Automated Bus

Abhishek Shrivastava
Hemanth Kumar Ponnuru
Jason Schmitt
Vinmay Nair

Team Auto

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Initiation Phase

Scope Definition

Team Auto aims at implementing automated, driverless buses to provide transportation throughout the UNC Charlotte campus for students and faculty members. We will be programming a software which will be installed in pre-existing UNC Charlotte buses, making them fully automated. We will be gathering research to ensure the bus pickup times and routes are at the most optimal times for students and faculty. We will be buying necessary hardware equipment from 3rd party vendors and will be hiring human resources in order to deploy our project on time. For deployment of our project we will be acquiring necessary legal permits from the university and the government.

Assumptions

- Only UNC Charlotte can use our automated buses.
- The ECUs (Engine Control Unit) of existing UNC Charlotte buses should be made compatible with our software.
- Maintenance of our software will be done by a 3rd party vendor.
- Our automated buses are tested for safety in a well-controlled environment before deployment in UNC Charlotte campus.
- Adequate budget allocations are made when needed.
- The North Carolina DMV does not revoke permits for usage of our buses.
- The university does not revoke permissions for usage of our automated buses in the campus.
- The 3rd party vendors for necessary hardware required in our buses are able to supply equipment on time.
- Training on how to use our automated buses will be given by a 3rd party vendor.
- The human resources we hire should work during the working hours of UNC Charlotte.

Constraints

- We have 2 years to implement our project.

- The estimated budget for implementation of our project is $3million.
- Our project will be implemented using the computers and labs currently existent in the UNC Charlotte campus.

Planning Phase

Activity Definition

Team Auto will be working on a project to implement an automated bus system for the students and faculty of the campus of UNC Charlotte. In order to complete this project, we will need to acquire equipment, program software, acquire legal permits, gather information and statistics, and have a human resource team.

Researching Information and Statistics

Prior to the project programming and implementation stages, our team will gather research on the outline of the bus schedule. The outline includes bus stop popularity as well as optimal routes for the buses. Student schedules will be gathered which will note the most popular class times as well as the most popular buildings these classes are held in, so we can provide bus transportation to those buildings as needed. We will also need to legally apply this service to the University, going through any approval process that is already set in place.

We will have a kick off meeting. Here we will be introducing participants to each other. We will present our plan to the participants so that they have an idea of what kind of challenges they will be facing. This also will include the step of setting our objectives as it will a critical resource to arrange our milestones in order. We will setup a communication plan between all of them. Then we will be conducting planning, status, review and sign-off meetings. Planning will involve confirming objectives and finalizing assignments of tasks, the status meeting can help us assign bottlenecks, etc.

The interviews will be conducted on a one to one and group basis where it will help us identify the stakeholders, prioritizing them and notifying them according to the requirements.

For surveys firstly we will be deciding the user base on which we need to conduct the survey. Then we will have a meeting where we will narrow down the user base. This will be followed by preparing the survey by us.

Then we will finalize the platform for the survey and finally we will organize the survey.

Here we will be gathering the information that is required by our application. Then we will be analyzing the interviews. Then after doing a prototype analysis we will be releasing a final statistical analysis followed by the concluding result.

Hiring Human Resources

Our human resources team will consist of multiple teams. The main member of human resources is our general manager. The general manager is in charge of payroll for all teams, as well as putting together a programming team and maintenance team. The general manager will also be controlling who is hired to operate the command center, which will most likely be a student currently enrolled in the college of computer and informatics through the university. Once the program is implemented and operating in full service, the general manager is in charge of putting together an enhancement team. The enhancement team will consist of students in the college of computer and informatics as well to continuously improve the project over each semester.

Firstly we will build the questions that are necessary for our interview. These questions will be differentiated by the job titles that we would be recruiting for. Then we will review these questions and make changes wherever necessary. Then we will have a background check on all the candidates that are going to be interviewed with us. The ones that clear the background test with our any problem will be suggested with a drug test. Then we will conduct a drug test on all the interviewees who cleared all the earlier rounds. Only when we are assured that the candidate has cleared all these essential tests, we will be conducting the interviews with them and whoever eligible, we will be calling them for the orientation.

We will conduct a survey with the people whom we have selected on what things they have experience about. This is necessary as it will provide an insight of who is good at what and how can we use their expertise in our project. Further, we will be analyzing this survey and categorize the employees according to what they answered in the survey. Further we will be preparing the list of available roles for these employees. Then one more interview will be conducted to check their eligibility to the role.

We will assign work details to students as to what their timings will be and what they will be working on. The general manager will be coordinating with all the conducted interviews and view the weekly report submitted by the students. The maintenance team will perform all the checks will the buses. We will assign an enhancement team which will have a continuous look on the performance and how to improve it.

Firstly, we will create a list of contact information for all employees. Then we will collect the emergency contacts. This followed by an abiding agreement contract with the team. Also, we will be collecting medical information of the employees.

Legal Permits

Our project will be required to obtain legal permits in order to implement our product and design. The team manager will be assigned the task of acquiring permission from the University, the patent rights, permission from the DMV, hiring a legal team, and establishing legal contracts with all 3rd party vendors.

We will be discussing the legal issues with the team. Then we will be calling the legal experts from the university and have a meeting with them to discuss the same. Then we will be looking for good lawyers. For this we will contact all lawyers who have experience in this field. Then we will meet them and check who is the most suitable and finalize a lawyer.

Then we met with the university and DMV's legal officials. We will discuss about the details of our project which will give them an idea of what our aim is. We will discuss the legal issues that may come up with them. We will also get suggestions from them. Then we will give a solution to them from our lawyer. This will be followed by getting replies from them. Then we meet with the team and lawyer to work on technical and legal solutions with the legalities we have in hand. Thus we will draft a final permit by taking into consideration the changes given by the university and DMV.

We will meet our lawyers and present the agenda of signing the legal papers. We will put forth the discussion we had with the officials with our lawyers. We meet the lawyer and discuss if there are any changes to be made from our side. Then we refer the previous documents. Then we check for loop holes if any and finalize the draft. Now, we review the

documentation we got from the University and DMV's legal team. Finally, we present the documents to the DMV and the university. They will read it thoroughly and take a final call of finalizing the document. Then we prepare the final documents and get them ready for signing.

We get a list of all the vendors and contact them regarding their product. We make a list of equipment we require and pass on the list to each vendor. Then we get an estimate for all the equipment. We will then contact hardware and software vendors that provide us with the most qualitative and cheapest solution. Discuss the features that we are going to be using. We discuss the cost that will be involved so as to get these licenses that are related to our requirement. We will ask the university experts and the finance team to review the requirement and give a feedback on the same with a sanctioning to the required amount of money. Then once we acquire this we will be procuring the licenses.

