# School Bus Management

**Group #11 project proposal**
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**Project URL:**https://github.com/YaochengTong/Rutgers-332-452-Group-11-Project

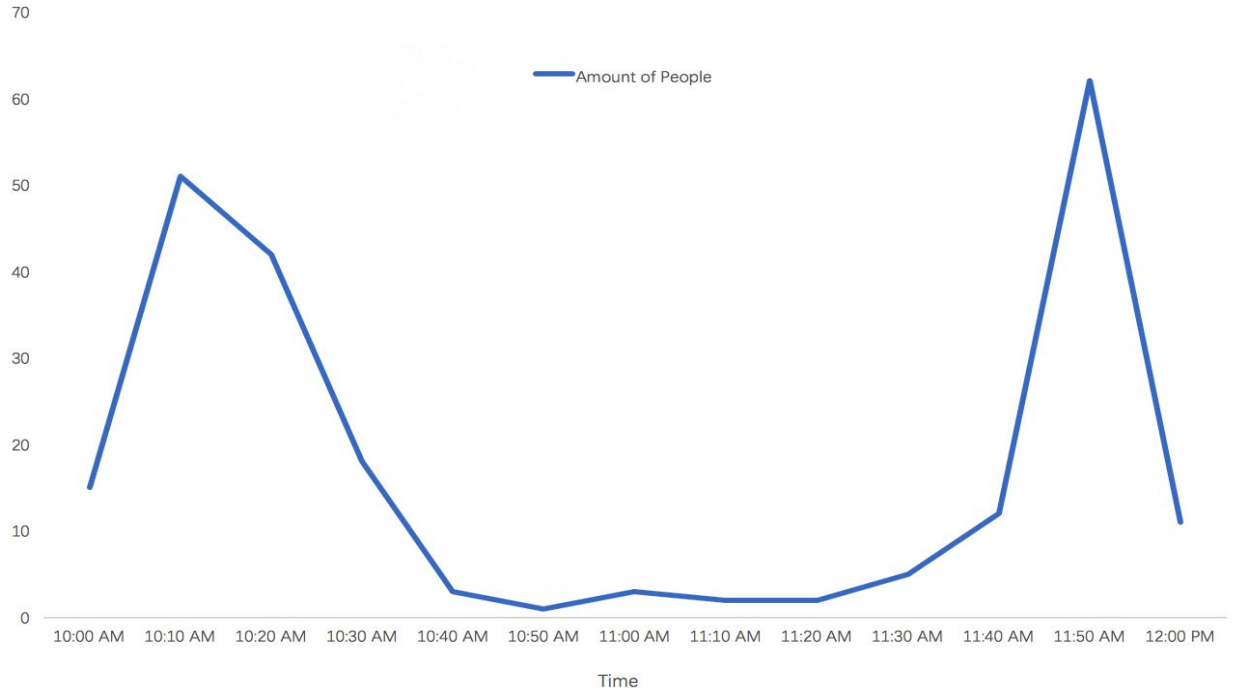
## 1. Problem Diagnosis:

The current school transportation system takes quite a bit of work for the school to manage and the university needs to put forth more effort in order to improve the flow of bus operations. We could take surveys of Rutgers students to identify and analyze the current problems confronting us or garner some suggestions for improvements to the system.

