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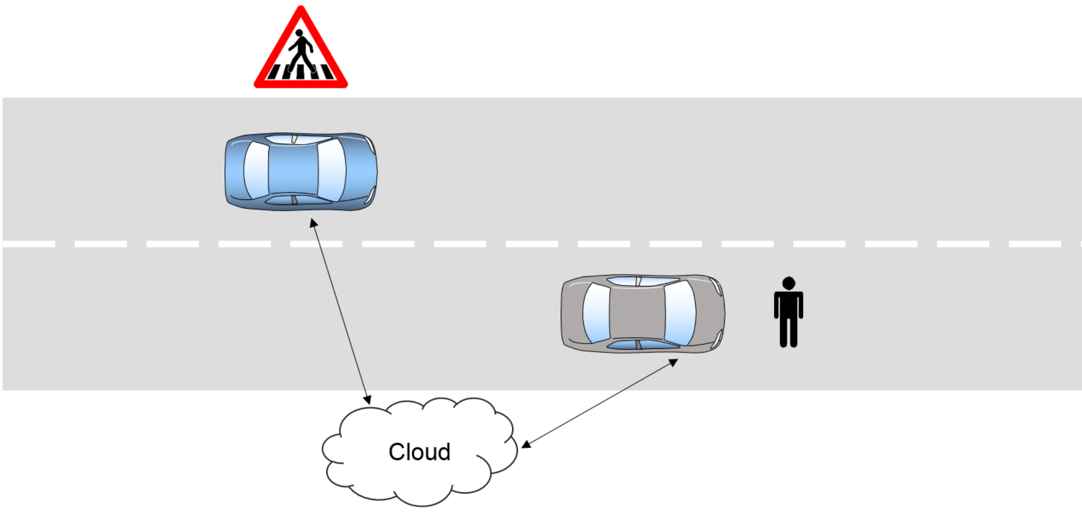

A Cooperative Function with Cloud Communication for Avoiding Collisions with Occluded Pedestrians

Concept Development and Feasibility Evaluation

Master's thesis in Systems, Control and Mechatronics

Caroline Stolt & Jeanna Fahlin Strömberg

Department of Applied Mechanics
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2017

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Abstract

Annually, there are 1.25 million fatalities in traffic accidents around the world. In EU, 21 % of the road fatalities are pedestrians. Without action, road traffic crashes are predicted to be the 7^{th} leading death cause by 2030. The safety of vehicles have improved over the past decades, during which, traditionally the focus has been on passive safety, reducing the injuries from a collision. During the last decade, however, active safety which focuses on preventing or mitigating collisions, have become increasingly important. Active safety functions, such as collision warning and avoidance systems, are common features in today's vehicles. However, in several common scenarios, today's active safety systems are not enough to avoid or mitigate a collision.

The aim of the thesis was to develop a concept of a cooperative active safety function which avoids or mitigates a collision between an occluded pedestrian and a following vehicle whose view is compromised by a vehicle in the adjacent lane. Within this thesis, we establish the potential benefit, limitations and feasibility of such function by extending existing active safety systems with cloud communication.

In this thesis, a concept of an occluded pedestrian warning and collision avoidance function was developed and evaluated in simulation. The function is cooperative and utilizes sensors in the occluding and following vehicle as well as cloud communication between them. The simulation was conducted in an ideal simulation environment with and without communication latency as well as in a cloud test bench. The developed concept yielded a large benefit for a wide set of parameter combinations and even for long latency of several hundred ms. Nevertheless, latency proved to be a limitation and should be limited to 100-200 ms considering the uncertainties.

To conclude, a benefit for our cooperative function was shown for a wide range of parameters and scenarios. Long latencies limit the effectiveness of such system but benefit can still be observed. The current function can yield benefits for the type of scenarios which were tested. With soon expected technology shifts, the benefit of our function in more complex scenarios would increase.

Keywords: Occluded Pedestrian, Collision Avoidance, Cooperative Active Safety, Cloud Communication

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Caroline Stolt and Jeanna Fahlin Strömberg, Gothenburg, June 2017

Contents

Nomenclature

Symbol	Units	Description
d_1	m	lateral distance between V_1 and V_2
d_2	m	longitudinal distance between V_1 and pedestrian
d_3	m	lateral distance between V_1 and pedestrian
a	m/s^2	acceleration
j	m/s^3	jerk
r	m	range/relative distance
$\dot{r}$	m/s	range rate/relative velocity
v	m/s	vehicle velocity