Acquiring Equipment

Team Auto will be acquiring hardware equipment from 3rd party vendors which will be installed in existing UNC Charlotte buses in order to make them automated. We will be installing cameras and sensors which will sense and detect motion around the bus. The buses will be equipped with a G.P.S. (Global Positioning System) which will keep track of its location around the campus and will help in navigating the bus. A weighing scale will be installed in order to weigh the cumulative weight of the passengers inside the bus. This will ensure that our automated buses operate at their optimal capacities and speeds. Our development team will be needing computers and servers with latest configurations to program our software on.

There will be a meeting where in we will explain all the requirements to the attendees. Here, the main part is to explain our goals to acquire equipment and how would we be going about it. Then we will have a brainstorming session where we will discuss various ideas. For this we aim to be using mind mapping to get better results than usual. As mind mapping helps us strain ourselves to get more and more points for a single stage, it is really useful for this purpose. This will be followed by creating a concept of our design. Then we will come up with a list of hardware that is required by us. It is necessary that we come up with a conceptual design of the bus while acquiring the equipment to build it. This will give us an idea of what we need before we try to make a final product.

We will firstly advertise for our hardware onto media. Then we will collect all the responses we get from the vendors. Further we will short list the vendors. Then we will reply with our offers and negotiations if any. Finally, we will place the order for the required hardware.

Firstly we will verify the hardware that we have with us if they fulfill the specifications we require. Then we will store the hardware in the warehouse. According to hardware requirement we will pass it on from the warehouse to the production area. Then we will install and configure the hardware as required.

Meet with the R and D team. Brainstorm upgrade ideas. Then create research and development plans. The R and D team will conduct research on new technologies and how we could incorporate it in or product. Then we will review the upgrade plans and understand its feasibility. Once that is done we will create an order for required hardware. This will be followed by bringing the hardware for upgrades and installing them.

Programming and installing software

Our programming team will create a software which will be installed in existing UNC Charlotte buses to make them automated. We will be programming and simulating maps and routes which the buses will follow to navigate around the campus. The software will read data from the sensors and cameras around the bus. That data will be used to drive or stop the bus throughout different bus-stops around the campus or in case of emergencies. The sensor data will also be used to open and close the bus doors. The program will gather data from the weighing scale and will keep track of the capacity of our bus. This will ensure that our buses don’t operate over their operating capacities. Our program will give audio and visual notifications to greet the passengers and will also update them about approaching stops, estimated time of arrival and change in routes. A central command and control center will have an interface for tracking and controlling the positions of all our buses from a centralized location.

We will conduct a meeting where in we get an idea of what the exact software requirement is. We will select certain participants who we feel are better for our project. They will be invited and introduced to each other. Then we will be setting certain standards to work on the project

with a particular agenda. The importance of this agenda is to keep the project alive and at certain pace. We will storyboard this to get a better idea. We will plan on getting the best development approach. We will collect various feature suggestions from the team.

We will assign a meeting time and location. Organize the tasks in form of stories as they were listed above. We will create development groups. Then we will be assigning these stories to various development groups. Then we will update these stories as we develop. Each of the task will be considered as a story. These stories will be recorded. We will create a summary for each of them and will be sharing that with the whole group. There will be discussions among the group and these stories will be updated regularly.

First, we will develop and install the sensing technology. Another important aspect that we will be developing around this time is the user interface, which will be used to interact with the hardware. This will be followed by developing the audio and visual technology required to run the busses and show notifications. Then we will create the command and control which handles all the operations of the bus. After this, we will transfer the busses to the installation lab. Here, we will verify the operations of the bus and install the required software on it like the command center software, etc. then transfer the busses back to the bay.

Sequencing (5)

Researching Information and Statistics

To kick off the Team Auto project, the first task that must happen is researching information and statistics. It is important to research and gather information as a first activity so that the project has a prediction and outline of how the team and project will be run. Projects that have a well thought out plan with researched information and statistics have a much higher chance of being successful than projects that do not have a well-defined plan.

Kickoff meetings are to be held to introduce the participants involved and to present project goals. By presenting project goals, this allows the participants to gain a better understanding of what type of information and statistics need to be gathered. Interviews are to be conducted on

participants involved to ensure that they are qualified to use our finished product, and surveys are created for them.

The surveys are to be prepared and targeted to our user base. The surveys will be a ratio of open ended and closed questions as well as a questionnaire. Having a open and closed ended questions will allow the survey participants to answer quickly, as well as have the option to state more of an explanation if they wish to elaborate on any idea they have. This allows us to get the most feedback that can be useful as opposed to just multiple choice type answers.

After surveys are gathered, prototyping will take place to plan and develop the project. This is when the objective and scope will be defined, as well as get feedback from stakeholders involved in the project. The statistics from the surveys is compiled into an analysis document, and distributed to all stakeholders and stored for project documentation.

Every meeting will have a sign off section where we do a short summary of everything that has been covered in that meeting, as well as emails will be sent out to everyone who is on the meeting list as well as with the company. This allows individuals who may not have been able to make the meeting a chance to see what had been discussed that day.

Hiring human resources

Hiring human resources is a big impact on our project, as the employees we hire will keep the project going. There will be a predetermined set of interview questions for employees being interviewed. The positions we have for available are front desk, general manager, maintenance team, enhancement team, and development team.

Background checks will be issued on every employee who is being hired by the team, this will ensure that the candidate is indeed an employable individual. Drug tests are mandatory for every position and are to be taken by every individual who wishes to be employed by the team. This ensures that our employees are drug free which is important when working on a University campus.

Assignment of roles and work details are distributed at the hiring phase. The work details allow each individual to understand and review what is

expected of them from the team when accepting this position. Paperwork is going to be filled out by every employee with all contact information for themselves, as well as emergency contact information in case of an issue that happens on the job.

Human resources are necessary for any company and any project. Human resources allow for employees a point of contact for any issues they have in the company. This is also a place where employees can gain any information they may need regarding pay, vacation, and benefits or anything regarding their well-being for their place of work. Human resources will handle any conflicts that may arise within the company as well. Many times, human resources deal with complaints from employees to ensure that employees have a safe work environment. These complaints can range anywhere from sexual harassment to incorrect pay. Human resources are a crucial part of any company and should be taken very seriously. All employees are to be overseen by the human resource department and all employees have strict guidelines that are lined out by human resources. Human resources provide all employees with documentation of what is expected of them as a new hire during their orientation. Employees are expected to follow this documentation and live up to these guidelines during their time of employment within the company.

Legal permits

Acquiring legal permits is imperative for this project due to legal issues since operation of buses on public roads is taking place. Meetings with legal experts in University are to be held. We will meet with lawyers and explain the project, getting any and all feedback from them and we will finalize a lawyer to hire.