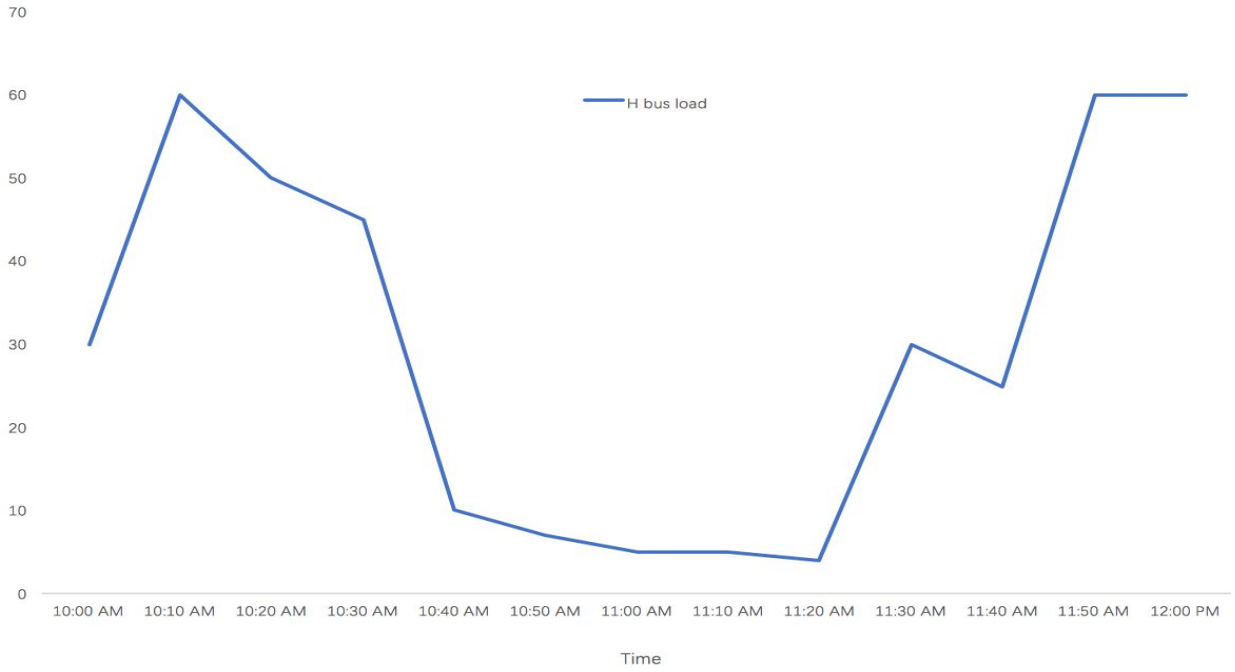
From our observations, there are two main issues with the current system and several common scenarios exist that justify the need for a new school bus management system. First, there is the problem of lack of peak-hours transportation capability. Rutgers has a massive student body and at a specific time, the bus stops will have hundreds of student waiting for campus buses. Since the buses will be overcrowded, a good portion of waiting students can not board upon arrival. Those students who are left behind at the station have only left the options of waiting for the next bus, which could take a significant amount of time depending on other factors. There are even situations in which students may miss multiple consecutive buses due to the increasing crowding at stops. This results in many students being tardy for class and a cyclical degradation of bussing services until the crowds are slowly dispersed over time.

During the peak hours, buses are usually loaded to capacity with as many students as they can hold, which can bring up bus overloading and safety concerns. Whenever such a situation occurs, not a single student can get on or off the bus easily, further increasing delays. Another issue to a lesser degree, the bus will be much heavier than usual and consequently have reduced control, resulting in increased chances of a traffic accident. To observe these relatively common phenomena, we have recorded some pertinent data and plotted it in the following charts.

The number of people waiting at the Hill Center bus stop on the Busch Campus between 10 AM to 12 PM, a common rush hour time slot. (Data recorded on January 17th, 2018)




The number of passengers on the H-bus spotted at the Hill Center bus station between 10 AM to 12 PM (rough estimation). (Data recorded on January 17th, 2018)



Parsing through these two data sets, we can see that between 10:10 AM and 11:50 AM, the buses are unable to handle the large influx of bystanders. Students remained at the bus stop and continued to wait for the next bus causing possible lateness to their classes. The H-Buses were loaded to capacity with passengers between 10:10 AM and 11:50 AM. Some relevant information on the vehicle used for the H route from the manufacturer's website:

H-Bus type: ENC AXESS
ENC AXESS specifications:

| TECHNICAL SPECIFICATIONS | 35′ MODEL | 40′ MODEL |
|---|---|---|
| GVWR | 43,420 lbs.* | 43,420 lbs.* |
| Body Length | 35′ 11.5″ | 40′ 11.5″ |
| Body Width | 102″ | 102″ |
| Wheelbase | 215″ | 275″ |
| Seating | Up to 35 | Up to 43 |

The currently used model is designed for 35 seats, but during peak hours it usually loaded to 50-60 passengers. As long as it loaded to such numbers, the bus will be much heavier and more difficult to handle. Due to this, the H-bus will have higher risks of traffic accidents on the way to College Avenue.

