Course 6230: Total Quality Project Management

Project Report

Vehicle to Vehicle (V2V) Communication System

Submitted To : Dr. Amin Hammad

Date: 09th August, 2019

Submitted By:

Name	ID	Email
Deep Alpesh Patel		

Summer 2019

ACKNOWLEDMENT

We take this opportunity with much pleasure to thank all the people who have helped us through the course of our journey towards producing this report. We sincerely thank our professor Prof. **Dr. Amin Hammad** for his guidance, help and motivation. Apart from the subject of our project, we learnt a lot from him, which we are sure, will be useful to us in different stages of our life. We would like to express our gratitude to him for much help with the project design and methodology, and for review and many helpful comments. We are also thankful to him for being supportive and allowing us to use the college resources for our project purposes. We would like to thank Concordia University for their caring and supportive attitude.

Deep Alpesh Patel

Index

List of Figures

List of Tables

1. Introduction

What is V2V?

V2V is a crash prevention technology, which depends on communication of information between nearby vehicles to potentially alert drivers about dangerous situations that could lead to a collision. For example, V2V could help warn a driver that a vehicle up ahead is braking and they need to slow down, or let a driver inform that it's not safe to move through an intersection because another vehicle (yet unseen by the driver) is quickly coming.

How does V2V work?

V2V communications systems are composed of devices, fix in vehicles, that use dedicated short-range radio communication (DSRC) to interchange messages that includes vehicle information (e.g., location, blind spots, vehicle's speed, braking status). V2V systems use this details from other automobiles and decide if a warning to the driver is required, which could stop a vehicle collision.

What are dedicated short-range communications?

Dedicated short-range communications (DSRC) are two- way, wireless communications permitting secure and fast messaging needed for safety applications, where "short range" is approximately 300 meters depending on the surrounding environment. These communications occur in a 75 MHz band of the 5.9 GHz spectrum, which has been allocated by the FCC for use by Intelligent Transportations Systems (ITS) vehicle safety and mobility applications. This band affords a relatively clean operating environment with very few preexisting users, allowing for a relatively unimpeded and interference-free communication zone.

What messages are exchanged?

A basic safety message (BSM) is exchanged between vehicles and contains vehicle dynamics information such as heading, speed, and location. The BSM is updated and broadcast up to 10 times per second to surrounding vehicles. The information is received by the other vehicles equipped with V2V devices and processed to determine collision threats. Based on that information, if required, a warning could be issued to drivers to take appropriate action to avoid an imminent crash.

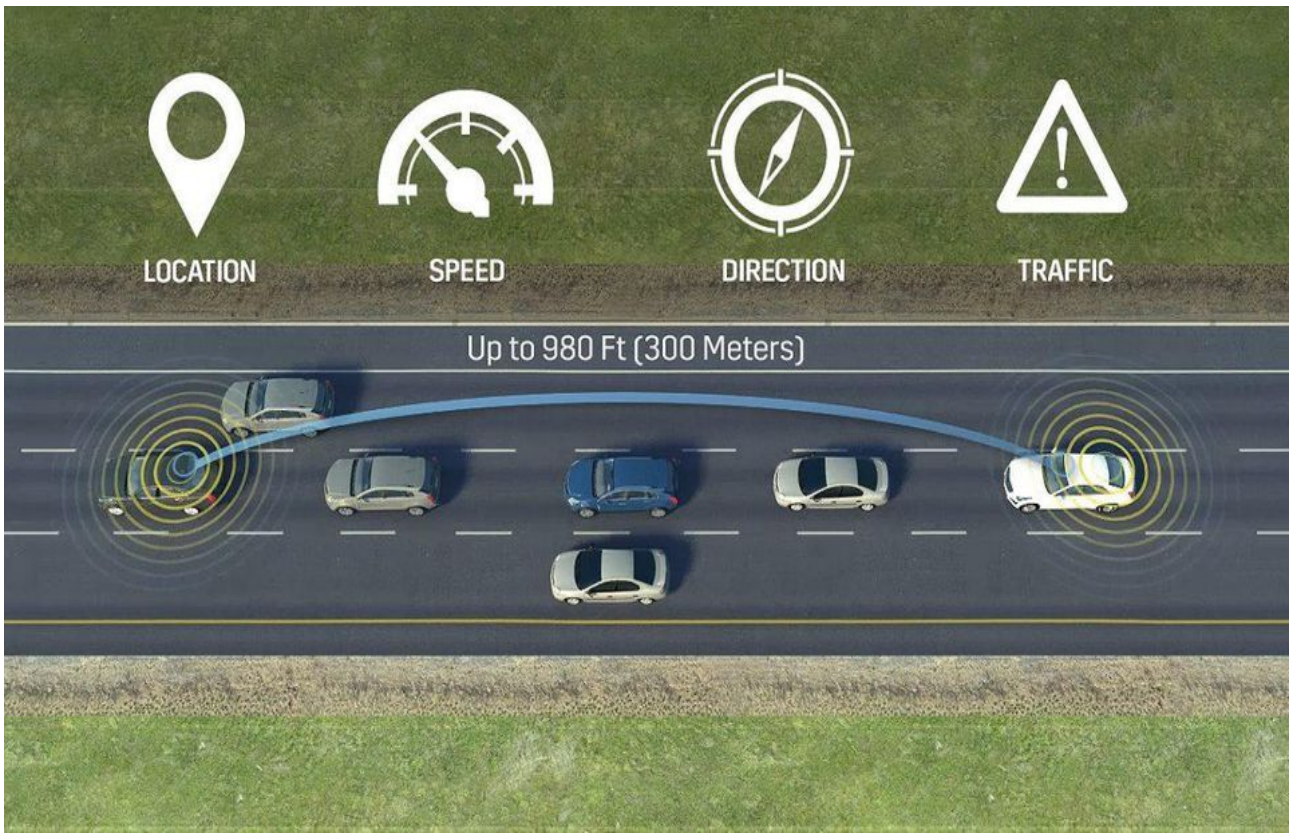


Figure 1.1 Dedicated short-range communications (DSRC) [1]

Privacy

The V2V system will not gather, broadcast, or share personal data between vehicles, nor does it allow tracking of particular drivers or their vehicles. V2V-enabled vehicles only exchange general and safety information. The system is planned with several layers of security and privacy protection to make sure that drivers can depend on messages sent from other vehicles, and that NHTSA and vehicle manufacturers can identify faulty V2V equipment without collecting or using any personal information.

What are the advantages of V2V?

V2V messages have a range of approximately 300 meters, which is more than the capabilities of systems with cameras, ultrasonic sensors, and radar – in some cases, by nearly double the distance, allowing more time to notify drivers. In addition, these radio messages can "see" around corners or "through" other vehicles addressing, for example, scenarios such as those where an oncoming vehicle come out from behind a truck, or perhaps from a blind passage. In those situations, V2V communications can detect the threat much earlier than radar or camera sensors.

Safety Applications Enabled by V2V

1. Intersection Movement Assist

IMA warns the driver when it's not safe to enter an inter- section because of an increased potential for colliding with one or more vehicles.

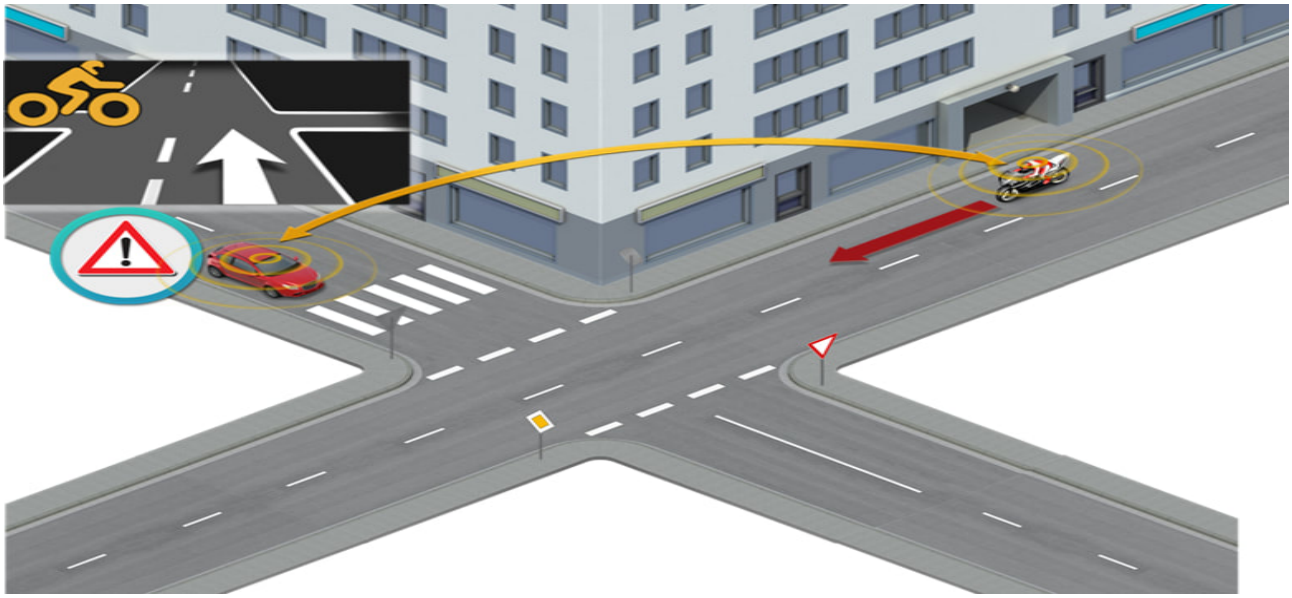


Figure 1.2 Intersection Movement Assist [2]

2. Left Turn Assist

LTA warns the driver when there is strong probability they will collide with an oncoming vehicle when making a left turn. This is especially critical when the driver's line of sight is blocked by a vehicle also making a left turn from the opposite direction.

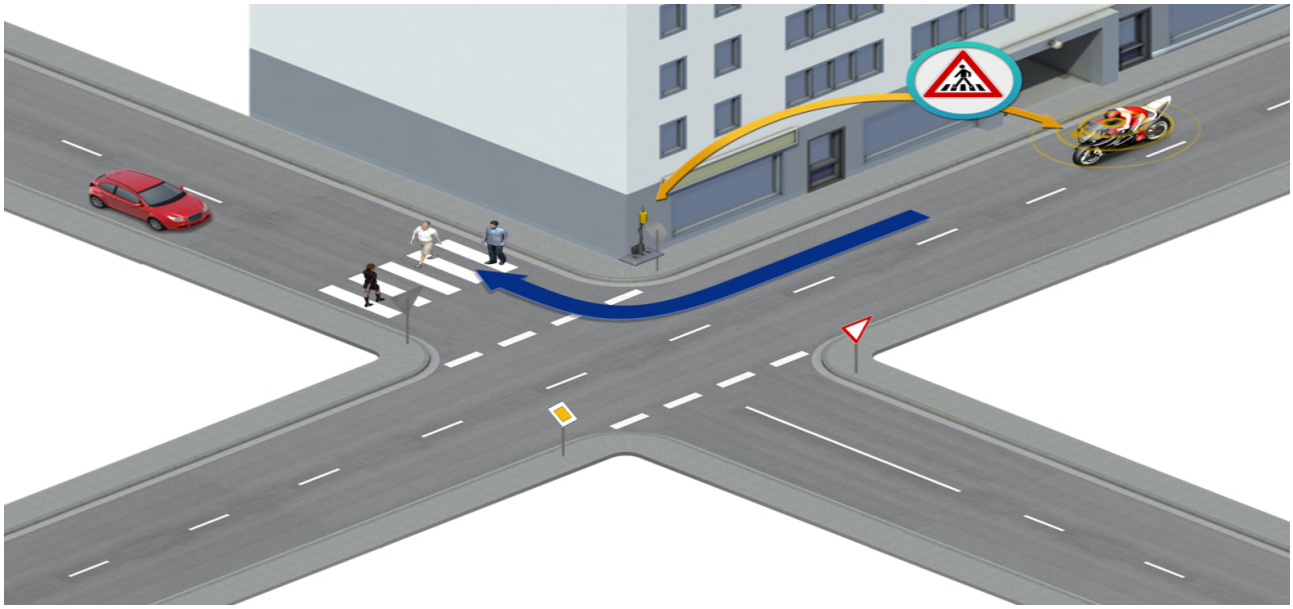


Figure 1.3 Left Turn Assist[2]

3. Emergency Electronic Brake Light

Emergency Electronic Brake Light (EEBL) warns the driver to be prepared to take action when a V2V-equipped vehicle traveling in the same direction but not in the driver's line-of-sight decelerates quickly. V2V would allow the driver to "see through" vehicles or poor weather conditions and know if traffic ahead may be coming to an abrupt stop.

