style-type: none"> • Prices for the parking spots have been changed

Operation	Manage Employee Information
Preconditions	<ul style="list-style-type: none"> • Manager has logged onto his account • Manager has selected the manage employee page on the website • Manager has added or changed employee information • Database has been updated
Postconditions	<ul style="list-style-type: none"> • Employee information has been changed

Operation	Check Statistics
Preconditions	<ul style="list-style-type: none"> • Manager has logged onto his account • Manager has selected check statistics page on the website
Postconditions	<ul style="list-style-type: none"> • Manager has viewed parking garage statistics

Simulation of Arrivals and Departures

Having a single customer at a time to park in the garage would not exhibit interesting behaviors. On the other hand, it would be difficult to allow many users to simultaneously simulate the parking activity. We would need to develop a server that can handle many simultaneous interactions and recruit many people. We will simulate many artificial customers by using two Poisson processes. One process will simulate artificial customer arrivals: customers will arrive one at a time and their arrivals will be modeled as a Poisson process. The other process will simulate how artificial customers depart the garage, also one at a time.

For a Poisson process with average arrival rate λ , the probability of seeing n arrivals in the time interval Δt equals:

$$\Pr(n) = \frac{(-\lambda\Delta t)^n e^{-\lambda\Delta t}}{n!} \text{ and } E\{n\} = \lambda \cdot \Delta t$$

Inter-arrival time t (time between successive arrivals) in a Poisson process follows exponential distribution with parameter λ :

$$\Pr(t) = \{\lambda \cdot e^{-\lambda t}, t \geq 0 \text{ and } E\{t\} = \frac{1}{\lambda}\}$$

$$\Pr(t) = \{0, t < 0\}$$

To generate exponentially distributed random numbers, generate a uniformly distributed random number u on the unit interval $[0, 1]$. Then apply the following function to obtain an exponentially distributed random number rx :

$$rx(u) = \frac{-\ln(u)}{\lambda}$$

where $\ln()$ is the natural logarithm (using basis e). Let us assume that the unit interval is one hour, so the parameter specifies the average number of arrivals per hour.

This module runs two threads in infinite loops as follows. The first thread simulates arrivals:

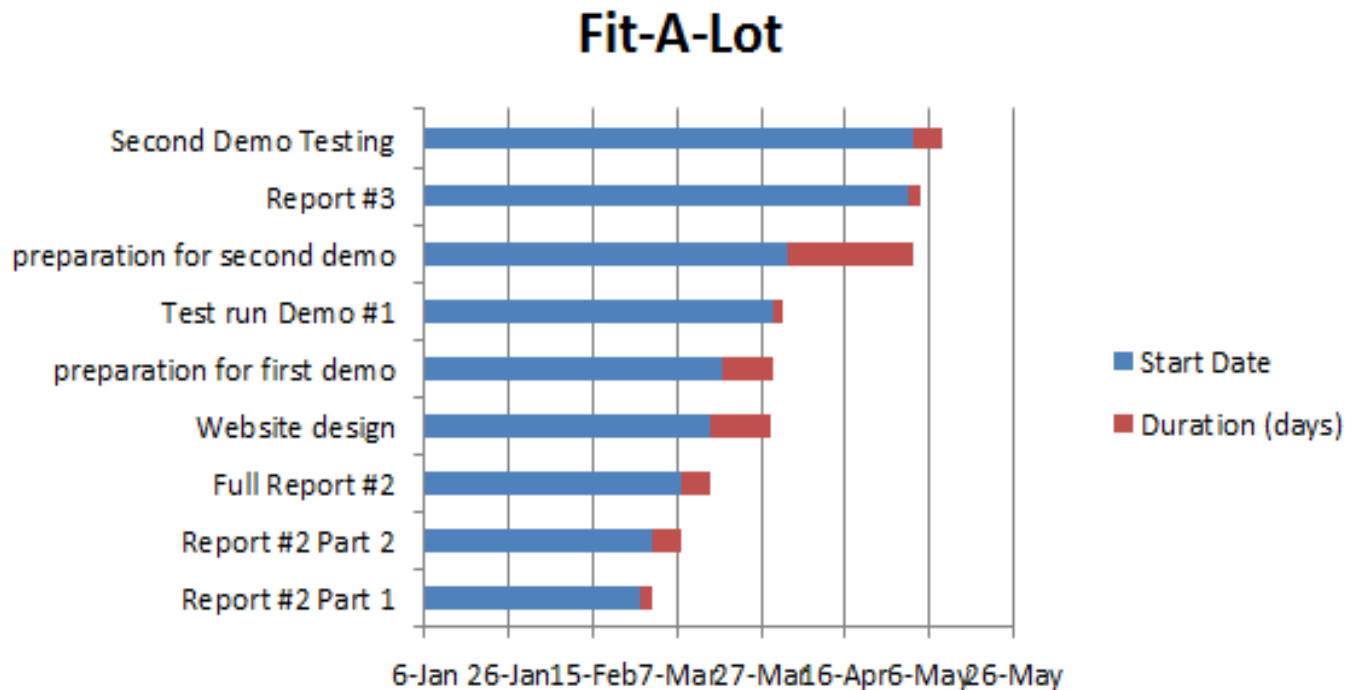
- 1 Query the database if there are currently any “Available” spots. If yes, select one randomly and change its state to “Occupied.” If there are no available parking spaces,