Another issue found within the current system is an inefficient use of resources during off-hours (i.e. not between class scheduling blocks). By controlling the intervals of the arrival times of two adjacents buses and reducing their variation, the peak load during rush hour can be significantly reduced while off-hour transport would see minimal impact. During normal class times, Rutgers bus stops have many less students waiting because most students are in class. However, the frequency of bus routes are exactly the same as during peak-hours, so generally only a few passengers are transported per bus (sometimes not even a single student at all). Looking back at the previously

mentioned data sets, between 10AM and 12PM, Hill center has an H-bus arriving every 9 minutes, but between 10:40 AM and 11:20 AM only a few passengers are aboard.

Another scenario in which the inefficiency of the current system is evident is when a bus is broken down on the road (some emergency issue) or cancellation of bus service. In both cases, there will be a large gap in service that cannot be filled due to the inflexibility of the current implementation. Students who are waiting at the bus stop for a long time have method of being notified about current conditions other than an estimated arrival time, leading to an understandably frustrating and unintuitive setup. Furthermore, when bus service are up and running again, the scheduling will not be in sync with what it was before the disruption in service, causing further issues later on.

The primary function of the bus system improvements should allow students and the bus control center that monitors bus activity to account for external factors and maintain flexibility in such cases in order to reduce the waiting time and reduce service disruption to a minimum. It would also allocate resources more evenly during peak hours to increase efficiency without increasing the number of total routes per business day.

## 2. Proposed Solution:

**Background**: In the past few years, Rutgers was vulnerable to a cyber attack due to a poor implementation of the bus scheduling system. While it has been improved upon, it can still be improved upon to increase reliability, functionality, and user friendliness. The core of the issue is that the current system that is in place is unable to account for external factors such as traffic due to an overflow of pedestrian during rush hour time slots between popular class periods at various hotspots like the student centers, Scott Hall, and Hill Center. Other possible obstacles would be road construction, overcrowding of a certain stop, and vehicle traffic caused by other events. In order to remedy the situation, our goal is to build upon the current foundation and improve through iteration rather than starting anew. We plan to achieve this by formulating a framework in which a rough count of the students residing at a certain bus stop along with their intended route can be taken into account to match the frequency at which buses make their routes to smooth out any spikes in transport needs. This would serve to eliminate overhead by reducing service during off hours and bolstering them at peak class times.

**Solution**: We are planning to tackle the issue of data collection head on by collecting rough pedestrian traffic numbers at various points in time at hotspots like Hill Center. By plotting the data, we can see the general trend of crowding throughout the day and consequently the time periods in which buses routes are required at shorter intervals. Section 3 will go over how this will be achieved in greater detail. The below figure shows a simplified visualisation of the I/O workflow of the proposed software.

Benchmark goals by which we will be judging the functionality of our software will include:

- Ease wait time for bystanders at bus stops
- Reduce wait time between bus arrivals during peak hours
- Notification system for events that may affect bus services
- Visualization of current traffic available to users
- A method of bus dispatch depending on transportation needs
- A dynamic scheduling system in which bus drivers will know when peak hours are occuring


**Value**: Successful implementation of the before-mentioned system will result in more efficient use of the currently allocated resources with reduced overhead. Buses will be running more frequently during busy periods and less frequently during off hours. As a result, students can plan their daily schedules with more leeway and increase productivity as well as academic performance.

**3. Plan of Work:**

Our goal: Solve problems of low transportation capacity on peak-hour and waste of slack-hour transportation.

Estimate cost for our project: $100

What circumstances we might need to think about?

- The regular weekday.
- The regular weekend.
- Occasional heavy traffic during regular weekday.
- Occasional heavy traffic during regular weekend.
- Planned Rutgers events during regular weekday.
- Planned Rutgers events during regular weekend.
- The midterm weeks.
- The final weeks.

To coordinate the bus schedules in these conditions, we need to do some preliminary work

1. We are planning to develop a mobile App for Rutgers students.

- How does this App work?
- Students first select a station that they are willing to take bus(e.g., stadium west lot and livingston student center).
- Then, they choose the bus(e.g., B bus and C bus).
- The students will also select the destination stop.
- The App will send the bus requestments to the control center.
- The control center needs to check the camera in the station which has the heavy demands of bus(This can prevent deliberately tricksy request)
- After verifying the high volumes of students, the control center schedules temporary bus to ease the traffic pressure.
- Sending a notification of extra bus schedule and estimated time to students who request bus.