Acronyms

ADAS	**A**dvanced **D**river-**A**ssistance **S**ystems
CAM	**C**oopertive **A**ssistance **M**essage
DENM	**D**ecentralized **E**nvironmental **N**otification **M**essage
DGPS	**D**ifferential **G**lobal **P**ositioning **S**ystem
FCW	**F**orward **C**ollision **W**arning
GPS	**G**lobal **P**ositioning **S**ystem
HMI	**H**uman **M**achine **I**nterface
kmph	**K**ilometers **P**er **H**our
LTE	**L**ong **T**erm **E**volution
m	**M**eter
s	**S**econd
TTC	**T**ime **T**o **C**ollision
UDP	**U**ser **D**atagram **P**rotocol
V2C	**V**ehicle **T**o **C**loud
V2P	**V**ehicle **T**o **P**edestrian
V2V	**V**ehicle **T**o **V**ehicle
VCP	**V**irtual **C**ollision **P**oint
VRU	**V**ulnerable **R**oad **U**ser

Glossary

Term	**Definition**
P	The occluded Pedestrian
Radar Camera	Combined radar and camera unit
Rear and Side Detection System	A rear and side detection system using radars
V_1	The occluding vehicle
V_2	The following vehicle
Virtual Collision Point	The collision point on V_2 between the pedestrian and V_2 if no action is taken

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1
Introduction

This report presents the master's thesis of 30 ECTS conducted by two students from the master program Systems, Control and Mechatronics at Chalmers University of Technology in a project with Volvo Car Corporation during spring 2017.

1.1 Background

Every year about 1.25 million people die due to traffic accidents across the world according to the World Health Organization, *WHO* [5]. Half of those dying on the world's roads are vulnerable road users (VRU): pedestrians, cyclists and motorcyclist. According to the European Commission, [6], 3637 pedestrians were killed in urban traffic during 2014, of which 48 in Sweden. Another report by the European Commission, [7], concludes that pedestrians stands for 21% of all fatal traffic injuries in the EU. WHO, [5], predicts that without action, road traffic crashes will increase to the 7^{th} leading cause of death by 2030.

Velocity is an important factor influencing both the risk of a collision and the severity of a resulting injury, [8]. A vehicle travelling at 50 kmph requires a braking distance of 13 meters while a vehicle travelling at 40 kmph requires less than 8.5 meters. The velocity especially affects the injury severity of VRUs; pedestrians stand a 90 % chance of survival when hit by a vehicle driving at 30 kmph compared to 50 % if it would be driving at 45 kmph. Hence, even if a crash is unavoidable, it is still important to reduce the velocity before a collision occurs.

The safety of vehicles have improved over the past decades where traditionally the focus has been on passive safety which refers to solutions such as airbags, seat belts and the vehicle's physical structure which reduce the effects of a possible crash. Along with the technical advances the market for active safety has received great attention and development. Active safety refers to solutions applying sensors, algorithms and actuators to prevent or mitigate crashes. The observations from the sensors can be translated to estimates of position and velocity of other vehicles, pedestrians and bicyclists, which can be used to detect dangerous situations and to take decisions to for example warn or to intervene by braking or steering. Vehicles of today are equipped with advanced sensors and multiple computing units making intelligent decisions to prevent the vehicle from causing or entering an accident.

Volvo Car's *City Safety* is described in [9]. It is a generic term describing all the

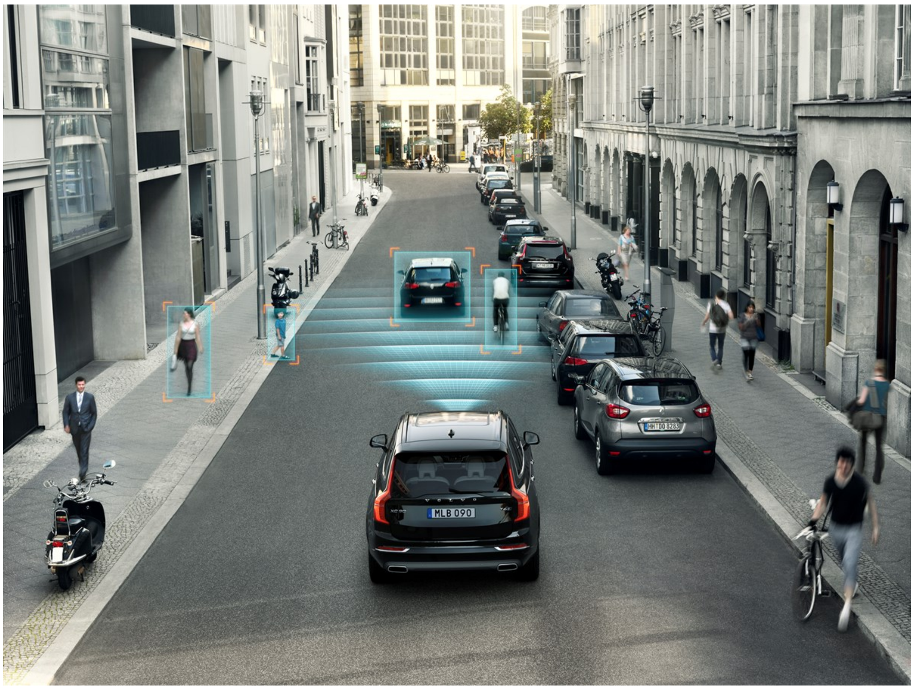


Figure 1.1: Illustration of object detection and estimation with radar and camera from *Volvo Cars Media* [1].

basic functions to avoid collisions with VRUs and other vehicles. One example is the Forward Collision Warning, *FCW*, a Collision Avoidance system which uses the front camera and radar in order to detect the risk of a collision. Volvo Car also has an auto brake which can avoid or mitigate the collision in case the deceleration from the driver is not sufficient.