Meetings are to be set up with the legal team from the University, this will allow us to get an idea of any issues that the University runs into during their normal legal permit issues. Records of all meetings are to be taken and stored in a safe place for documentation purposes. Since our project is working on the roads with traffic and involving people, we will also need to meet with the legal team from the DMV.

Permits are to be acquired and all signing of documents are needed to be taken care of, stored in a digital copy as well as a hard copy. This will allow for documentation for the future of the project.

We acquire legal permits before the deployment of the final product to allow all legal bases to be covered in case of any incident that may occur between the buses, students and faculty. It is good to clear all permits before the beginning of any project to ensure that the project does not have any issues. It would delay a project significantly if say during the middle of development, when you are halfway complete with your project, you find out you are unable to obtain a certain permit that completely derails your project. The cost of that would be detrimental to the project due to the fact that the project would basically need a complete overhaul on how it will be able to complete the tasks at hand.

Legal permits are important to acquire for projects, especially projects that involve the general public. If the public has any chance at all of getting injured then it is absolutely necessary to cover all bases with legal permits. In case of any legal action, the University could be held liable for any incidents/wrongdoings that could happen by any student or faculty using the bus transportation service. This could end up in large fines to the University if the University does not obtain all correct permits to be able to operate their operation in the conditions the University is in.

Acquiring Equipment

Acquiring the equipment for Team Auto is one of our most important tasks, due to if we do not have the correct equipment, we will be unable to complete and maintain the project. To begin acquiring equipment, we will have a kickoff meeting to explain the project goals to the attendees and to create a list of action items. Brainstorming sessions are held for any ideas that are had, as well as explain the project scope, time and cost of goals.

Creation of a concept design of the bus is to be done at this stage. Information from the brainstorming sessions will provide new ideas for the design concept of our project. The design will then be created into a 3D design and distributed among the team and stakeholders.

After the design concept is complete, the list of required hardware is needed. We will refer to the design to determine all materials and equipment that will be needed for the project. In order to find the best prices on our materials, we will advertise the hardware we need for the project, and receive responses from vendors willing to work with us. The vendors will be able to tell us what hardware they can get for us, as well as at what prices they will be able to do so. Then we will hold a meeting to discuss which vendor we wish to continue with to ensure we get the proper equipment required, at the best cost. After a decision has been made on a vendor, we will then place the final order with them after any negotiations about equipment and prices.

When all the hardware comes in, it is important to check it to verify that all the equipment is intact and present. Installing the hardware in the buses according to our concept design so we can begin setting up the project. This is to be done by our development team, which is a contract team. The hardware is tested to ensure installation is correct and done properly.

It is very important that the correct hardware is acquired for all projects. Without the correct hardware, it could be impossible or much more difficult to fully complete the project. One good point about acquiring hardware is that hardware is usually returnable if the incorrect hardware is delivered or damaged upon arrival. The downfall to this is that this process may delay the project if the hardware ordered is not ordered in a timely manner.

Programming and installing software

Programming and installing software will begin with requirements gathering and brainstorming sessions to refine specifications to our software. Working in two weeks sprints, we will size each story to get it ready for the development stage. Development is then done, tested, and reviewed to see what errors need to be attended to and fixed. Once we have a foundation of our program complete, the installation process is to be started on for the buses. The development team still develops the software and completes the program in two-week increments. This allows the software to be installed and enhanced while it is being tested in a production-like environment.

The command center is to be set up during this time on campus. A location is to be identified and supplied by the University. The command center will be set up to monitor each bus and to make sure that the software on every bus is functioning correctly. The command center is acquired at this time because it is after we have just received the equipment for the project, and right as we begin programming and installing the software.

The programming and installation of software is a very important part of any project because if the program is not programmed to the correct specifications, then the program will not function as intended. This ties with research information and statistics, to make sure what is being programmed is synched up with the correct researched information. Program teams have to work closely with business analysts to ensure that what is being programmed is not only on track with the project, but that programming is done correctly as well. Installation of the software is important so that the end user is able to interact with the final version of the product as well. The software should be able to be updated easily for future updates. This will allow the project to evolve overtime and improve as new employees and new ideas are born. These ideas should enhance the project and as the project matures, the project will gain more attention and become more popular causing students and faculty to use the bus system more. If the installation process is not done correctly, then all of this will not be able to be complete. So it is imperative that the programming and installation process is done correctly. It is also a good idea to have documentation for any and all of the programming and the installation process, so that future employees would be able to go back and look into reasons why the program was set up the way it was initially.

Duration Estimating (5)

Researching Information and Statistics

The entire process of Gathering Information and Statistics will take 43 days right from doing interviews with the stakeholder till the completion of prototype analysis.

This entire process have different meeting going on, which takes around 5 days. This task starts with kickoff meeting and would also have

different meeting like planning meeting, status meeting and review meeting. This would end with signoff meeting.

The task of interviewing stakeholders will take 14 days for completion. Firstly we need to Identifying people involving and affected by project. And categorize them as internal or external project stakeholders, this would take 2 days. Secondly task is to perform Stakeholder Analysis and Expert Judgment to create stakeholders matrix which helps in assign priorities to stakeholders, which consumes 3 days. Next task is to notify stakeholders and request for their appointment. The final task is conduct stakeholder interviews which would take 5 days based on the availabilities provided by the stakeholders.

The task of planning and organizing the Survey will take 13 days. Initially task is to identify the people utilizing or affected by project and then categorize these people which leads to the creation of user base matrix. While the initial process takes 2 days to complete, the next two process of narrowing user base and survey creation will take 3 days each. Creating the surveys will take a lot of time as questions should be framed without any errors and also maintain the ratio of Open-ended & closed questions. Then there need to explore the platform in which the survey need to organized. Once these are done, there comes the task of finalizing these. This task would need at least 2 days. The finals task is to organize the survey and extrapolate the results which takes around 6 days.

The prototyping task will consume around 27 days. This involves around 8 days for development and 5days for testing. Upon completion of these stakeholder feedback is obtained, there would be modification based on the feedback provided and then finalize the prototype. This take around 13days.

The statistics task will handle the tasks of analyzing interviews, surveys and prototype. And then come to conclusion. This whole task takes around 37 days for completion.

Hiring Human Resources

The overall process relate to Hiring Human Resources will be 68 days in total. Its starts with Interviews and ends with Hiring Qualified Employees.

The interview process is the critical task in the entire process, which would 30 days. The first task here is to create interview questions which would consume 7 days. Followed by background check and drug test both of these will take 6 days each. The background check task has two main activities, namely receive results and analyzing the results of background check these two involves 3 days in total. The sub-task of administer drug test in the drug test task consumes 2 days. Interview scheduling task in takes 11 days for completion as involves a tedious job managing availabilities of different stake holder of this task.