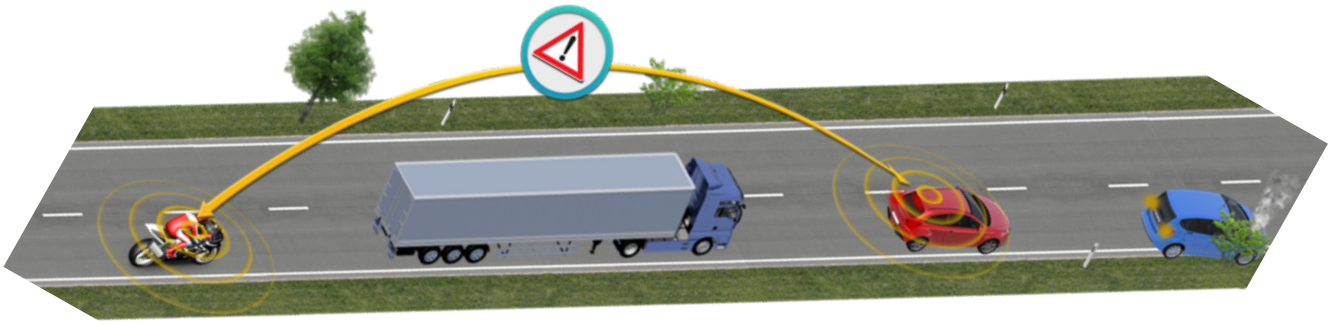


Figure 1.4 Emergency Electronic Brake Light[2]

4. Forward Collision Warning

Forward Collision Warning (FCW) warns the driver of the risk of an impending rear-end collision with a vehicle ahead in traffic in the same lane and direction of travel.

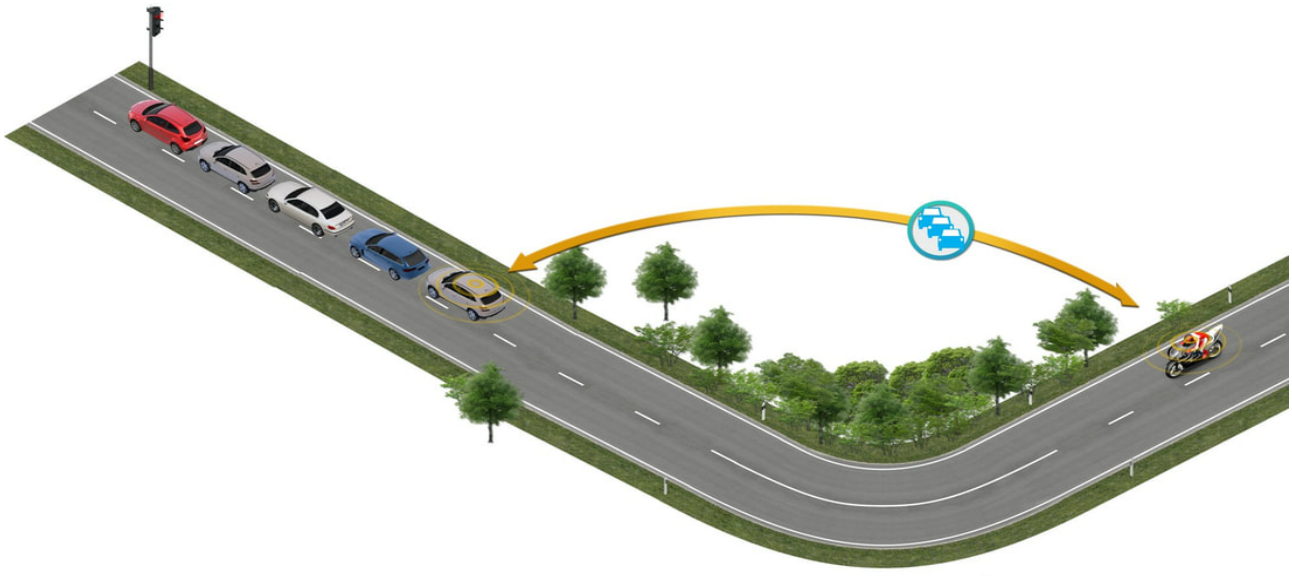


Figure 1.5 Forward Collision Warning[2]

5. Do-Not-Pass Warning

Do-Not-Pass Warning (DNPW) warns the driver that it is not safe to pass a slower-moving vehicle when vehicles are approaching from the opposite direction.

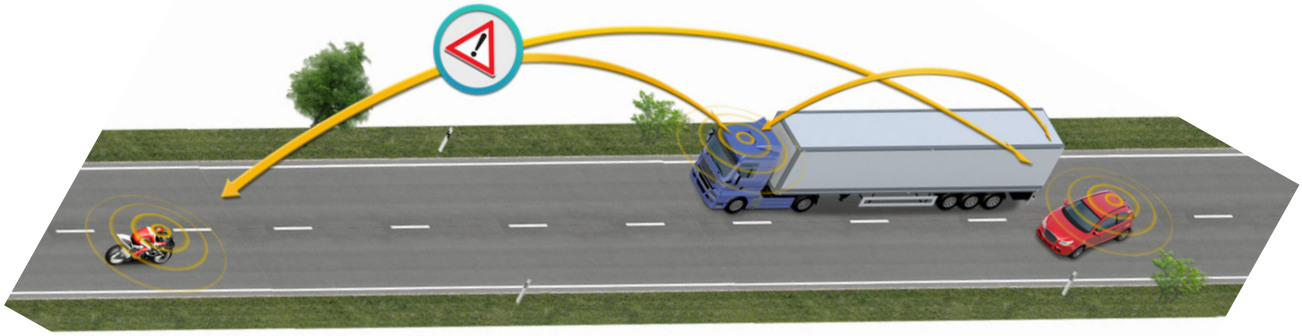


Figure 1.6 Do-Not-Pass Warning[2]

6. Green Light Optimized Speed Advisory

By sharing information with traffic light infrastructure, the GLOSA system can provide a speed advisory to the rider, so that the motorcycle can pass the oncoming intersection while the traffic light is green. This will enable a smoother traffic flow and optimum efficiency by avoiding unnecessary braking and acceleration. The application can also display the remaining time till green in case the light is red, and so mitigates rider's stress.

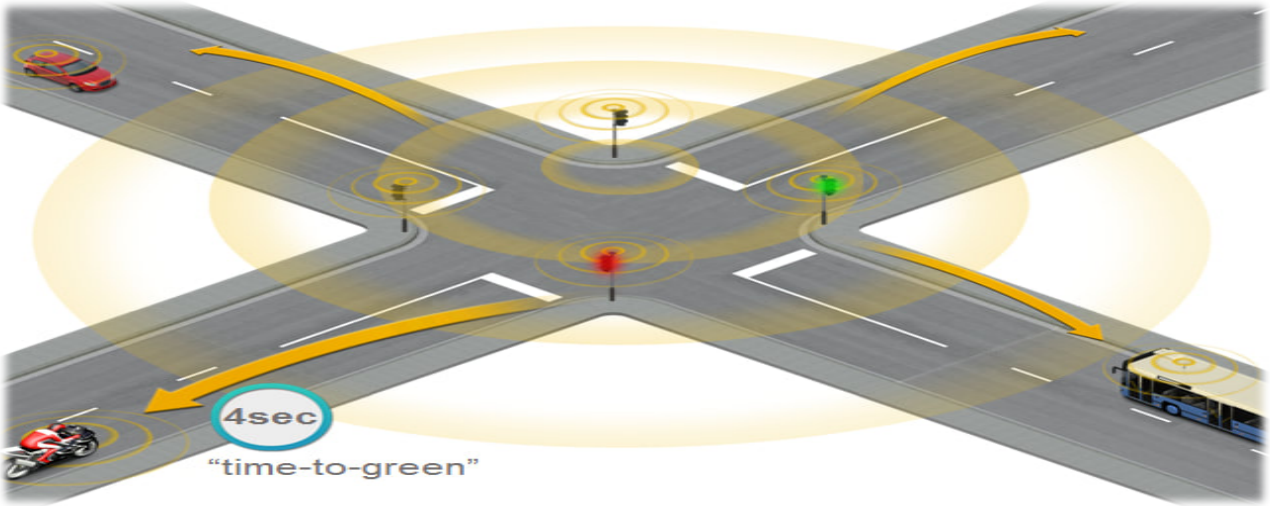


Figure 1.7 Green Light Optimized Speed Advisory[2]

2. Initiation Phase

2.1. Scope Statement

Project Scope Statement includes at least a product scope description, product user acceptance criteria and detailed information on all project deliverables.

(Version 01)	
Project Title: V2V Systems	**Date:** March 26, 2019
Project Justification: The goal of V2V communication is to prevent accidents by allowing vehicles in transit to send position and speed data to one another over an ad hoc mesh network. Depending upon how the technology is implemented, the vehicle's driver may simply receive a warning should there be a risk of an accident or the vehicle itself may take preemptive actions such as braking to slow down.	
Characteristics and Requirements: 1. A Head Team will find the best programing languages, web server, Network equipment, sensors and internet provider to meet the project requirements. 2. The Head Team will create 4 teams: Development team, Networking Team, Testing team and Training team. 3. The developer has to create a code for the program and be installable on the most useable platforms in the market. 4. The networking team will install external network infrastructures that need to be fully Distributed Systems. 5. The testing has to make sure that there aren't any bugs or exactions in the code before the final release.	
Summary of Project Deliverables: **Project management-related deliverables:** business case study, charters, team contracts, scope statements, WBS, schedule, cost baseline, status reports, final project presentation, final project report, lessons-learned report, and any other documentations required to manage the project. **Product-related deliverables:** 1. Design documents. 2. Training and safety workshops 3. Promotional Website. 4. Invitation Emails. 5. Resource efficiency and innovative culture.	

Project Success Criteria:

1. Meeting the Planned budget is important successful criteria.
2. Finding some interested sponsors for fund of the project.
3. All of the documentation must be ready on the release day and all the software and hardware versions are installed and ready for demonstration.
4. Finding the number of automobile companies whom were interested in buying the software after the releasing event.

Table 2.1 : Scope Statement (version 1)

(Version 02)

Project Title: V2V Systems **Date:** May 29, 2019

Project Justification:

The goal of V2V communication is to prevent accidents by allowing vehicles in transit to send position and speed data to one another over an ad hoc mesh network. Depending upon how the technology is implemented, the vehicle's driver may simply receive a warning should there be a risk of an accident or the vehicle itself may take preemptive actions such as braking to slow down.

Characteristics and Requirements:

1. A Head Team will find the best programing language, web server, Network equipment, sensors and internet provider to meet the project requirements.
2. The Head Team will create 4 teams: Development team, Networking Team, Testing team and Training team.
3. The developer has to create a code for the program and be installable on the most useable platforms in the market.
4. The networking team will install external network infrastructures that need to be fully Distributed Systems.
5. The testing has to make sure that there aren’t any bugs or exactions in the code before the final release.
6. Networking team will ensure of high mobility of network nodes.
7. A user friendly GUI to meet the targeted customers

Summary of Project Deliverables:

Project management-related deliverables:

business case study, charters, team contracts, scope statements, WBS, schedule, cost baseline, status reports, final project presentation, final project report, lessons-learned report, and any other documentations required to manage the project.

Product-related deliverables:

1. Design documents.
2. Training and safety workshops
3. Promotional Website.
4. Invitation Emails.
5. Resource efficiency and innovative culture.
6. Infrastructure Details
7. Platforms versions.
8. Installation steps.

Project Success Criteria:

1. System meets all functional and safety requirements and adaptable in implemented infrastructure/external environment.
2. Meeting the Planned budget is a important successful criteria.
3. Finding some interested sponsors for fund of the project.
4. All of the documentation must be ready on the release day and all the software and hardware versions are installed and ready for demonstration.
5. Finding the number of automobile companies whom were interested in buying the software after the releasing event.

Table 2.2 : Scope Statement (version 2)

(Version 03)

Project Title: V2V Systems **Date:** August 04, 2019

Project Justification:

The goal of V2V communication is to prevent accidents by allowing vehicles in transit to send position and speed data to one another over an ad hoc mesh network. Depending upon how the technology is implemented, the vehicle's driver may simply receive a warning should there be a risk of an accident or the vehicle itself may take preemptive actions such as braking to slow down.

Characteristics and Requirements:

1. A Head Team will find the best programing language, web server, Network equipment, sensors and internet provider to meet the project requirements.
2. The Head Team will create 4 teams: Development team, Networking Team, Testing team and Training team.
3. The developer has to create a code for the program and be installable on the most useable platforms in the market.
4. The networking team will install external network infrastructures that need to be fully Distributed Systems.