2. Collecting requesments data in trial period(probably two weeks to a month), or analysing existing data from Rutgers bus control center.

Why we need this step?

- We need to know that each station is busy at which time.

- We need to know that each routing of bus is highly demanded at which time.
- We can forecast a heavy period and schedule more buses in advance to avoid congestions and reduce student waiting time.
- We can plot the graph of busy period and send notifications to students.

How can we complete this step?

- Questionnaire
- Recording student flow rate at each stations by some instructors(e.g., gopro)
- Asking Rutgers for previous records.
- Communicating with students who did similar researches.

3. Applying data to different circumstances to validate our App's feasibility.
   How can we do it?
   - We input our analysis into the regular weekday and weekend (predictable busy period with scheduled bus system).
   - If the occasional heavy traffic happens during regular weekday and weekend, which means that our App receives great demands of bus, our App will work as described before---verifying the student volume, scheduling extra buses and sending notifications.
   - We will send notifications one day before holding Rutgers planned events(e.g., football game and Mega fair) to remind student to avoid some stations. Also, our App will coordinate buses according to the temporal circumstances.
   - More students will be taking buses during the exam week. Due to this, we will schedule more buses in certain stations(e.g., Hill center station). For example, most student need to drop off at Hill center station if they take exams in Busch campus.
   - In final week, we will focus on the time before final exams start and after final exams end.For example, final exams are usually held during 4pm-7pm and 8pm-11pm. We will schedule more buses during 7pm-8pm to make sure all students can leave the stations and arrive on next exam time.

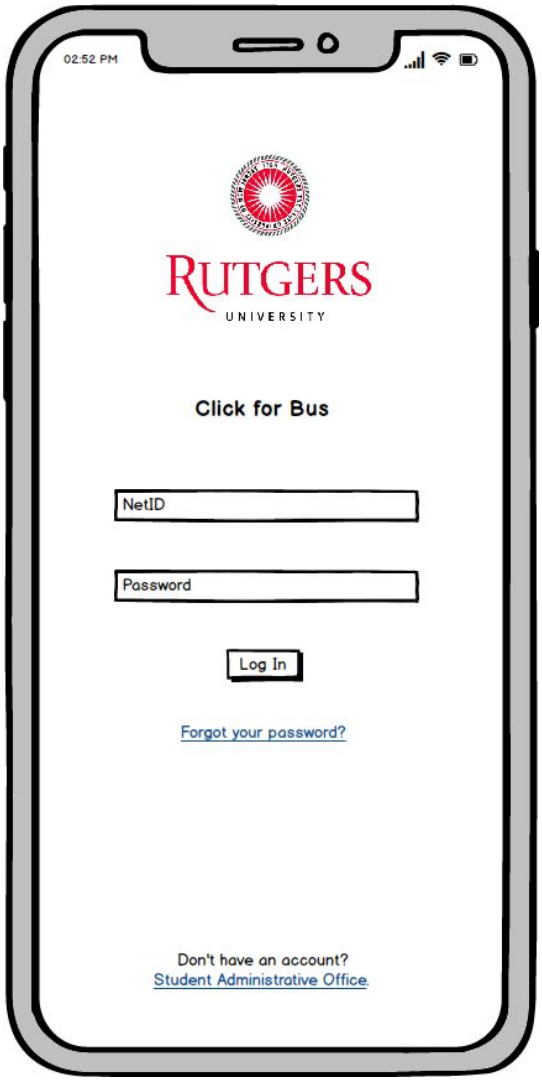
4. Taking care users' feedback
   Why we need feedback?
   - Feedback can guide us to improve our App, especially in trial period.
   - Bug reports from users may help us to be more precise and resolve the errors that are experienced in the app.