The task of Assign Roles will take 14 days for its completion. Its starts with organizing and conducting surveys, this process takes 2 days. It is followed by survey analysis, which would take just on 1day. The next task is prepare a list of available roles, this would consume 6 days. This the lengthiest task in the main task of "Assign Role". Here project scope is reviewed to determine which positions are not filled the put together a document of unfilled positions and finalize the unfilled positions. Lastly interviews are organized based on the availabilities.

The task of Work Details is one of the intermediate task in the main task of Hiring Human Resources. This would take 5 days for the completion. This task has 5 sub-tasks Students, General Manager, Maintenance team, Enhancement team and Development team each of these activities consume 1 days each.

The task of Paperwork details is another the intermediate task in the main task of Hiring Human Resources. It has 2 major sub-tasks, one is contact information task which is related obtaining contact information of the hire employees this would take 4 days. While the second major sub-task contract employees would consume 5 days.

The final task of the main Hiring Human Resources is Hiring Qualified Employees task. This would take 5 days for the completion. This task has 5 sub-tasks Students, General Manager, Maintenance team, Enhancement team and Development team each of these activities consume 1 days each.

Legal permits

The entire process of related to Legal Permits will take 129 days in total. It starts with a task related to discussion on legal issue and end with renewal of licenses & permits.

The task related to discussion on legal will take 39 days. Team meeting starts this sub-task, which would consume 1 day's effort. Next sub-task is to meet legal expert in university to find out their needs, this tasks an effort of 1 day. Checking out lawyers is the next sub-task, this one is a tedious task and would need 23 days for its completion. The sub-task of meeting lawyers would need 13 days for its completion. The final sub-task here is finalizing lawyer which need a 1 day's effort.

The next task in this activity is Permit from university and DMV would take 22 days for its completion. It involves with meeting legal team from university and DMV, followed by discussion on the details obtained in these meeting. Following up these with a meeting with the lawyer. Finally list out the permits in the final sub-task of Finalizing permits from university and DMV.

Signing Legal documents is the next task, which takes 18 days for its closure. It start with 4 days sub-task of meeting lawyer, which involves with analysis of the finalized permits. Then the review of these documents with university and DMV's legal team will be carried out, followed by the sub task of finalizing changes both of these would take 5 days respectively for their completion. Finally sign document task is carried out which would take 3 days for completion.

Software and hardware licenses is the next task, which takes 15 days for its closure. It start with 4 days sub-task of Contact hardware and software vendors. Then discussing with them about 2 days related the specification in the sub task "Discuss the features". Further there would be discuss with vendors related to cost of the license which has been allotted 5 days for completion. These thing are put in the discussion about the incurring cost with university experts. Finally buying the licenses and coming to agreement with vendors.

The final task in this activity is about Renewal of permits and licenses, which will take 13 days for completion. First sub task here is renewal of

permits and licenses, which will take 4 days. This followed by discussion on new terms for renewal, then make a final document of legal terms. Acquire the new legal permit and manage Risk for missing Renewal are the final sub tasks in this whole activity related to Legal permits.

Acquiring Equipment

This entire process of Acquiring Equipment will take 94 days right from Required Hardware till Future Scope and Updates.

Acquiring equipment, will have a kickoff meeting start the proceedings to explain the project goals to the attendees and to create a list of action items. Brainstorming sessions are held for any ideas that are had, as well as explain the project scope, time and cost of goals. Both these sub tasks will take 1 day each for completion. Based on the details obtained from brainstorm session a 'concept' design of the bus will be processed this will take 8 days for completion. Next to this is to come up with a list of required hardware and distribute workload amongst teams, will take 3 days in total.

The next task in this activity is getting required hardware based on the details obtained from previous sub tasks, which would take 16 days to complete. It starts with the sub task of related to advertise the required hardware followed by sub tasks receive responses from vendors and short list vendors these three would consume 10 days in total. These are followed by sub task related to negotiate on price quotes with vendors and conclude by placing order for required hardware from vendor.

Installing and configuring the obtained hardware is the next task here, taking 21 days in total for completion. It involves verifying the obtained hardware is of required specifications. Followed by the sub task of moving the acquired HW in warehouse. The combined effort for these is 5 days. Later this task contains two major subtasks of installing and configuring HW in buses which takes 12 days and 4 days for completion respectively.

Testing the hardware is one of the most important task in this activity, taking 42 days for completion. Firstly a meeting to decide test plan kick start this task, taking 5 days of effort. Secondly the bus is to be transferred to the test facility to perform the tests on the bus in testing field. Thirdly

on the results obtained fixes had to be developed. Finally managing issues with failed hardware is a critical sub task among all other subtasks, which is allotted 5 days of effort.

The final task in the activity is related future scope & upgrades, this is task consumes 31 days. It has various sub tasks stating from R&D Meeting, then perform the research. Followed by determine and perform upgrades. Finally testing the upgrades designed. The major sub task here is testing upgrades and it takes 15 days for its completion.

Programming and installing software

This entire process of programming and installing software will take 119 days. It's one of the major activity of the activities defined.

The first task in this activity is Requirements Gathering. It kicks off with the sub task conduct an explanation meeting, taking 27 days in completion. Followed by a sub task that helps to decide on best development approach. Gather ideas for project is the subsequent sub task after obtaining developing approach. The next sub tasks are creating a software requirements specification report and divide the workload amongst teams.

Planning is the next task in this activity, it is allotted 16 days for completion. It is initiated by planning a poker meeting. Next sub task here is organize story tasks, in this stories are structured and story board is updated. This takes 5 days for completion. It is followed by the size story tasks, record story tasks and update story tasks.

Based on the things planned in planning task, Development task is made. This has 51 days for completion. It begins with developing Sensing and Simulation software, following development sub tasks are Audio and Visual Notifications as well as Command Centre Module. These three sub tasks have been allotted 23 days for their completion. Once these sub task are completed, Integrate Modules sub task comes in to picture, which will integrate all these 3 sub task. Once these are done a risk management plan dealing with the failure of the develop software sub task is created and allotted 7 days.

Once the development task is completed, Installing is the next task in this activity. The whole task is allotted 29 days for its completion. It begins with the transfer of the buses to installation lab, followed by verification if bus is ready for installation. Next sub task is to install the software on bus and install the command center software, these installations will take 22 days. Finally the buses is transferred back to storage area.

Final task in this activity is setting Up Command Centre, it takes 60 days for its completion. Firstly location need to be identified and then setup the equipment. This will take 32 days in total. Then we have to manage the risk for Revocation of Command Centre, so this has been allotted 2 days. Maintaining and training of Command Centre Staff are the final sub tasks after managing risks, which are allotted 26 days in total.