5. The testing has to make sure that there aren't any bugs or exactions in the code before the final release.
6. Networking team will ensure of high mobility of network nodes.
7. A user friendly GUI to meet the targeted customers
8. The training team has to train the retailers on the new product and all the help if needed.
9. A advertisement campaign will introduce the system especially on the internet.

Summary of Project Deliverables:

Project management-related deliverables:

business case study, charters, team contracts, scope statements, WBS, schedule, cost baseline, status reports, final project presentation, final project report, lessons-learned report, and any other documentations required to manage the project.

Product-related deliverables:

1. Design documents.
2. Training and safety workshops
3. Promotional Website.
4. Invitation Emails.
5. Resource efficiency and innovative culture.
6. Infrastructure Details
7. Platforms versions.
8. Installation steps.

Project Success Criteria:

1. System meets all functional and safety requirements and adaptable in implemented infrastructure/external environment.
2. Meeting the Planned budget is a important successful criteria.
3. Finding some interested sponsors for fund of the project.
4. All of the documentation must be ready on the release day and all the software and hardware versions are installed and ready for demonstration.
5. Finding the number of automobile companies whom were interested in buying the software after the releasing event.
6. Make some trust agreements with some portable device manufactures.

Table 2.3 : Scope Statement (version 3)

2.2. SWOT analysis

SWOT analysis has been performed in this project because it guide us to determine the internal strengths of the V2V systems. In addition, this type of analysis is necessary in the initial stage of planning due to the clearness it is made to all problems of system. In particular, SWOT analysis introduced us to strengths, weaknesses, opportunities and threats of V2V systems.

Strengths

- Provide accessibility to non-drivers.
- Autonomy is necessary technology and intelligence that available on board.
- Increases safety and comfort
- Smooth traffic flow
- Potential to decrease the number of road accidents.
- Potential to decrease the number of parking spaces needed, freeing space for other more productive land uses (especially in areas where space is scarce, like city centers).

weaknesses

- Costs: today technology demands the installation of vehicle systems or/and infrastructure systems that are still expensive.
- Most of the countries do not have legislation that allows the use of autonomous vehicles on non-dedicated infrastructure. This is the reality in the Netherlands today.
- Electronic security: there may be hacking of the vehicle management system.
- Privacy: who controls the data that is being generated and transferred between the vehicles and between the vehicle and the infrastructure?
- Limited wireless/telecom bandwidth availability for V2V communication.
- New vehicle models needed to cope with the greater usage intensity of each vehicle.

Opportunities

- Potential to increase road capacity (shorter headways) and thereby reduce congestion.
- Enabling network-wide beneficial system setting via V2V and V2I communication.
- Technology maturity may reduce system cost.
- sustainability might increase by more fuel efficient driving
- Central data processing approach for different sensing functions increases functional safety and real time processing
- Increasing cooperation with AI-software/IT specialist and automotive industry concentrating on development of solutions for automated driving.

Threats

- Uncertainty on deployment staging.
- Technology investments needed for supporting the use of the automated vehicle may not be possible due to lack of funds.
- Poor user acceptance
- The development of different regulations in different regions of the country. If there is no top-down coordination from the national government, or if regional authorities do not work together or communicate with each other.
- Fusion of image and non image data cannot be solved accurately
- Uncertainty regarding bandwidth and electromagnetic interference
- Lack of sufficient training data

2.3. Weighted Decision Matrix for the Project

A weighted scoring model is a tool that provides a systematic process for selecting projects based on several criteria. We have 4 ways to implement the more reliable V2V systems using: Sensors, Cameras, Radar & DSRC (Dedicated Short-Range Communication).

V2V messages have a range of approximately 300 meters, which exceeds the capabilities of systems with ultrasonic sensors, cameras, and radar – in some cases, by nearly double the distance, allowing more time to warn drivers. From the result we can see that V2V communications can detect the threat much earlier than radar or camera or sensors.

We used the weighted model to make a decision on which project to invest in. the criteria we used was Position & Motion Accuracy, Cost, Vehicle safety extension, Communication coverage and Data exchange/message structure.

Criteria	Weight	Sensors	Cameras	radar	DSRC
Position & Motion Accuracy	40%	85	62	77	90
Cost (million)	5%	95	75	55	70
Vehicle safety extension	20%	80	70	80	90
Communication coverage	10%	75	60	82	75
Data exchange/message structure	25%	70	65	80	95
	100%	79.75	64.8	77.75	88.75

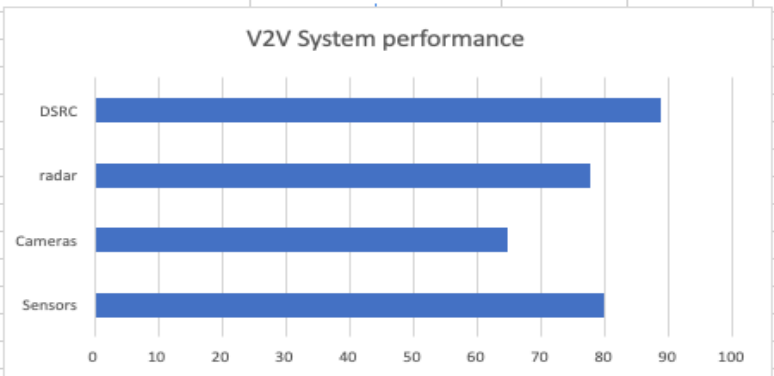


Figure 2.1 : Weighted Decision Matrix

2.4. Business case

Date : 10/January/2019

1.0 Introduction/ Background

Connected Vehicle research has emerged as one of the highest priorities in the transportation field because connected vehicle technology has the potential to improve safety, mobility, and environment for local and wide-area traffic management and operation. Connected vehicle system can be divided into Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communications using wireless technologies such as Dedicated Short Range Communications (DSRC). Connected vehicles can provide continuous real-time connectivity to all system users between vehicles, infrastructure, wireless devices, and transportation management centers. The vehicles equipped with V2V communication system can exchange their data between nearby vehicles such as position, speed, and location data. V2V communication enables an equipped vehicle to avoid crashes by receiving warning threats or hazards. V2I communication enables an equipped vehicle to exchange safety and operational data with highway infrastructure.

2.0 Business Objective

The goal of V2V technology is to establish a real-world operating environment for additional safety, mobility, and environmental applications development. The claim is that V2V communication, in conjunction with the vehicle to infrastructure communication, could reduce crashes by up to 80 percent. Depending upon how the technology is implemented, the vehicle's driver may simply receive a warning should there be a risk of an accident or the vehicle itself may take preemptive actions such as braking to slow down.

3.0 Current Situation and Problem/Opportunity Statement

- Nine scenarios are analyzed in this study based on two variables, market penetration rate of equipped vehicles and wireless communication coverage. Two market penetration rates of equipped vehicles (10%, 20%), and three wireless communication coverage (100m, 200m) are evaluated for the two study area networks. In this study the maximum wireless communication coverage is limited to 200m.
- DSRC’s typical transmission range is estimated to be on the order of 350m, with a best-case range under the most favorable conditions of less than 509m[3].

4.0 Critical Assumption and Constraints

- V2V system projects require a large number of interdisciplinary components to merge to ensure final project success. The assumption of covered range is upto 1000m using Infrastructure wireless communication network and work in the development a V2I and V2V communication mechanism that allows a global optimization of the congestion not for individual trips of the vehicles, but for the whole vehicular network.
- This project has to match the three important requirements which are privacy, secure and safety. Budget and time and system installation compatibility with the vehicle will be major constrains for this project.

5.0 Analysis of Option and Recommendation

- Invest more in project management and project development and research to gain profitable outcomes of the project.
- Contracts with government giving the project more credits.
- Contracts with private or cooperate companies which would provide more flexibility.
- Collaboration with government and private sectors would provide financial security as well as flexibility.

6.0 Budget Estimate and Financial Analysis

The estimated budget for this project is $1,75,658 CAD. This budget is covering everything such as Software development, Hardware development, Installation cost, Testing cost, Marketing Cost, Human resources, excavation, Network equipment, etc. Any changes of the project it should be within the planned budget.

7.0 Schedule Estimate

- Planning (1-2 years) : Project Resource Assessment, Requirement gathering
- Designing (1-2 years) : Network Infrastructure, Development method, System Design
- Operations (1- 4 years) : Development, Maintenance, Marketing, Training, Exploration
- Closure (1- 4 years) : Compliance, On-going Testing, Changes

8.0 Preliminary Project Requirements

- Large and very secure database and servers.
- User Friendly GUI
  Experienced development team.
  Networking Equipments
  Since it is a prototype project, required sufficient budget.
  Learning and support program to educate customers/retailers

9.0 Potential Risks

- Finishing the project within the approved project schedule
- Finishing the project within the approved budget.
- The quality of the final product.
- Commodity market and the requirements, the volatility of the commodity markets and the unpredictable change of requirements.
- The development of different regulations in different regions of the country. If there is no top-down coordination from the national government, or if regional authorities do not work together or communicate with each other.

Table 2.4 : Business case

2.5. Project charter

Tittle : Vehicle to Vehicle Communication System (V2V system)

Project Start Date : 5/January /2019 Project **Finish Date** : 21/January/2023

Project Manager : Deep Alpesh Patel, (deeppatel2223@gmail.com)

Budget Information : For this project total budget allocated is $1,75,658. Most of this planned budget will be utilise in the most important the Implementation & Planning phase.

Project objective : The objective of V2V technology is to establish a real-world operating environment for additional safety, mobility, and environmental applications development. The claim is that V2V communication, in conjunction with the vehicle to infrastructure communication, could reduce crashes by up to 80 %. Depending upon how the technology is implemented, the vehicle's driver may simply receive a warning should there be a risk of an accident or the vehicle itself may take preemptive actions such as braking to slow down.

Toward success and approaches

- Weighted Scoring model Approach
- Make skilled project team.
- Determining the success measure for the project.
- Proper software life cycle for successful completion of project.
- Getting all work done in time and should stay in budget limits.
- Providing all latest hardware configurations and licensed software's for the developers.
- Studying every aspect of the V2V systems for continuous improvements.

Role	Name	Position	Contact Information
Project Manager	Deep Alpesh Patel	Manager	deeppatel2223@gmail.com
Programming consultant	Blesson Samuel Benny	Software Developer	blessonsam1995@gmail.com
Hardware design consultant	Mohan Kumar killadi	System Engineer	killadimohankumar02@gmail.com
Applications support specialist	Shahbaaz Mohammad	Technical and System Training	md.shahbaaz.2994@gmail.com

Table 2.5 : Roles and Responsibilities

Sign-off :

3. Planning Phase

3.1. Team contract

Project Name: Goyer Mines

Project Team Members Names and Sign-off:

Name	Position	Sign-off (Initials)
Deep Alpesh Patel	Project Manager	DP
Blesson Samuel Benny	Software Developer	BS
Mohan Kumar killadi	System Engineer	MK
Shahbaaz Mohammad	Technical and System Training	SM

Table 3.1 : Team contract

Code of Conduct: We will:

- Completion the work on the relegated date and time.
- Attend to all the problems that are coming in our way during the project.
- Communicate & share the problems with every member of the team at all costs.
- Respect all the decisions made as a team. [6]

Participation: We will:

- Ensure that all the members will be a part of all the team meetings no matter what.
- Make sure that each individual of the team is relegated individual duties to be satisfied apart from the work done as a team.
- Take all the major decisions in the presence of all the other team members and never object the majority decision.
- Be conscious about the choices that we made and ensure that the university and its reputation is not degraded in any way possible. [6]

Communication: We will:

- Share and talk all the disadvantages before we begin any of the steps.
- Update the whole group regarding all the advancement made and provide constant finishing status consistently.
- Come to common grounds whenever there is a slight difference during any phases.
- Slender the summed topics and focus mainly upon the major tasks and goals. [6]

Problem Solving: We will:

- Help and attend to each and every problem as soon as it has been reported.
- Help our comrades if they‘re unable to handle something on their own.

- Refer to already existing projects as much as possible to gain more knowledge and experience so that we can avoid the mistakes made by them. [6]

Meeting Guidelines: We will:

- Be punctual for all our team meetings.
- Respect all the other team members‘ privacy at all costs.
- Have extra meetings if necessary.

3.2. Kick-off meeting

Date: 12/29/2018 Next Meeting Date: 01/29/2019

Meeting Objective: the purpose of the kick off meeting is to stand on the project objective, and clarify project objectives to team members in order to begin the project in the right way.