record this attempt as an “Overbooked” event in the statistics table, maintained by Module-5 in Figure 4.

- 2 Generate an exponentially-distributed random number rx using equation (4). Convert the number to the time scale, e.g., if $rx = 0.3$, then $t(rx) = 0.3 \times 60 \text{ minutes} = 18 \text{ minutes}$. This number represents the time of the next arrival.
- 3 Suspend this thread to sleep for $t(rx)$ time. When the thread wakes up, go to Step 1.

A similar thread runs the departures process. The departures thread selects a random occupant/customer from the database for departure. We must be careful to allow dislodging of only artificially generated customers. A more realistic simulation would also simulate reservations and another Poisson process.

Plan of Work



References

1) Drivers License Reader

<http://www.idscanner.com/IDWedgeBT/IDWedgeBT.htm>

- Drivers license reader will be used to extract information from the Drivers License into the system
- It will be used for customers which are 'walk-ins', customers which the system has not recognized or customers that have not placed a reservation
- The device will scan data into an electronic form, it will extract information such as name, address, city, state, zip, date of birth and drivers license number.

- The device will be able to extract information from drivers license within the United States
- Using the device will minimize time and will be accurate

2) Current Parking garage entrance implementation

I personally went and parked at garage. This reference will be used to help us figure out how to make parking better than current implementations.

- Wills Eye Hospital (Philadelphia, PA)
 - Drive to gate
 - Select payment type:
 - Fast (Cash or Credit/Debit - Also for lost tickets)
 - Push button to obtain ticket (time stamps the start time)
 - When you are about to leave, drive to the exit and pay there.
 - If you lost your ticket, notify the employee at the end and pay the fee to exit
 - Faster (Cash or Credit/Debit)
 - Push button to obtain ticket (time stamps the start time)
 - When you are about to leave, walk to pay machine to complete transaction
 - Need to present ticket at machine
 - You will have an 20minutes to leave after payment
 - Insert ticket at exit to leave
 - Fastest (Credit/Debit)
 - Insert credit/debit card
 - When you are about to leave, insert same credit/debit card

Note: I had to search for my own parking spot.

3) http://en.wikipedia.org/wiki/Non-functional_requirement

Enumerated Non-Functional Requirement

- Used the non-functional requirements in wikipedia to create enumerated non-functional requirements
- Implemented the example section of the non-functional requirements

4) http://en.wikipedia.org/wiki/Exponential_distribution

5) http://en.wikipedia.org/wiki/Gantt_charts