Scheduling (5)

All the tasks that are involved in the project are necessarily be completed in not less than 12 months (1 year) as mentioned which has a detailed description in the WBS. All the activities are provided a schedule that spans across the days starting from October 2015 to September 2016.

Researching Information and Statistics

This is the initial activity and it involves performing research and analysis of data (WBS 1.1. This phase will be going on for 2 months. Initially we will have a meeting with the whole team to understand what our goals are and set certain important objectives to achieve those goals (WBS 1.1.1). These meeting will be of various types. There will be Planning meetings, status meetings, review meetings, etc. (WBS 1.1.1.1 – WBS 1.1.1.5) each meeting has certain goal that it meets.

The meetings are followed by series of interviews. These interviews are the ones that are done with the stakeholders that are involved in the project so as to understand the needs and requirements in a deeper way and give it an angle where we can get useful information (WBS 1.1.2). This step involves identifying the stakeholders, once that is done we prioritize them and interview them individually (WBS 1.1.2.1 – WBS 1.1.2.4).

Further, we will be conducting surveys to get information about the expectations of our users (WBS 1.1.3). Firstly, we conduct a target base test with which we try to understand a large user base. Then we will be performing a user base analysis to narrow down our user base (WBS 1.1.3.2).

The next step is a prototyping where we firstly plan and develop a prototype (WBS 1.1.4, WBS 1.1.4.1). Here, we will be defining the scope and objective to develop a prototype. Then we test the prototype using various evaluation methods. This will help us improve our prototype by understanding the weaknesses (WBS 1.1.4.2). Further, the evaluation will be done by the users and stakeholders to check is it has really met the terms or not. This can be an opportunity to know what the stakeholders and users really expect the product to be (WBS 1.1.4.3).

Statistics is a crucial part of the project which tells us how we can amend our project looking at numbers (WBS 1.1.5). We will analyze the data we got from the surveys, prototype, etc. in a statistical manner and conclude results which can be used to improve our product (WBS 1.1.5.1 – WBS 1.1.5.5).

Hiring Human Resources

This phase would last for more than 2 months (WBS 1.5). We will initially start with the interviews (WBS 1.5.1). Here we will build questions for each interviews. For all these interviews, questions would be segregated according to the positions (WBS 1.5.1.1). This will be followed by a background check and drug test. The ones that clear all these tests will allow the candidates for the interview. Further, we will be having an orientation session for the candidates (WBS 1.5.1.2 – WBS 1.5.1.5).

The next step would be to assign roles to the people who have been given the orientation (WBS 1.5.2). Initially we perform a survey. This survey will be required so as to understand the strengths and weaknesses of a the candidates and get information about what they are good at (WBS 1.5.2.1). Then we will need to analyze the survey the data to get the information (WBS 1.5.2.2). The preparation of roles and unfilled positions on to a list and match them with the candidates that we have hired (WBS 1.5.2.3).

Now, we need to provide the work details to all the developers. This will go on for few days. Students need to attend meetings and understand the project goals (WBS 1.5.2.1 – WBS 1.5.2.3). The general manager will be arranging the interviews and schedules. Further, there are the maintenance and enhancement teams that are also dealing with the development team (WBS 1.5.2.4 – WBS 1.5.2.5).

Then, for more than 5 days we need to deal with paperwork details (WBS 1.5.3). First, we co-ordinate with the contact information (WBS 1.5.4.1). We also need to put in the emergency contacts, agreement contract to be signed, development team agreement and medical information (WBS 1.5.4.2 – WBS 1.5.4.5). This information in required for official reasons, which can be used in medical/personal emergencies.

Now, we need to hire a few other employees that we require for general purposes (WBS 1.5.5). We need a front desk employees, general mangers, maintenance team, development team and the enhancement team and each of these will require one day.

Legal Permits

Acquiring legal permits would require 129 days to be cleared. This is important as the only way to run busses should be legal as this is an autonomous busses. As this is a new concepts it would require new safety rules so as to keep the people in and around the bus safe. (WBS 1.4)

We need to talk to the legal experts from the university to understand the issues that we would be facing during the release of the busses. Then we need to check for good lawyers that can understand the project in a legal and technological manner. (WBS 1.4.1.2 – WBS 1.4.1.3) Once we finalize the lawyers we meet them and discuss our case and explain our product in depth. (WBS 1.4.1.4 – WBS 1.4.1.5) This process would take us around 39 days to be complete.

Now, we would meet with the officials at the DMV and the officials from the university. Once we get the issues that persist from the project we need to go back to our lawyers and discuss the same. (WBS 1.4.2.1 – WBS 1.4.2.2). Once we have met with both officials and the legal team, we will be finalizing the permits. (WBS 1.4.2.5)

Once the documents are finalized we can get them ready for signing to the officials of DMV and the university. Before this, we need to review the document for one final time with the legal team and ask their opinions. If there are any changes we can make that and be ready for signing the papers. Finally, after this we will be contacting the vendors for getting the cost of hardware and software licenses.(WBS 1.4.3 – WBS 1.4.4)

Acquiring Equipment

This is a process that will be a continuous process for more than 5 months. It is because that we need to acquire a huge load of hardware. There can be cases where we will also need to test and replace the hardware. All these require time and thus we are spending a lot of time in acquiring this required hardware (WBS 1.2).

To start with we will conduct a kick off meeting which will involve the new participants to get everyone together. Then they will have an interaction with each other. Then everyone will be briefed on the project organization and the action items (WBS 1.2.1.2). This will be followed by an intense brainstorming session to discuss ideas and concepts. Here, we will be studying the options that we went through during our research phase (WBS 1.1) of the project. This will also be a continuous process which will all be documented (WBS 1.2.1.1). This will be followed by creating a concept design. This would be a 3D concept which will take 3 days for being designed and processed (WBS 1.2.1.3). Then we will be coming up with a list of hardware that we require to build our busses (WBS 1.2.1.4).

Now, we get the required hardware. The whole process would take 16 days to fully complete (WBS 1.2.2). Firstly, we will advertise our requirement and which ever vendors reply back, we would have a conversation with them (WBS 1.2.2.1 – WBS 1.2.2.2). Now, we will be checking the quality and cost of each of these vendors by comparing their price on each equipment we require along with the reviews of their products to understand the quality. This would require 3 days to be completed (WBS 1.2.2.3). Then, we get the quote from the vendor we wish to buy from. If required we will negotiate the prices and finally place orders for our equipment (WBS 1.2.2.3 – WBS 1.2.2.5).