Action Item	Agenda	Examples	Due Date
Introduction	Introduce key team member	This section identifies names and titles of key team members, such as the project manager, business sponsor, etc.	12/29/2018
Project Overview	A high-level discussion of the project objectives	This section articulates the big picture about the project and its business objectives.	01/01/2019
Project Team	Identify project team and business project team members	List resources for both project team and business. Usually, these resources will be in attendance in the kickoff meeting.	01/08/2019
Roles & Responsibilities	Define the roles and responsibilities of key team members of both the project team and business	This section can be combined in the agenda with the project team introductions.	01/15/2019
Project Timelines & Milestone	Provide a high-level overview of the key milestones and overall timeline of the project	These details can be provided in Microsoft Project or other format as appropriate.	09/11/2020

Issues & Risks	Identify known risks to the project. This identification is the basis to schedule the risk identification meeting.	These risks can be bulleted either in a word document or a PowerPoint presentation	11/18/2022
Plan Review	As appropriate, drill down into the detail of the work to be performed. This review is a continuation of the project overview performed earlier	A bulleted objectives/goals list for the meeting is useful. With a complete copy of the Plan, team members can review prior to the kickoff meeting and be prepared.	10/27/2020
Communication Plan	Identify key communications that will take place during the project	This identification will usually be a table of communications, such as weekly status reports, status meetings, etc.	04/25/2019
Metrics/ Reporting	Identify any metrics and reports that will be required during the project	This identification could be status report requirements or any other quantitative measurements required by the business.	12/28/2020
Action Items	Articulate all action items coming from the meeting	During the kickoff meeting, minutes should be taken into account and action items be documented. This is the time to review and receive consensus on the action.	08/11/2021

Table 3.2 : Kick-off meeting

3.3. Mind Map

See Appendix # 5

3.4. Gantt chart

See Appendix # 1

3.5. Work Breakdown Structure (WBS)

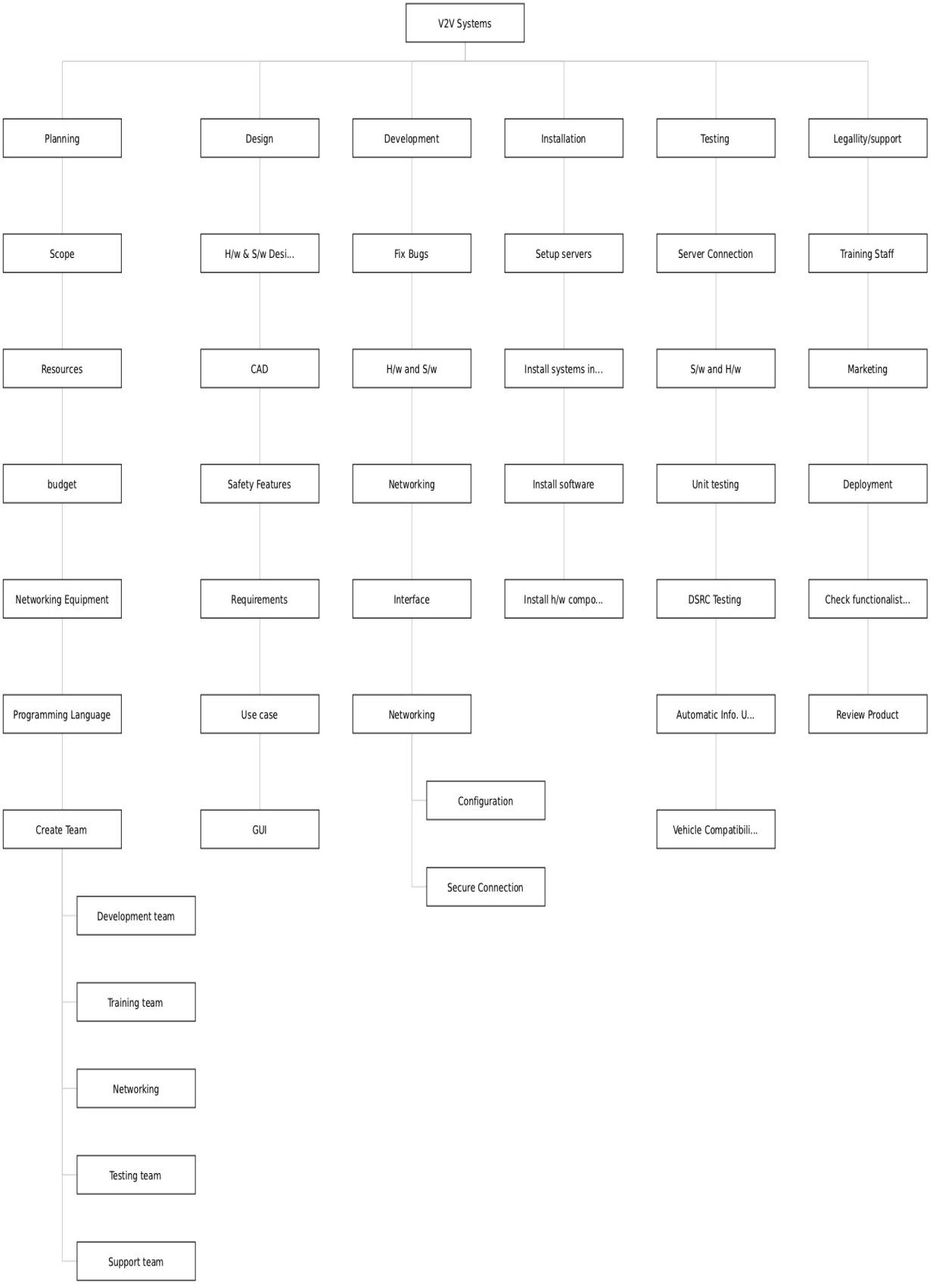


Figure 3.1 : WBS

3.6. Milestone list

Used for observing and measuring the progress of the project.

Milestone	Date	Status	Responsible
Selecting the project	12/25/2018	Achieved	Deep
Information Gathering	12/29/2018	Achieved	Blesson & Mohan
Requirement Gathering	03/02/2019	Achieved	Blesson & Mohan
Project initiation	01/05/2019	Achieved	Mohan & Shahbaaz
SWOT Analysis	03/10/2019	Achieved	Mohan
Business case	01/10/2019	Achieved	Mohan
Planning Phase	08/17/2019	To be achieved	Deep, Mohan & Blesson
Execution Phase	02/01/2020	To be achieved	Blesson
Change in plans & actions	07/15/2022	To be achieved	Deep & Shahbaaz
Project Closure	01/21/2023	To be achieved	Deep, Mohan, Blesson & Shahbaaz

Table 3.3 : Milestone list

3.7. Activity and resource requirement list

See Appendix # 2

3.8. Activity cost estimates

See Appendix # 3

3.9. Network diagram

See Appendix # 4

3.10. Quality Management and Assurance Plan

Introduction

This document is being set up after a through consultation with Quality Assurance team. The primary objective creating this document is to list down a set of standards to be followed at every phase of the project. Maintaining a common quality standard is significant in light of the fact because it helps in the longevity of the project and guarantees the satisfaction of the investors of the project. [5]

Purpose

The principle motivation behind the creation of this document is to ensure that all the equipment's and other raw materials , Hardwares and systems are of superior quality. This will also reduce the hazard to human life as there is no inferior product being used during the project at any point. Keeping up the quality likewise guarantees that the task remains on track and evades delays.

Policy Statement

Based upon the history of our construction projects in the past, our organization has been known for the superior quality of our projects. Ensuring equal rights to the employees as well as satisfying our clients is our top priority at all times.

Scope

The scope of the QA plan is to ensure that the proper software lifecycle model have been followed and at each stage the proper documentation has been done. It assures the following:

- The SRS record characterizes the extension and usefulness of the product
- Documentation is done in timely and detailed fashion during the planning phase
- Programming language is followed during development phase
- Function module analysis has been done for each module developed
- Appropriate database analysis has been done
- Second version of SRS is being made and a problem-solution document has been made

Organizational structure

The organization is hierarchical in nature and execution. There are different teams working on different projects at a time, additionally we have master committed groups chipping away at tackling specialized issues experienced during any venture improvement stage. Each project has a project manager and a team of highly skilled and enthusiastic professionals, dedicated to achieve success during any project given to them. QA team tracks record of all the projects and assures appropriate advancement of progress and quality simultaneously. Project managers report to a senior manager and are encouraged to plan ahead with their teams.

3.11. Change Management Plan

Change management plan is needed in order to succeed in the future. Change is inevitable and should occur so companies do not stay stagnant and continue seeking all the time to same activities. On the other words, Change management training is needed in order to succeed in the long run. To ensure that the project is going on the right way, we have to re-evaluate continually the activities in the project. The changes could impact the time and the cost of the project, so changes should be chosen very carefully and reasonable. Some steps to Write a Change Management Plan are listed below:

Demonstrate the reasons for the change [4]

1. Determine the scope
2. Identify stakeholders and the change management team.
3. Review and Audit Process
4. Clarify the expected benefits.
5. Milestones as well as costs must also be clearly outlined.
6. Create a change management communication plan.

There are three basic elements to communications in the context of change management.

- Identify the stakeholders and those impacted by the change.
- Next, schedule regular face to face interactions and email communications to keep stakeholders updated on progress.
- Finally, communications should be consistent, thorough, and regular. Communications should also clearly explain the change, define the reasons for change, present the benefits of the change, and always include change owner's contact information.

Change Management Processes and Systems includes

- Configurable change request forms
- Change approvals
- Change monitoring
- Updating change
- Change assignment
- Ability to classify as a change and reclassify as a defect if necessary
- Schedule of changes
- Configurable change management processes
- Role assignment
- Change log for historical tracking
- Budgeting and cost controls
- Ability to break work down into tasks

3.12. Communication Management Plan

Introduction The main objective of this document is to make sure that all the team members are updated about all the situations that are taking place at all times. An update sheet must be regularly updated where all the progress made until the previous day must be noted for the next person to carry forward.
Collection and filing structure for gathering and storing project information All the information gathered must be shared with each and every member of the team so that every person is equally educated about his/her roles and duties for the following day.
Distribution structure (what information goes to whom, when, and how) All the information must be shared in the progress report from the previous day. The person who is responsible of a job must make sure that the information is passed onto the next person responsible. The progress report must be sent to a common email address at the end of each day.
Frequency of communication The progress report must be sent to a common email address at the end of each day.
Escalation procedures As soon as a risk is detected at any point, the risk should be reported to the risk management team. Once the risk analysis team receives the risk report, the person in charge of that department will be responsible for contacting the respective organization and eventually work out a plan to take appropriate measures.

Table 3.4 : Communication Management Plan

Tools and Techniques for communication are as follows:

Tools & Techniques	Proportion
Emails	As needed
Face to face Meetings	Monthly
Telephone	As needed
Documentation	To be conveyed instantly
Code Repository for Developers	as soon as deliverable code developed
Text Messages	As needed
Fax	As needed

Table 3.5 : Tools and Techniques for communication

3.13. Risk Register

No.	Risk	Description	Root Cause	Potential Responses	Risk Owner	Probability	Impact
R1	Privacy leakage	Compromise security	Leak of private data	Implement Security measures	Software Developer & System Engineer	High	High
R2	Cost overrun	The used equipment may change because of new technologies	Stop/Delay the project	Relay on expert to advise if the equipment able to upgrade without change the whole things	Installation team	High	Medium
R3	Schedule delay	If the applications have bugs after the second test, it will cause delays.	Delaying the project	Assign new members in the testing team	Manger	Medium	Low
R4	Cost overrun	The exact price is unknown	Increase the cost	Relay on expert to review the estimating	Installation team	Medium	Low
R5	Quality	Stockholders' satisfaction	Level of acceptance	Progress report after each phase	QA team	Medium	Medium
R6	Software Manipulation	Software hack	Can fail the project	Implement Security measures	Software Developer	Low	High
R7	Lack of Productivity	integral measure of performance is low	Poor allocation of resources to all projects	Closer timesheet tracking from project managers to all sites	Project Manager & Software Developer	High	High
R8	Skill shortage	Longer project duration must be anticipated in order to balance between local and external workforce	Frequently changing technology	Company must conduct technical training to increase workforce skills.	Technical and System Training	Medium	High