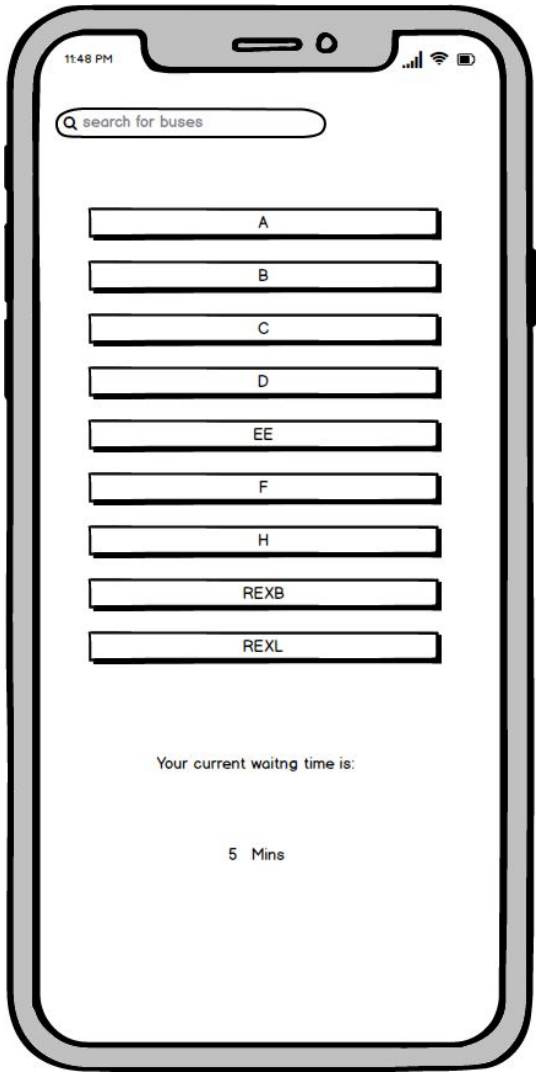
- Great ideas from users may help us develop a better interface.
- Reminders from user may lead us to satisfy their demands which we do not consider.

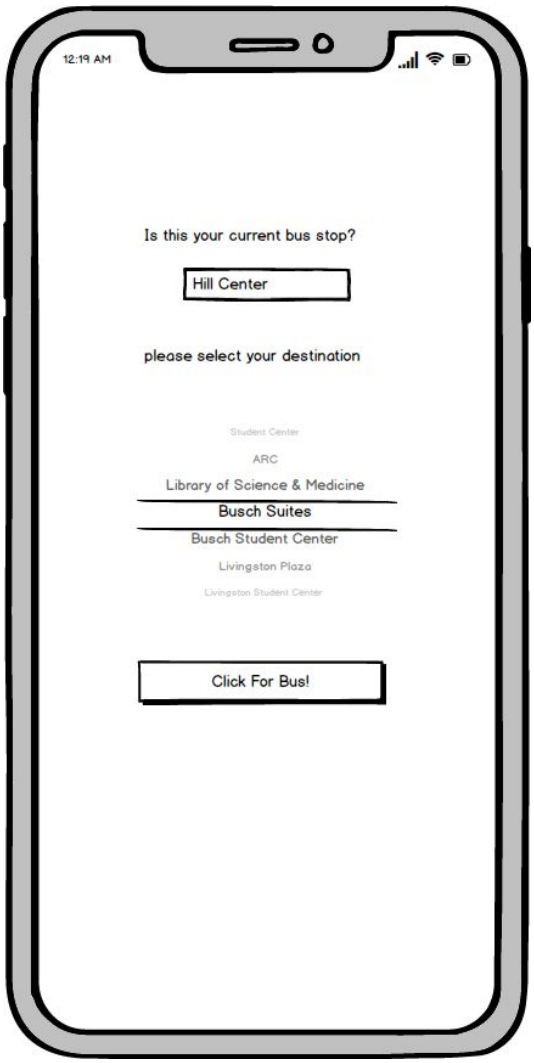
5. All the team members are proficient in C++ and Java, which will be required to develop the application and the backend components. We have eight students working on our team. Any fewer number of students would not be efficient for this project because it will not be feasible to develop different components of the program and communicate its purpose and functionality with fewer than eight students.

Use application to collect current data of amount student in various bus stop. Recorded each location’s click amounts and analyze data to arrange idea bus dispatch schedule.

Proposed App UX:




11:48 PM
search for buses
A
B
C
D
EE
F
H
REXB
REXL
Your current waitng time is:
5 Mins


12:19 AM
Is this your current bus stop?
Hill Center
please select your destination
Student Center
ARC
Library of Science & Medicine
Busch Suites
Busch Student Center
Livingston Plaza
Livingston Student Center
Click For Bus!

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