Now, we have the most critical step which is installing and configuring the hardware. First, we verify the order that we have. This process will require 21 days. This is because it will have an intense amount of work which includes a lot of testing too. Check if we have the correct equipment and is it qualitatively useful for the busses (WBS 1.2.3.1). Then we will be storing the hardware in our store. Now, when ever the requirement comes up we will be transferring the hardware from the store to mechanical workshop. This is based on demand. Finally, once we get to the mechanical workshop, it will take 12 days to setup the hardware and install it thoroughly and 4 more days to configure them. (WBS 1.2.3.2 – WBS 1.2.3.5).

Further, it will take nearly 42 days to test the hardware that we have installed. This will include preparing test plan to fixing issues. We will be managing the hardware issues in the final 15 days (WBS 1.2.4.1 – WBS 1.2.4.5).

Programming and Installing Software

The major amount of time is dedicated to this part of the project. It would take 119 days for this section to be successfully completed. This part will start in March 2016 and will be continued till end of August 2016. This is a critical part of the project as all the control and working aspect depends on it (WBS 1.3).

We conduct an initial meeting among the team where we discuss the initial goals. Here the aim is to make everyone aware of the software goals that the project has. This discussion will be documented for future references. (WBS 1.3.1) We decide the SDLC process that we are going to take up by comparing with many models. Then we gather ideas of our project that can further improve our product. Then we will be creating software requirements for the project as a whole. Further, we divide the work among all the developers. This would take us 27 days. (WBS 1.3.1.1 – WBS 1.3.1.5)

Now, we will be planning the complete software development cycle. (WBS 1.3.2). There would be poker meeting which will involve setting up meeting locations, and time. Each task will be organized as a story. Each story is recorded. They are been summarized and documented. All this data is emailed to each of the team members. Also, these stories are

updated with all the discussions among the team. (WBS 1.3.2.1 – WBS 1.3.2.5).

In the development phase, we have a planned process which start with sensing and simulation followed by audio visual notification. (WBS 1.3.3.1 – WBS 1.3.3.2) We will then work on the command and control and then finally integrate all the modules. (WBS 1.3.3.3 – WBS 1.3.3.4) Then we debug the software we built for errors. This process would take 51 days to complete.

Further, we would spend next 29 days installing the software and check its performance with the hardware that we have installed. And the further require time to setup the command center. (WBS 1.3.4 – WBS 1.3.5)

Risk Management Plan (5)

The following are the potential risks which might take place during the execution of the project.

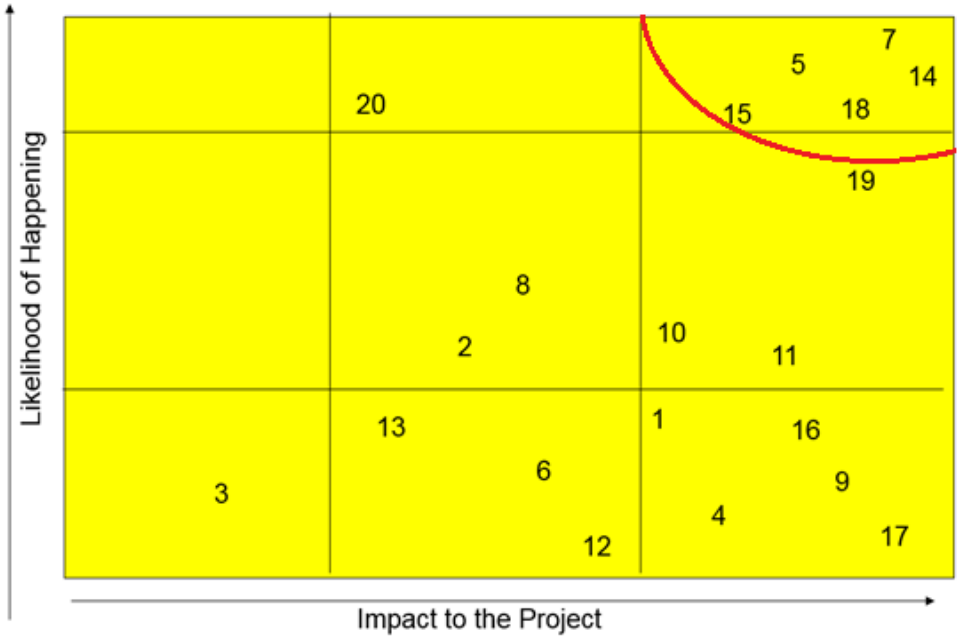
Internal Risk

1. The development team fails to program updated routes for buses.
2. Recruiting people based on the wrong set of skills.
3. Failing to negotiate during buying of a particular hardware or software.
4. The stakeholders might not come to a consensus and disagree on the specifications.
5. Issues with hardware supplied by vendors.
6. The Engine Control Unit of bus fails to operate.
7. Software fails to operate correctly.
8. The employees quit the organization.
9. The infrastructure required for development of the project is not available.
10. University revokes the teams command center.

External Risk

11. Attendees for meetings don't show up.

12. Robbery at the hardware warehouse.
13. Bus breaks down during test runs.
14. Unexpected reduction in the budget allocated.
15. Software(s) license renewal missed.
16. The vendor for hardware goes bankrupt.
17. University shuts down.
18. Network connectivity interruption by the Internet service provider.
19. Unexpected power outages can make the project come to a halt.
20. Weather issues.



Top 5 Risks

1. Issues with hardware supplied by vendors.
2. Software fails to operate correctly.

3. University revokes the teams command center.
4. Unexpected reduction in the budget allocated.
5. Software(s) license renewal missed.

Risk-1: Issues with hardware supplied by vendors.

Description: The issue with hardware supplied by the vendors on time is critical as it could lead to a delay in delivering the total project. This delay might cut down a few days for the developers to develop the system which may lead to further complications in the product.

Risk Strategy: The approach we need to take is mitigation. The reason why we need to mitigate it is that, the other options are seemingly a costly affair and can cause a larger impact monetarily on our product. To give a justification about the above point, firstly elimination of a delay is not a plausible solution as this will definitely bring the product development to a standstill. Accepting the delay will be pushing the project development dates further which will have an impact on the current funds as the developers would have to be paid more and also will affect the further revenues that will be gained from the product in the future. Transferring the task to another project scope will be no different than accepting the delay and will have similar results.

Mitigation Plan: To have the project stay on track and on our timeline, we will need to be sure to plan to have extra time allotted to our hardware that is being supplied for our project. Since this is a third party vendor, any issues that come up will be out of our control. In order to compensate for any faults with any orders, we will create a small buffer in our timeline for obtaining any and all hardware supplied. During this small buffer, we will have future tasks to the project being worked on so time is still being utilized to its fullest potential and so that when the correct hardware comes in at good condition, we will be able to smoothly continue the project.