Table 3.6 : Risk Register

3.14. Probability Impact Matrix

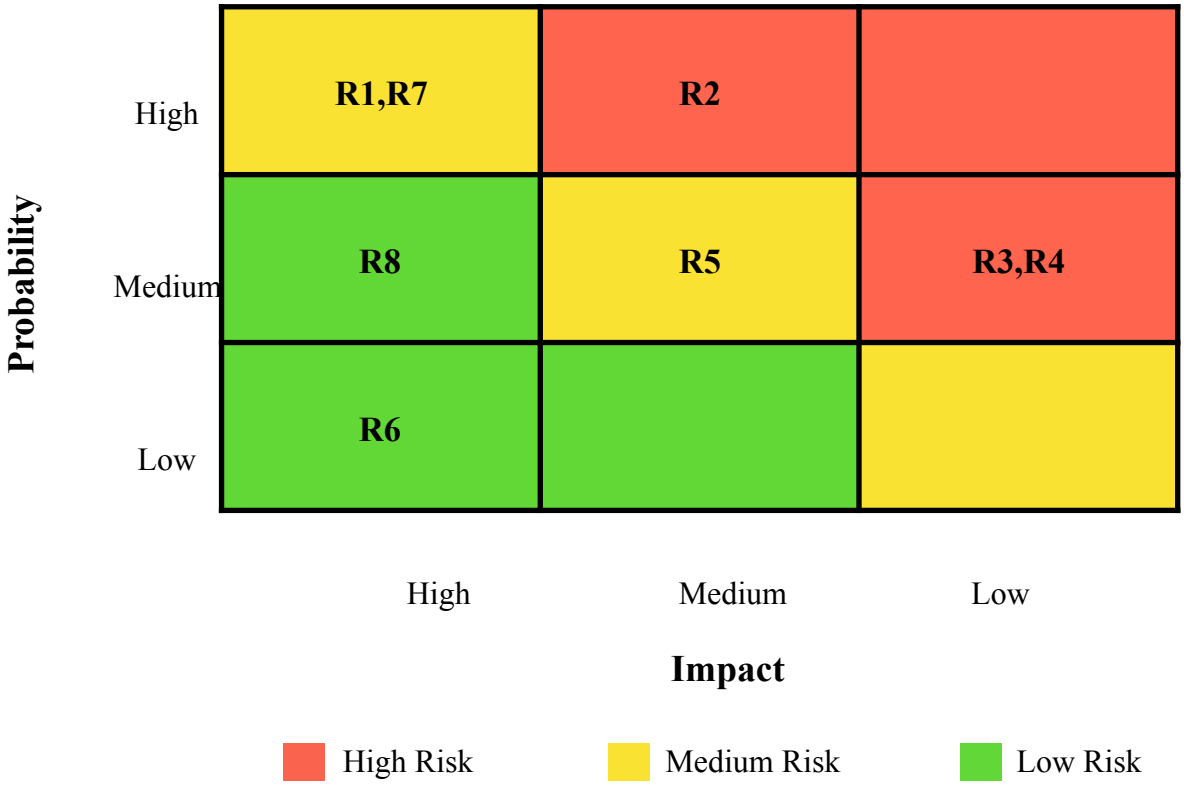


Figure 3.2 : Probability Impact Matrix

3.15. Risk Breakdown Structure

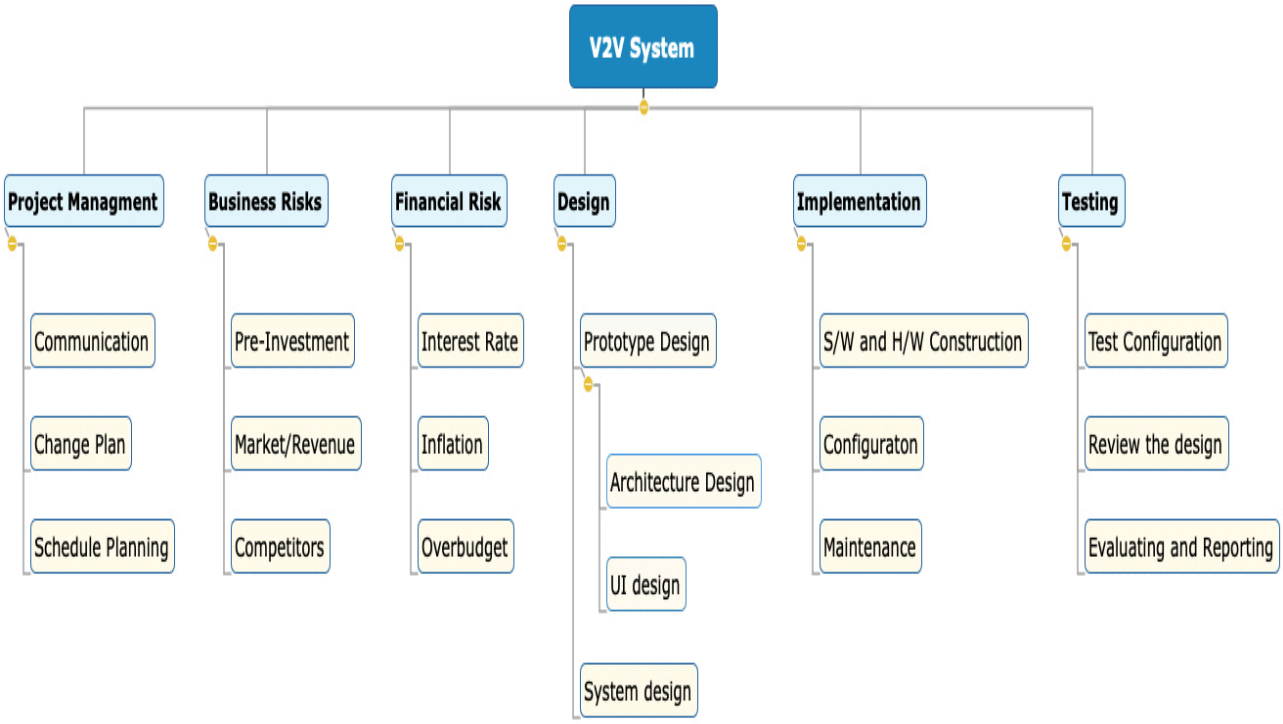


Figure 3.3 : Risk Breakdown Structure

4. Execution Phase

4.1. Work performance information

Status/Progress Report (1):

Reporting Period: 2/27/19- 3/21/19
Work completed in this reporting period: • In the beginning, we created our development and support, testing and training teams as the successes of the project depends on these attributes. • suitable database and web server and programming language were selected. • Initiate development of software
Work to complete next reporting period: • We will configure the server to work as a server, create apps for all operation systems, install interface, database on web server etc. • Proper testing tools will be used to examine every side of the V2V system and if bugs found corrective steps should be adopted to correct that error and again retesting of the system would be done to ensure 100% performance
What's going well and why: • We got enough information about our project and whatever we are trying to implement, it's going in a positive manner. • Testing was successful on all the operating systems
What's not going well and why: • Some problems with DSRC connectivity and our team is working to solve this problem • Some differences in development team members but going good with them.
Suggestions/Issues: • Proper time management and cost management should be done so as to complete this project while staying in limits.
Project changes : • Some changes in the development team are done as some of the programmer were cloning the programs for the system and this is not accepted. • Time duration given for the implementation phase increased, so that the number of bugs should be as less as possible.

Table 4.1 : Progress report 1

Status/Progress Report (2):

Reporting Period: 5/27/20- 6/21/20
Work completed in this reporting period: • Executable code is almost developed and was running without any error. • All staff members are aware of their tasks to be completed during the whole project. • Further development in software and hardware.
Work to complete next reporting period: • We will maintain the server to work as a server, create apps for all operation systems, install interface, database on web server etc. • Our product will be tested with many different work environment in order to check its validity for that system environment.
What's going well and why: • Testing was successful in all the environment scenarios • Due to the proper distribution of the tasks there is a good planned and very good going of the execution
What's not going well and why: • Some problems with DSRC interface and our team is working to solve this problem. • There is some security problem regarding the crypto systems
Suggestions/Issues: • Some good ethical hackers are hired in order to test the security of the developing system.
Project changes : • No changes were made to the project during this period.

Table 4.2 : Progress report 2

Status/Progress Report (3):

Reporting Period: 8/27/22- 10/21/22
Work completed in this reporting period: • We are in the testing phases the project our application is being tested with different work environment • Bugs tracking was also done in order to improve the performance of the product-related • We are just in the closing phase in a while after the testing is done.
Work to complete next reporting period: • We The project should be closed by next phase.
What's going well and why: • Due to the proper coordination of the staff, stakeholders the project will finish as a success • Testing was successful on all the operating systems
What's not going well and why: • Security is the basic problem which is still a big issues as all the credentials are to be saved in the database and should not be compromised at all cost
Suggestions/Issues: • No suggestions
Project changes : • No changes were made to the project during this period.

Table 4.3 : Progress report 3

4.2. Quality Assurance Checklist

Quality Control Checklist In the inspection section all Quality Metrics inspect by using Quality Control checklists, you can see an example of this checklists.

Metrics	Standards	Control checking list		
		Yes	No	N/A
Working conditions	Does the project have an experienced project manager and executive sponsor assigned to the project?	✓		
	Are all project roles and responsibilities clearly defined and assigned?	✓		
	Are accepted industry best practices for project management being followed?	✓		
Requirement analysis	Does the project plan contain all the tasks required to successfully deliver the project?	✓		
	Have the available requirements been analyzed accurately?	✓		
Risk Management	Does a Risk Management Plan exist for the project?	✓		
	As risks are encountered are they being confronted in a timely manner to determine a proper response strategy?	✓	(minor)	
	Is the project experiencing variances from schedule baselines? Have significant milestones been missed? If so how frequently?	✓	(minor issues)	
Budget	Is the project underperforming or overperforming?			✓
Testing	Does the project have clear criteria for testing and acceptance?	✓		
Support	Is proper training, knowledge transfer and documentation accompanying all deliverables?	✓		

Table 4.4 : Quality Assurance Checklist

5. Monitoring and controlling phase

5.1. Measure project performance

Expected	16	18	16	16	9
Actual	14	19	17	18	11

Figure 5.1 : Measure project performance

The Values decided by us during our planning phase had low and this was realized during the execution phase of the project. This led to an overrun in our project as we had to switch to higher quality of system. This also caused a considerable delay in the overall time frame of our project. The bar graph above displays our progress during the overall duration of the project.

5.2. Noncompliance Reporting Procedures

Noncompliance issues have to be reported to the Project Manager. Reporting and analyzing the causes of non-compliance is done using cause-effect diagrams. Also it is up to the discretion of the Project Manager to use the proper tools to analyze any problem that occurs as he/she sees fit. A timely report of all the progress made each day was sent to the Project Manager. This helped the project manager to understand the real time status of the project and it also helped him in assigning the duties to the appropriate member of the allocated team.

5.3. Change requests and recommended actions

Change Request (1)
Project : V2V systems **Description**: Cost should be increased to reach a higher level of security and proper information exchange between vehicles. **Submitted**: January 22/2020
Change Category: cost
Description of change requested: The cost that was estimated to Secure the connection is not that enough. To reach a higher level of security there is 3000$ should be added.
Events that made this change necessary or desirable: It is requested that the cost of Securing the connection should be changed from $2000 to $3000 due to many reasons. The level of security it is very important due to that fact that we deal with very sensitive information. Moreover any vulnerability will affect the whole Software at the end.
Justification for the change: Knowing that the security issue is very important, this makes us focus on security as much as we can. Safetly is also another important issue, related to this.
Impact of the proposed change on: • **Scope**: No • **Schedule**: No • **Cost**: Yes. $3000 will be added to the final cost of the project • **Staffing**: No • **Risk**: No • **Other**: No
Suggested implementation if the change request is approved: The development team, Management team and Maintenance team should be informed about the change in the security level

Table 5.1 : Change Request 1

Change Request (2)

Project : V2V systems
Description: The advertising should be started earlier
Submitted: March 11/2021

Change Category: Schedule

Description of change requested:

The advertising for the project should be started from the beginning of the project which means 6 months before.

Events that made this change necessary or desirable:

Due to the fact that the number of Automotive companies who interested to use the software in their vehicles should be not too small. Therefore, starting the advertising in earlier time gives the chance for more people to know about the product.

Justification for the change:

Advertising issues make the difference between the products, people are more likely to trust the product that has been advertising more.

Impact of the proposed change on:

- **Scope**: No
- **Schedule**: The advertising is not a predecessor of any activity , so any time changing on this activity will not affect the time of the project (delay the project)
- **Cost**: No
- **Staffing**: No
- **Risk**: No
- **Other**: No

Suggested implementation if the change request is approved:

The advertising team should be informed about the what to include in advertising.

Table 5.2 : Change Request 2

6. Project Closing Phase

6.1. Project Closure Documents

With the aim of providing better accessibility, support and safety to everybody we created this project of V2V Systems. The project is designed keeping in mind the necessity of future technology and innovation. Our primary motivation was to introduce and promote safety in automation industry. Although, the project was overrun in terms of time but we eventually managed to achieve our major motive. This project was considered to be finished in 4 years but it took longer than 4 years to complete as we did not compromise on our major goal of vehicle safety.

6.2. Lessons Learned Document

Project Name: V2V Systems

Project Sponsor: GM Moters

Project Manager: Deep Alpesh Patel

Final Budget: $ 1,75,658

1. Did the project meet scope, time, and cost goals?

No, the project didn‘t meet all its planned goals.

2. What was the success criteria listed in the project scope statement?

It was to ensure vehicle safety and also not to overrun the cost.

3. Reflect on whether or not you met the project success criteria.

However, we managed to achieve scope but were unable to manage time which delayed our project by around 8 months. Our risk management team managed the risks quite efficiently.

4. In terms of managing the project, what were the main lessons your team learned?

- Project planning must include the scope of last minute changes and must be flexible.
- Managing all the difference of opinions.
- There should be tolerance for last minute negotiation and budget changes.

5. Describe one example of what went right on this project.

Information gathering and monitoring phases were right on schedule. And all the required features of V2V systems implemented and work correctly.

6. Describe one example of what went wrong on this project.

Since the project has overschedule, time is the major factor.

7. What will you do differently on the next project based on your experience working on this project?
Spend more time in precise planning and budgeting of the project also flexibility for any last minutes changes.

Table 6.1 : Lessons Learned Document

6.3. Future of V2V Systems

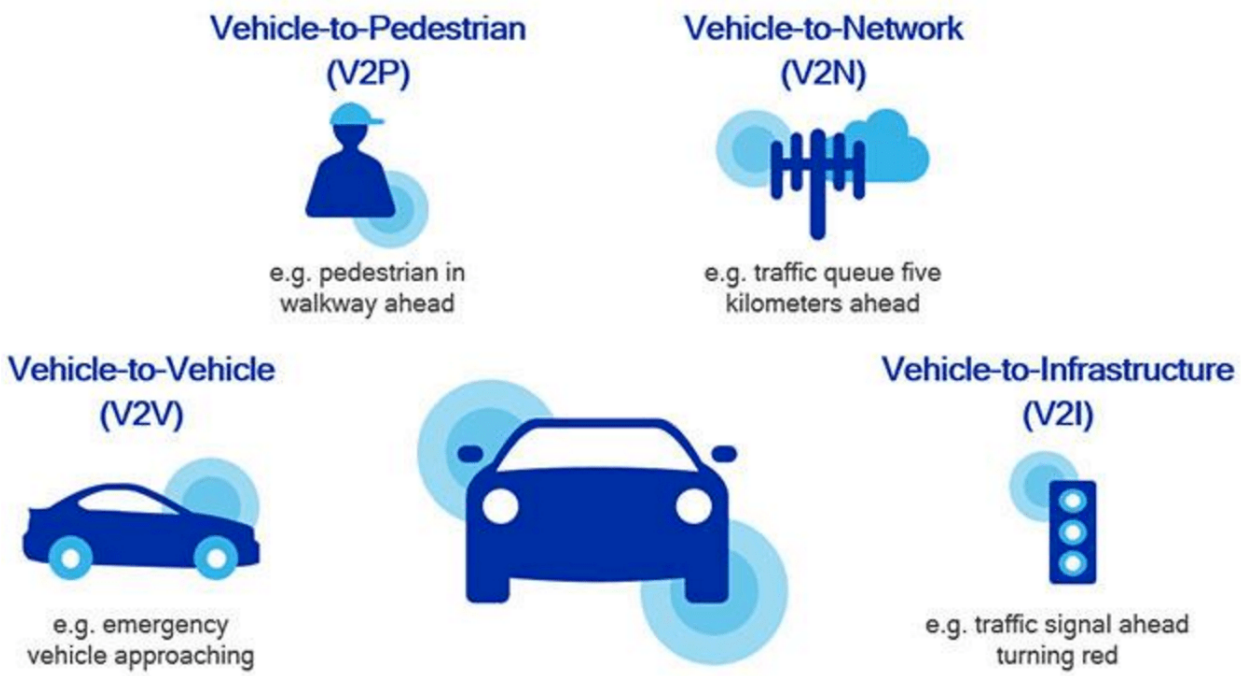


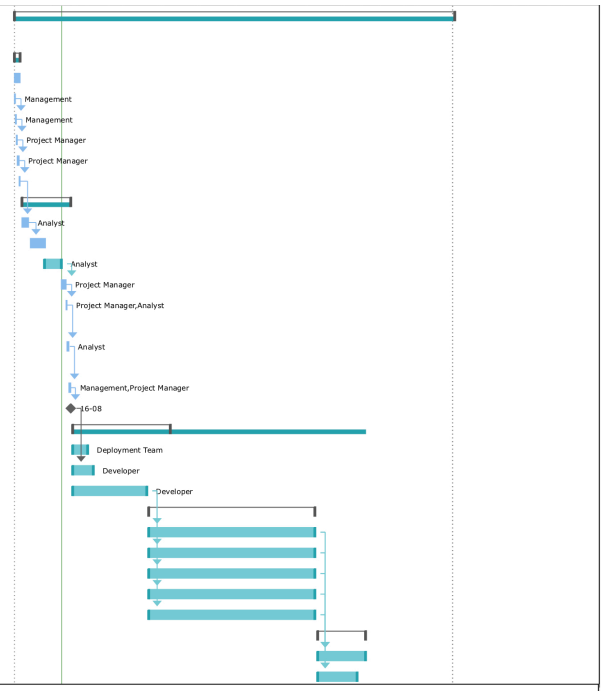
Figure 6.1 :Future of V2V (V2I) [11]

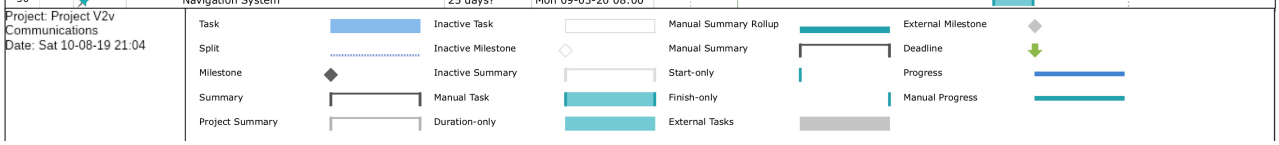
In the not-too-distant future the cars we drive will not only be talking to us, but communicating with each other and the roads. Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies, collectively knowns to as “V2X,” are currently being developed and tested, with initial integration into new car models planned for 2020. This technology allows the cars to be “connected,” providing the capability of alerting or warning the driver of conditions or threats around him, with the potential to reduce traffic jams, prevent accidents and save lives.[8]

7. Appendices

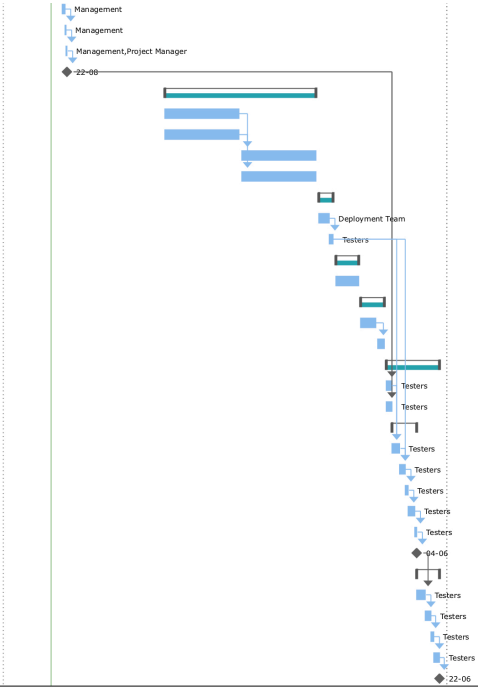
APPENDIX 1 : Gantt chart

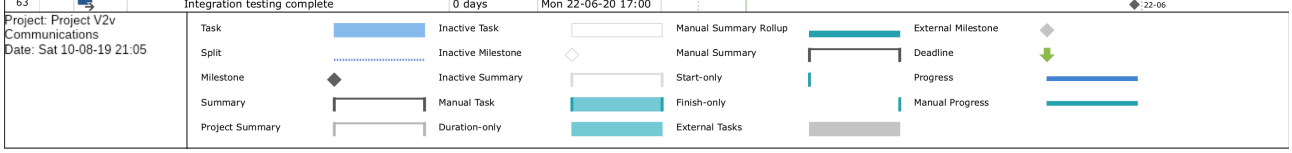
1		**V2V Communications**	**262 days**	**Mon 01-07-19 08:00**
2		**Concept**	**5 days**	**Mon 01-07-19**
3		Kick off meeting	5 days	Mon 01-07-19 08:00
4		Determine project scope	1 day	Mon 01-07-19 08:00
5		Secure project sponsorship	1 day	Tue 02-07-19 08:00
6		Define preliminary resources	1 day	Wed 03-07-19 08:00
7		Brief on avaliable resources	1 day	Thu 04-07-19 08:00
8		Scope complete	1 day	Fri 05-07-19 08:00
9		**Analysis/Software/Hardware Requirements**	**30 days**	**Mon 08-07-19**
10		Conduct needs analysis	5 days	Mon 08-07-19 08:00
11		Draft Preliminary Hardware Specifications	10 days	Mon 15-07-19 08:00
12		Draft preliminary software specifications	10 days	Fri 26-07-19 08:00
13		Develop preliminary budget	2 days	Fri 09-08-19 08:00
14		Review software specifications/Hardware Specifications/ budget with team	1 day	Tue 13-08-19 08:00
15		Incorporate feedback on Specifications & Budget	2 days	Wed 14-08-19 08:00
16		Obtain approvals to proceed (concept,	1 day	Fri 16-08-19 08:00
17		Analysis complete	0 days	Fri 16-08-19 17:00
18		**Hardware and Software Design**	**59 days**	**Mon 19-08-19**
19		CAD Design	10 days	Mon 19-08-19 08:00
20		Start Designing Software	13 days	Mon 19-08-19 08:00
21		Start Designing Hardware Components	45 days	Mon 19-08-19 08:00
22		**Develop functional specifications**	**100 days**	**Mon 21-10-19**
23		Lane keeping system	100 days	Mon 21-10-19 08:00
24		speed Monitoring system	100 days	Mon 21-10-19 08:00
25		Collision warning and avoidance systems	100 days	Mon 21-10-19 08:00
26		Intersection systems	100 days	Mon 21-10-19 08:00
27		Other Warning Systems	100 days	Mon 21-10-19 08:00
28		**Develop prototype based on functional**	**30 days**	**Mon 09-03-20**
29		Vehicle Platooning System	30 days?	Mon 09-03-20 08:00
30		Navigation System	25 days?	Mon 09-03-20 08:00





31		Review functional specifications	2 days	Mon 19-08-19 08:00
32		Incorporate feedback into functional specifications	1 day	Wed 21-08-19 08:00
33		Obtain approval to proceed	1 day	Thu 22-08-19 08:00
34		Design complete	0 days	Thu 22-08-19 17:00
35		**Hardware and Software Development**	**90 days**	**Mon 11-11-19**
36		Hardware Development	45 days	Mon 11-11-19 08:00
37		Sotfware Develoment	45 days	Mon 11-11-19 08:00
38		Testing of Sofware	45 days	Mon 13-01-20 08:00
39		Tesing of Hardware Components	45 days	Mon 13-01-20 08:00
40		**Integration**	**10 days**	**Mon 16-03-20**
41		Integration of Software and Hardware	7 days	Mon 16-03-20 08:00
42		Testing after Integration	3 days	Wed 25-03-20 08:00
43		**Networks**	**15 days?**	**Mon 30-03-20**
44		Create Networks	15 days?	Mon 30-03-20 08:00
45		**Data Collection & Management**	**15 days**	**Mon 20-04-20**
46		Creation of Data Centers	10 days	Mon 20-04-20 08:00
47		Sending& Receiving from data Centers	5 days	Mon 04-05-20 08:00
48		**Testing**	**31 days**	**Mon 11-05-20**
49		Develop unit test plans using product specifications	4 days	Mon 11-05-20 08:00
50		Develop integration test plans using product	4 days	Mon 11-05-20 08:00
51		**Unit Testing**	**15 days**	**Fri 15-05-20 08:00**
52		Review modular code	5 days	Fri 15-05-20 08:00
53		Test component modules to product specifications	2 days	Fri 22-05-20 08:00
54		Identify anomalies to product specifications	3 days	Tue 26-05-20 08:00
55		Modify code	3 days	Fri 29-05-20 08:00
56		Re-test modified code	2 days	Wed 03-06-20 08:00
57		Unit testing complete	0 days	Thu 04-06-20 17:00
58		**Integration Testing**	**12 days**	**Fri 05-06-20 08:00**
59		Test module integration	5 days	Fri 05-06-20 08:00
60		Identify anomalies to specifications	2 days	Fri 12-06-20 08:00
61		Modify code	3 days	Tue 16-06-20 08:00
62		Re-test modified code	2 days	Fri 19-06-20 08:00
63		Integration testing complete	0 days	Mon 22-06-20 17:00