In the event of any issue with hardware that is supplied by third party vendors, the general manager will record and document every issue with the time and date the issue has occurred, as well as record what the defect that caused the issue. This will ensure all documentation is up to date for future records and for the University as well. These records are to keep the University informed on where the money that is budgeted for this project is going.

Risk-2: Software fails to operate correctly.

Description: The risk of software failing to operate as intended is extremely crucial. Our automated buses without the software, will lose all automation capabilities. There are chances of casualties if the software malfunctions in some way. For example, if the sensor data is not interpreted by the software, the bus might collide with nearby vehicles or even run-over pedestrians.

Risk Strategy: To manage this risk we will be using the mitigation approach. The reason for that is because other options can simply not be utilized for this risk. We cannot eliminate this risk. We cannot assign a 3rd party to look after this issue. We need a backup plan which needs to be ready in case the software fails. Mitigation provides the option of having a backup plan.

Mitigation Plan: We will be hosting a backup server at the command center location. That server will take over when a software failure occurs. This way the bus will continue to operate normally without any issues even if there is a software failure. The command center server will connect to the bus wirelessly.

Risk-3: Network connectivity interruption by the internet service provider.

Description: This is one among our top risks involved ,checking the network settings network and internet setting tools check for the strong signals parse the signals and use for the application check the connection' connect to the network provider

Risk Strategy: Survey about the network operators in that locality make a list of network operators compare their signal strengths make a list of customer's using those networks prioritize the customers make a report and give it to development team

Applications network settings should be properly implemented settings should be done to work even with minimal signal use tools to signal strength code the software accordingly check the response time validate the network settings.

Contact network assistance when needed check the signal strength. If its poor contact for assistance monitor the network settings at backend Notify the network assistance team when there is a signal drop Seek assistance.

Risk 4: Unexpected reduction in the budget allocated.

Description: Our project greatly relies on the resources provided and made available by the university. The allocated university budget of 3 million dollars is required in full for completion of this project. If there is even a slight decrease in the allocated budget the project team can and will experience very drastic setbacks in maintaining the overall quality of the project. Project management involves making compromises between the triple constraints for maintaining quality. The three constraints are scope, time and cost. If cost is less, it affects the scope and time and therefore the overall quality of the project.

Risk Strategy: To manage this risk we will be using the transfer methodology of risk management. We will employ a secondary stakeholder who can invest in our project. For that we can conduct open bidding sessions for identifying secondary stakeholders. The company offering the best quality for the least cost should be employed as the new stakeholder. For example: - Instead of UNC Charlotte we can transfer this project to CATS bus system which can then fund our project. This way we will transfer the stakeholder and handle the risk in a positive way.

Risk 5: Software(s) license and legal permits renewal missed.

Description: The automated bus system being developed is supposed to last for many years after it's deployment in the charlotte campus. The working of the automated bus heavily relies on the proper operation of the software. The legal permits from the North Carolina DMV and the university needs to be renewed periodically whenever they expire. Without the necessary software licenses and the legal permits, the bus system wil fail to operate legally.

Risk Strategy: To tackle the risk of missing renewal of necessary licenses and legal permits, we need to make sure that there is an approach to mitigate the risk. In case, license renewal is missed a team will be employed which will handle the renewal of license as a separate project. We will also ensure

that the team gets proper reminders and notifications before cancellation or missing a license renewal. In case of cancellation of license, appropriate measures will be taken by the team to fix the issues responsible for the license renewal.

Project Plan (1 page plus appendix)

Refer WBS in the rear of this document.

Executing Phase

Quality Plan (5)

Leverage point 1: Finalized requirements

Requirement is a condition or capability that must be possessed by a system. A great deal of formal and anecdotal evidence exists that the typical quality of actual requirement specifications today is poor. In practice, far too many requirements are ambiguous, incomplete, infeasible, unverifiable, inadequately prioritized, and mutually inconsistent.

Qualitative metrics:

- Problem analysis: interviewing client and users, reading manuals, studying current systems, and help client/users understand new possibilities.
- Clear understanding about what is expected and the working of organization.
- Employing techniques like data flow diagrams, object diagrams etc. used in the analysis.
- Conduct the SRS (software requirement specification), a complete specification of what the proposed system should do.

Quantitative metrics:

- SRS reviewed by 100 people, this group of people includes author, client, user and dev team. 90% of this group people agree with the SRS.
- Build 5 use cases to describe how the system can be used.

- Action plan:
- Analysis: In order to gain an understanding of needs, requirements and constraints on the software, problem analysis is the first step in gathering requirement. This part focuses on problem structure. We plan to use data flow diagrams and functional decomposition in modeling, view system as transforming inputs to outputs.
- Specification: Conduct the SRS, which focuses on external behavior. It must specify requirements on functionality, performance, design constraints and external interfaces.

Leverage point 2: Finalized the budget

The project plan is important because it provides baseline information such as the budget, schedule and management plans for executing and controlling the project. The budget provides the detail estimates for labor, material and other items for the duration of the project. The budget adjustments provide details about budget modifications which occur during the Execute and Control stage of the project

Qualitative metrics:

- Compile deliverables or results from all the Planning Stage activities into a project plan document.
- Conduct the project plan which includes the cost of software/hardware etc.
- Record the baseline budget – the budget as approved by the project sponsor. (Each time the sponsor approves a new budget; the new approved budget becomes the baseline budget for tracking project costs.)

Quantitative metrics:

- Distribute the project plan to all Project Sponsors (at least 1 sponsor in the project) and 5 appropriate stakeholders.
- Conduct 1 resource plan, 1 cost plan, and 1 payment plan. These 3 plans should be reviewed by sponsors and stakeholders, 90% of these people agree with those plans.

Action plan:

A project plan is finalized when it is formally accepted and approved by the project sponsor and other designated stakeholders. Make any changes from the formal review and finalize the project plan deliverable. Formal approval acknowledges that all the deliverables produced during the Plan Stage are complete, reviewed and accepted.

Leverage point 3: Identify the System Architecture

Proper H/w and s/w installation and its setup helps to manage the software and hardware required by the system and the appropriate infrastructure is provided for the development process.

Qualitative metrics:

For the system to meet its qualitative metrics, the components of the system should meet certain standards:

a) Server Requirements:

Operating Systems:	Win98 / NT / 2000 / XP / Linux / Solaris / HP-UX
Server:	Apache (Tomcat 8.0.20)
Server Side:	Java (builds compatible with the standard API)
Database:	MySQL

b) Software Requirements: Android SDK (Mobile app development)

Sun Microsystems' Sun ONE (Open Network Environment) Studio 4 Mobile Edition

Quantitative metric:

The quantitative metric for the system to be acceptable is 90%. I.e. 90% of the equipment’s including hardware and software must be available for development.