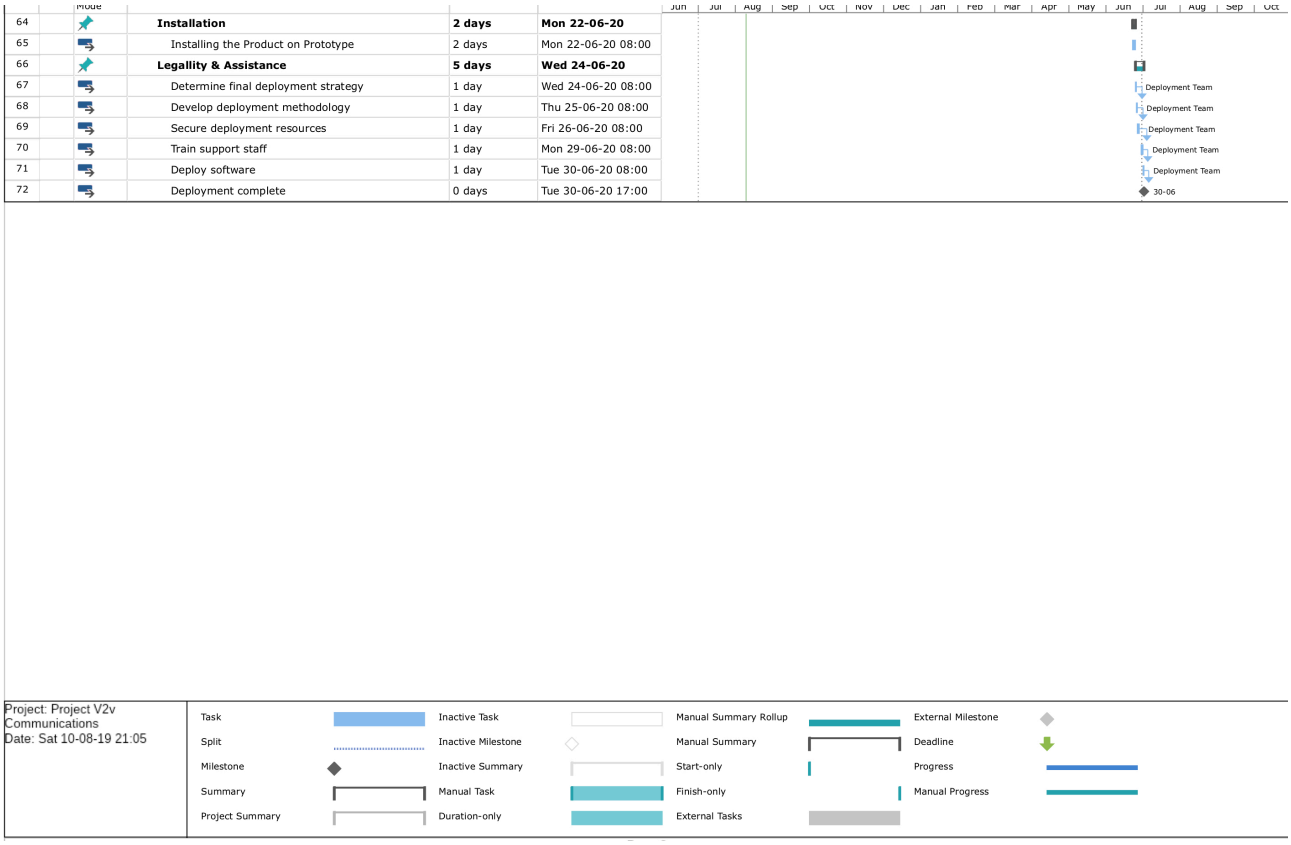


Figure 3.4 : Gantt Chart

APPENDIX 2: Activity and resource requirement list

	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**V2V Communications**	**262 days**	**Mon 01-07-19 08:00**	**Tue 30-06-20 17:00**		
2		**Concept**	**5 days**	**Mon 01-07-19**	**Fri 05-07-19**		
3		Kick off meeting	5 days	Mon 01-07-19 08:00	Fri 05-07-19 17:00		
4		Determine project scope	1 day	Mon 01-07-19 08:00	Mon 01-07-19		Management
5		Secure project sponsorship	1 day	Tue 02-07-19 08:00	Tue 02-07-19 17:00	4	Management
6		Define preliminary resources	1 day	Wed 03-07-19 08:00	Wed 03-07-19	5	Project Manager
7		Brief on avaliable resources	1 day	Thu 04-07-19 08:00	Thu 04-07-19	6	Project Manager
8		Scope complete	1 day	Fri 05-07-19 08:00	Fri 05-07-19 17:00	7	
9		**Analysis/Software/Hardware Requirements**	**30 days**	**Mon 08-07-19**	**Fri 16-08-19**		
10		Conduct needs analysis	5 days	Mon 08-07-19 08:00	Fri 12-07-19 17:00	8	Analyst
11		Draft Preliminary Hardware Specifications	10 days	Mon 15-07-19 08:00	Fri 26-07-19 17:00	10	
12		Draft preliminary software specifications	10 days	Fri 26-07-19 08:00	Thu 08-08-19		Analyst
13		Develop preliminary budget	2 days	Fri 09-08-19 08:00	Mon 12-08-19	12	Project Manager
14		Review software specifications/Hardware Specifications/ budget with team	1 day	Tue 13-08-19 08:00	Tue 13-08-19 17:00	13	Project Manager,Analyst
15		Incorporate feedback on Specifications & Budget	2 days	Wed 14-08-19 08:00	Thu 15-08-19 17:00	14	Analyst
16		Obtain approvals to proceed (concept,	1 day	Fri 16-08-19 08:00	Fri 16-08-19 17:00	15	Management,Project
17		Analysis complete	0 days	Fri 16-08-19 17:00	Fri 16-08-19 17:00	16	
18		**Hardware and Software Design**	**59 days**	**Mon 19-08-19**	**Thu 07-11-19**		
19		CAD Design	10 days	Mon 19-08-19 08:00	Fri 30-08-19 17:00		Deployment Team
20		Start Designing Software	13 days	Mon 19-08-19 08:00	Wed 04-09-19	17	Developer
21		Start Designing Hardware Components	45 days	Mon 19-08-19 08:00	Fri 18-10-19 17:00		Developer
22		**Develop functional specifications**	**100 days**	**Mon 21-10-19**	**Fri 06-03-20**		**Deployment Team**
23		Lane keeping system	100 days	Mon 21-10-19 08:00	Fri 06-03-20 17:00	21	
24		speed Monitoring system	100 days	Mon 21-10-19 08:00	Fri 06-03-20 17:00	21	
25		Collision warning and avoidance systems	100 days	Mon 21-10-19 08:00	Fri 06-03-20 17:00	21	
26		Intersection systems	100 days	Mon 21-10-19 08:00	Fri 06-03-20 17:00	21	
27		Other Warning Systems	100 days	Mon 21-10-19 08:00	Fri 06-03-20 17:00	21	
28		**Develop prototype based on functional**	**30 days**	**Mon 09-03-20**	**Fri 17-04-20**		**Developer**
29		Vehicle Platooning System	30 days?	Mon 09-03-20 08:00	Fri 17-04-20 17:00	23,24,25,26,27	
30		Navigation System	25 days?	Mon 09-03-20 08:00	Fri 10-04-20 17:00	23,24,25,26,27	
31		Review functional specifications	2 days	Mon 19-08-19 08:00	Tue 20-08-19 17:00		Management
32		Incorporate feedback into functional specifications	1 day	Wed 21-08-19 08:00	Wed 21-08-19	31	Management
33		Obtain approval to proceed	1 day	Thu 22-08-19 08:00	Thu 22-08-19	32	Management,Project
34		Design complete	0 days	Thu 22-08-19 17:00	Thu 22-08-19	33	
35		**Hardware and Software Development**	**90 days**	**Mon 11-11-19**	**Fri 13-03-20**		
36		Hardware Development	45 days	Mon 11-11-19 08:00	Fri 10-01-20 17:00		
37		Sotfware Develoment	45 days	Mon 11-11-19 08:00	Fri 10-01-20 17:00		
38		Testing of Sofware	45 days	Mon 13-01-20 08:00	Fri 13-03-20 17:00	37	
39		Tesing of Hardware Components	45 days	Mon 13-01-20 08:00	Fri 13-03-20 17:00	36	

40		**Integration**	**10 days**	**Mon 16-03-20**	**Fri 27-03-20**		
41		Integration of Software and Hardware	7 days	Mon 16-03-20 08:00	Tue 24-03-20 17:00		Deployment Team
42		Testing after Integration	3 days	Wed 25-03-20 08:00	Fri 27-03-20 17:00	41	Testers
43		**Networks**	**15 days?**	**Mon 30-03-20**	**Fri 17-04-20**		
44		Create Networks	15 days?	Mon 30-03-20 08:00	Fri 17-04-20 17:00		
45		**Data Collection & Management**	**15 days**	**Mon 20-04-20**	**Fri 08-05-20**		
46		Creation of Data Centers	10 days	Mon 20-04-20 08:00	Fri 01-05-20 17:00		
47		Sending& Receiving from data Centers	5 days	Mon 04-05-20 08:00	Fri 08-05-20 17:00	46	
48		**Testing**	**31 days**	**Mon 11-05-20**	**Mon 22-06-20**		
49		Develop unit test plans using product specifications	4 days	Mon 11-05-20 08:00	Thu 14-05-20	34	Testers
50		Develop integration test plans using product	4 days	Mon 11-05-20 08:00	Thu 14-05-20	34	Testers
51		**Unit Testing**	**15 days**	**Fri 15-05-20 08:00**	**Thu 04-06-20**		
52		Review modular code	5 days	Fri 15-05-20 08:00	Thu 21-05-20	42,49	Testers
53		Test component modules to product specifications	2 days	Fri 22-05-20 08:00	Mon 25-05-20	42,52	Testers
54		Identify anomalies to product specifications	3 days	Tue 26-05-20 08:00	Thu 28-05-20	53	Testers
55		Modify code	3 days	Fri 29-05-20 08:00	Tue 02-06-20 17:00	54	Testers
56		Re-test modified code	2 days	Wed 03-06-20 08:00	Thu 04-06-20	55	Testers
57		Unit testing complete	0 days	Thu 04-06-20 17:00	Thu 04-06-20	56	
58		**Integration Testing**	**12 days**	**Fri 05-06-20 08:00**	**Mon 22-06-20**		
59		Test module integration	5 days	Fri 05-06-20 08:00	Thu 11-06-20	57	Testers
60		Identify anomalies to specifications	2 days	Fri 12-06-20 08:00	Mon 15-06-20	59	Testers
61		Modify code	3 days	Tue 16-06-20 08:00	Thu 18-06-20	60	Testers
62		Re-test modified code	2 days	Fri 19-06-20 08:00	Mon 22-06-20	61	Testers
63		Integration testing complete	0 days	Mon 22-06-20 17:00	Mon 22-06-20	62	
64		**Installation**	**2 days**	**Mon 22-06-20**	**Tue 23-06-20**		
65		Installing the Product on Prototype	2 days	Mon 22-06-20 08:00	Tue 23-06-20 17:00		
66		**Legallity & Assistance**	**5 days**	**Wed 24-06-20**	**Tue 30-06-20**		
67		Determine final deployment strategy	1 day	Wed 24-06-20 08:00	Wed 24-06-20		Deployment Team
68		Develop deployment methodology	1 day	Thu 25-06-20 08:00	Thu 25-06-20	67	Deployment Team
69		Secure deployment resources	1 day	Fri 26-06-20 08:00	Fri 26-06-20 17:00	68	Deployment Team
70		Train support staff	1 day	Mon 29-06-20 08:00	Mon 29-06-20	69	Deployment Team
71		Deploy software	1 day	Tue 30-06-20 08:00	Tue 30-06-20 17:00	70	Deployment Team
72		Deployment complete	0 days	Tue 30-06-20 17:00	Tue 30-06-20 17:00	71	