Steps to close the gap:

To cover up the gap and fulfill the needed requirements, the team members must decide upon the web servers and workstations to be licensed.

Leverage point 4: Comparing similar Application models

Qualitative metric: Should be more accurate than previous models, since ours is a car pooling application the accuracy here deals with GPS. The interface (UI) must be designed efficiently for the user to use with ease. The payment method must be secured.

Quantitative metric: The GPS should be 90 %more accurate than similar models.

Interface should be 70% more comfortable than older versions and response time should be less than 2 sec. The security algorithm selected for payment method should be more efficient.

Steps to close the Gap:

In order to ensure accuracy and quality in the system, the existing system should have been studied thoroughly and its pros and cons must be observed clearly. For e.g.: Performance check for the system should be done after developing or adding features. The application should not consume more physical storage in mobile

Leverage point 5: Testing the framework

If the software and system are poorly tested – i.e.) if they are insufficiently tested or doesn't meet the user's requirement before they are rolled out, then the project is more likely to fail causing rework resulting in wastage of cost and resources. In order for the project to be deployed successfully, it is very essential to test the project properly and thoroughly.

Qualitative metrics:

All projects, regardless of their type or size should be tested based on specific testing standards and must be measured based on some metric to achieve project's success. In our project, best practices for testing include:

- The system should be available 24 hours 7 days a week.

- The system should respond to the user's request in 30 seconds
- The system should run smoothly on all mobiles and tablets irrespective of their Operating System.

Quantitative metrics:

The quantitative metrics must be a 100% for testing the test cases and at least 85% of them must pass. Testing can be improved to reach a 95% by implementing various effective testing techniques

Steps to close the gap:

To improve the quality metrics for the testing phase, several measures can be taken to close the gap. Firstly, members from the testing team must be involved during the requirements gathering phase and also during other major discussions so that the testers will better understand the scope and objectives of the project. Secondly, Testing must be followed in a systematic order such as Test Planning, Test Execution and Test Reporting.

Controlling Phase

Change Control Plan (1)

Change Control plan is necessary for any project during its life cycle to ensure that any changes to product or system are introduced in a controlled and coordinated manner. For our project, we will be using a change control document below. Any changes to the application during any phase should be initiated through that document. Organization or the person requesting change should be either part of the working team for our application or person working on our application.

Each change control document is identified by a Change Request Number. This is a unique ID given by the system for every form. This helps in maintaining the track of changes that are being done on the system. Requestor By and Date Requested should be answered in the change request form. All the fields in the change control document are mandatory fields and should be filled before submitting the request. Change can be requested in any of the categories present. The information requested includes a description of the change, and a justification for the change. The requestor

may also assign a priority to the change request and comment on the impact of not making the requested change.

Once the change request form has been submitted, the impact analysis section will be completed by designated members of the project team, who will evaluate the effect of the change on the project's scope, resource allocation, budget and schedule. If necessary, a risk assessment will be carried out and the risk management plan will be amended accordingly. The change request resolution section of the change request form records the decision reached (i.e. whether or not the change is approved), the reasons for the decision, and the identity of the person responsible for the decision.

When the change request form is first submitted it is assigned a change request number, and the details of the request are entered into a change log. The log will be updated with the relevant information once a decision has been made as to whether to implement the change or not. The information recorded in the log includes the change request number, the name of the requestor, the date on which the change was requested, brief details of the changes required, and the outcome of the request. If the change is approved, the task of implementing the change is assigned to appropriate personnel.

Change Control Documents (1)

This form contains all the field that are required for requesting any change request in our project. We will use this template to request change, take action and approve/ reject any change from the project manager.

(Change Request from is shown in the next page.)

Project Change Request Form		
Change request number:	Requested by:	Date requested:
Change Request Description		
Change description:		
Business or technical justification for change request:		
Priority: ☐ Top ☐ High ☐ Medium ☐ Low		
Impact of not making the change:		
Change Impact Analysis		
Impact on project requirements:		
Impact on project risk:		
Impact on project schedule:		
Impact on project budget projection:		
Impact on project configuration:		
Alternatives:		
Recommendation:		
Change Request Resolution		
Change request decision: ☐ Approved ☐ On hold ☐ Denied	Decision date:	
Decision made by: ☐ Project manager ☐ Project sponsor ☐ Executive sponsor ☐ Other		
Reason for decision:		

Change Request Tracking (updates to project baseline)					
Requirements document	Yes	N/A	By:	Date:	Comments:
Schedule (WBS)	Yes	N/A	By:	Date:	Comments:
Risk management plan	Yes	N/A	By:	Date:	Comments:
Configuration management plan	Yes	N/A	By:	Date:	Comments:
Communication plan	Yes	N/A	By:	Date:	Comments:

http://www.technologyuk.net/computing/project_management/images/change_request_form.gif

Closing Phase

Project Summary and Next Steps (1)

The initiation of this project was done with researching on various autonomous vehicular technologies. This included hardware and software of various kinds. For this we first had discussions with the internal teams and officials from UNCC. This gave us an insight of what kind of product we are aiming for and what should be the initial goals to be focused on. We also conducted surveys from people around the university so as to get an idea of what the people are expecting from this product and how we can improve our idea to be more efficient and successful. In the beginning it was a new concept for all of us. There was a point when we thought things were chaotic, only when we started applying a definite and planned approach to our project that we understood how we can go about making this project a success.

This was followed by acquiring the hardware and software we require to build our product. We as a team came together and discussed the pros and cons of the equipment that we had monitored which would be the best for our autonomous busses. For our brainstorming we used methods like mind mapping that helped us improve our results and we could branch out newer options to follow our aim to increase the efficiency and quality of the busses. Our first practical step was to create a concept bus to build an example of how our final product would look like. This gave us the flexibility to experiment and test various ideas. This also gave us the luxury to improve our product each time we tested with newer technologies. We talk to vendors that provided us with the cheapest equipment for the best quality products. We did this by comparing all of their products and their quality under controlled quality analysis.

The most critical step we faced was programming and installing the necessary software to run the autonomous busses. This required an enormous amount of man hours put in by the software and hardware developers. We had setup a good SDLC process so as to achieve our milestones. We gathered ideas from our developers and form the data we had consolidated from the surveys. We divided the work equally among all of the developers according to their expertise which was determined from the hiring processes. The development went according to plan which included a calculated process of building the sensing, simulation, user interface, audio visual notifications and finally the command center for controlling all the components.

We were able to deliver the product successfully and on time. There were several test rides that were taken initially, before having the first official ride. There were errors that occurred spontaneously, which slowed the process of the bus ride. There were necessary precautions taken for the safety of the people inside the bus. We would like to research more and make safety our priority as we go on taking this project to further success.