Figure 3.5 : Activity and resource requirement list

APPENDIX 3 : Activity cost estimates

	Subtotals	WBS Level 1 Totals	% of Total
1. Project Management		**$84,380**	**48%**
1.1 Project manager	$40,000		
1.2 Project development team	$24,000		
1.3 Project testing team	$18,000		
1.4 Contractors (10% of software development and testing)	$2,380		
2. Hardware		**$23,208**	**13%**
2.1 DSRC Radios	$18,999		
2.2 DSRC Antenna	$900		
2.3 GPS systems	$800		
2.4 GPS antenna	$1,200		
2.5 Wiring	$90		
2.7 DSRC Transmitter/Receiver	$799		
2.8 Displays	$420		
3. Software		**$20,799**	**12%**
3.1 Licensed software	$799		
3.2 Software development	$20,000		
4. Network		$39,000	**22%**
4.1 Data Servers	$8,000		
4.2 Configure the server to work as Web Server	$2,000		
4.3 Secure the connection	$12,000		
4.4 Prototype Development	$17,000		
5. Testing	$7,000	**$3,000**	**2%**
6. Installation	$1,499	$999	**1%**
7. Support		**$1,899**	**1%**
7.1 Maintenance cost	$2,999		
8. Publicity/ Advertisement	$2,400	**$2,400**	**1%**
Total project cost estimate		**$1,75,685**	

Figure 3.6 : Activity cost estimates

APPENDIX 4: Network diagram

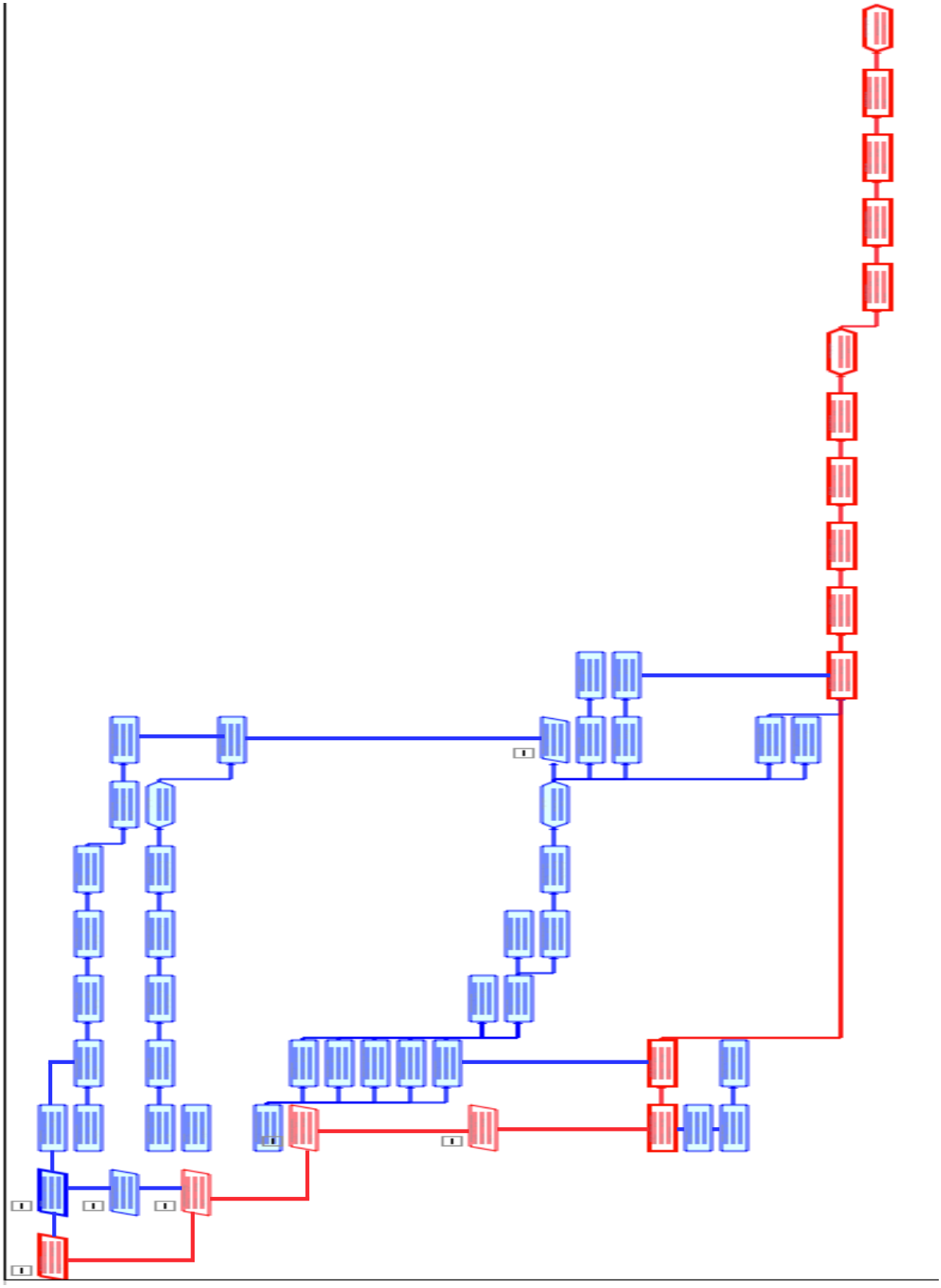


Figure 3.7 : Network Diagram

APPENDIX 5 : Mind Map

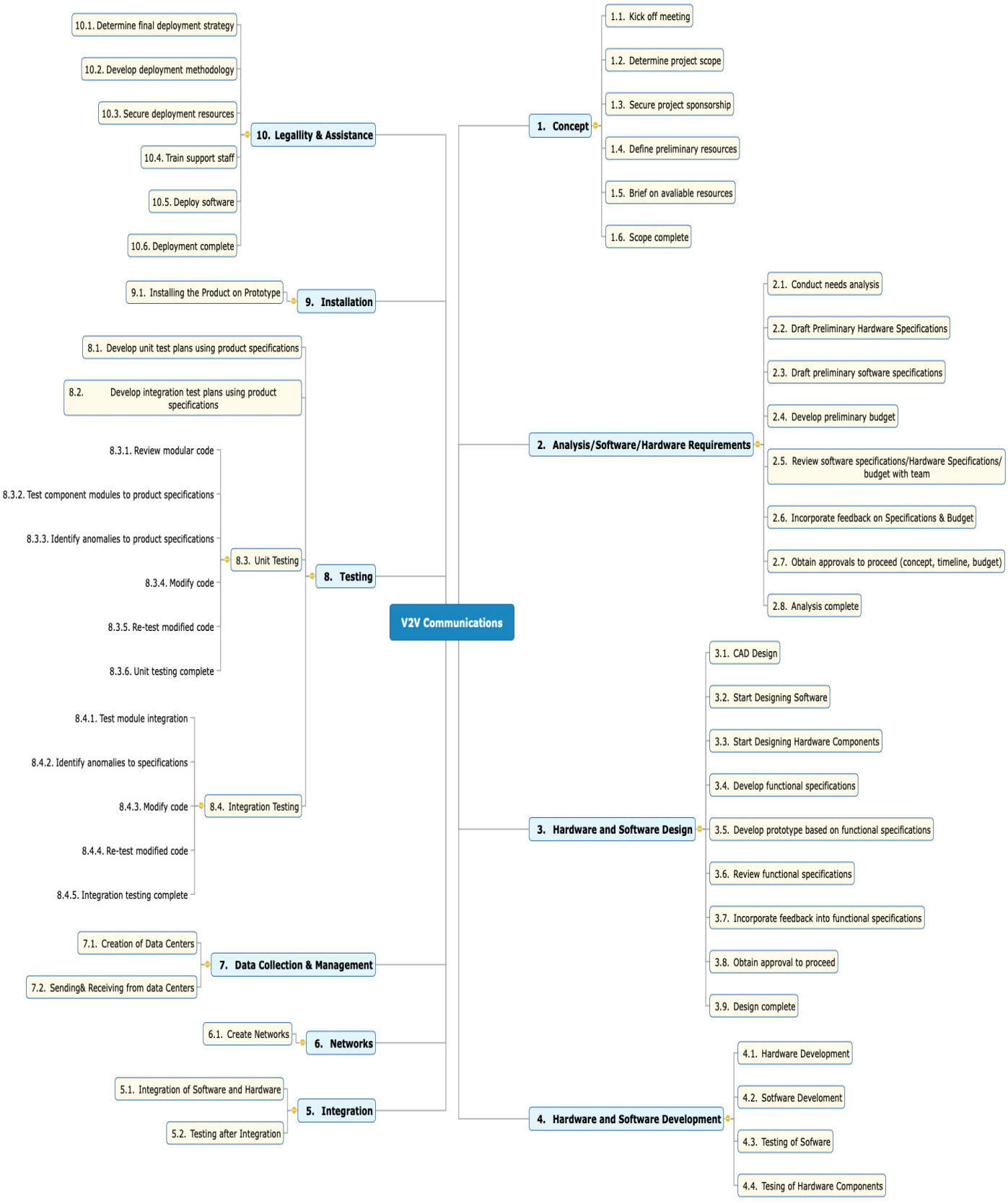


Figure 3.8 : Mind Map

8. References

1. https://daseuropeanautohaus.com/is-a-v2v-communication-system-worth-it/
2. https://www.thedrive.com/tech/15677/u-s-set-to-drop-v2v-communication-mandate-report-says
3. http://www.caee.utexas.edu/prof/bhat/REPORTS/0_6845_s.pdf
4. https://www.smartsheet.com/expert-guide-writing-effective-change-management-plan
5. https://pma.doit.wisc.edu/plan/3-2/print.html
6. http://web.mit.edu/6.005/www/fa15/projects/abcplayer/team-contract/
7. https://enterpriseiotinsights.com
8. https://www.techpats.com/v2x-the-future-of-driving-through-v2v-and-v2i-standards
9. T.Komine and M.Nakagawa,"Fundamental analysis for visible-light communication system using LED lights," IEEE Trans. Consum. Electron., vol. 50, no. 1, pp. 100–107, Feb. 2004.
10. Takeshi M, Kazuki E, Katsuya M. Inter-Vehicle Communication and Ranging System Using Ultra Wide¬band Impulse Radio. (Institute of Electronics, Information and Communication Engineers Technical Report. 2002; 102(95): 31-36.
11. European Telecommunications Standards Institute (ETSI). Intelligent Transport Systems (ITS); Communications Architecture, 2010. Available online: http://webapp.etsi.org/workprogram/ Report_WorkItem.asp?WKI_ID=28554 (accessed on 17 October 2014).
12. ISO/IEC 7498-1. Information technology—Open Systems Interconnection–Basic Reference Model: The Basic Model, 1994. Available online: http://www.ecma-international.org/activities/ Communications/TG11/s020269e.pdf (accessed on 17 October 2014).
13. Perera, C.; Zaslavsky, A.; Christen, P.; Georgakopoulos, D. Context Aware Computing for The Internet of Things: A Survey. IEEE Commun. Surv. Tutor. 2014, 16, 414–454.
14. Cunha, F.D.; Boukerche, A.; Villas, L. Data Communication in VANETs: A Survey, Challenges and Applications. Available online: https://hal.inria.fr/hal-00981126/document (accessed on 17 October 2014).
15. http://www.autonews.com/article/20140203/OEM11/140209988/u.s.-regulators-pave-way-for-vehicle-to- vehicle-communications-safety-
16. http://spectrum.ieee.org/tech-talk/transportation/infrastructure/vehicle-to-vehicle-tech-will-be-mandatory-say- feds
17. http://www.cnet.com/news/us-to-push-for-mandatory-car-to-car-wireless-communications/
18. http://www.cnet.com/news/us-to-push-for-mandatory-car-to-car-wireless-communications/
19. http://mlab.seas.upenn.edu/groovenet/
20. http://car.osu.edu/vehicle-vehicle-communication-intelligent-transportation
21. http://www.its.dot.gov/presentations/safety_workshop2010/IntelliDrive%20Safety%20Program%20Worksho p%20Certification%20Pilot%20—%20W%20Fehr.pdf
22. http://ieeecss.org/sites/ieeecss.org/files/documents/IoCT-Part4-13VehicleToVehicle-HR.pdf

23. http://www.nhtsa.gov/About+NHTSA/Press+Releases/NHTSA-issues-advanced-notice-of-proposed- rulemaking-on-V2V-communications.

24. http://www.rita.dot.gov/

25. http://link.springer.com/book/10.1007%2F978-1-4614-3272-2

26. http://repository.upenn.edu/cgi/viewcontent.cgi?article=1001&context=mlab_papers

27. www.nhtsa.gov