In several common scenarios however, the sensors, actuators and logic of the own vehicle is not enough to avoid or mitigate an accident. This is especially the case when the field of view of the sensors are occluded by other vehicles or buildings. In this case communication can be used to share data between the vehicles on the road informing about objects and environmental conditions which can not be observed from the own vehicle. One such example is described by Tsai et al. in [10]; three vehicles driving too close after one another, if the first vehicle brakes hard, the second vehicle could avoid the collision but the driver in the third vehicle might react too late to the braking lights of the second vehicle. Tsai et al. proposed a vehicle-to-vehicle, *V2V*, communication solution; in the case of the first vehicle emergency braking, a warning signal is broadcasted to the following vehicles. Since the transmission time is much shorter than the human reaction time, the driver of the third vehicle can be warned immediately before the brake lights of the second vehicle are turned on. Another example is when the field of view of a following vehicle is compromised by a leading vehicle which has slowed down in the adjacent lane to let a pedestrian cross the road. The pedestrian is thus initially occluded to the driver and vehicle sensors of the following vehicle and it might be too late to stop when the pedestrian steps into the own lane. If the leading vehicle could tell the following vehicle about the pedestrian the chance to stop in time could potentially increase. In scenarios like the ones mentioned the existing functions could be leveraged by alerting other vehicles through communication and thus make the whole traffic environment safer.

The scenario with the occluded pedestrian is addressed in the Euro NCAP pedestrian safety assessment, [11], which is described in 2.6. The evaluation implies that even for the safest cars it is a difficult task.

1.2 Purpose and Goal

The purpose of this thesis is to develop a concept of a cooperative active safety function which avoids or mitigates collisions between an occluded pedestrian and a following vehicle where the view of the following vehicle is occluded by a leading vehicle in the adjacent lane, see figure 1.2. The goal is to establish the potential benefit, limitations and feasibility of an occluded pedestrian warning and collision mitigation function by extending the existing technologies with cloud communication.

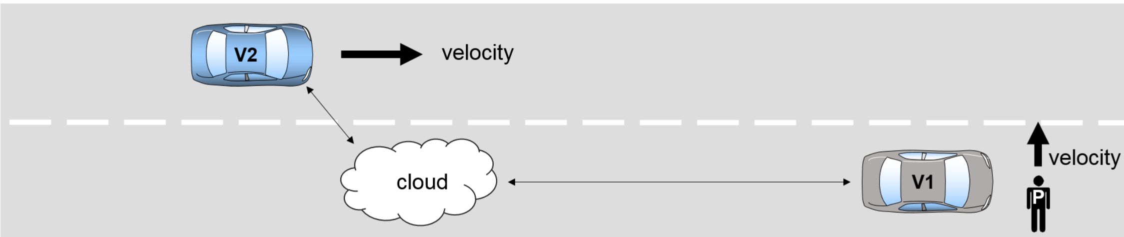


Figure 1.2: The scenario with a pedestrian *P* which is out of the following vehicle V_2's line of sight because of the presence of the occluding vehicle V_1.

1.3 Limitations on the Scenario

The following assumptions were made during the course of the thesis:

- The environments considered are urban and suburban straight roads with a specific width with two lanes with the same driving direction.
- The scenario is limited to one occluding vehicle V_1, one following vehicle V_2 and one pedestrian.
- The pedestrian crosses the road perpendicularly with a constant velocity from the right side of the driving direction of the vehicle V_1 lane. V_2 is approaching with a constant velocity in the adjacent lane. The occluding vehicle is assumed to be stationary to simplify the creation of scenarios.

In addition the focus was on the positive performance, to avoid collisions. The suppression of false warnings was thus not prioritized in the design process.

1.4 Related Work

Previous solutions have been developed or considered to solve the problem of occluded VRU.

In 2015 Bowers et al., [12], patented the idea *Systems and Methods for Coordinating Sensor Operation for Collision Detection* of a general cooperative collision detection system created by acquiring data from one or several sources from vehicles or other sensing systems by sending requests. The collision detection model consists of a kinematic object model of the objects in proximity of the vehicle and may include the position, orientation, size etc. The collision detection may be translated between different frames and the collision detection may be conducted by the host vehicle or other vehicles on request. There are several possible embodiments of the collision detection system. In general the sensor information and collision detection models can be requested by other vehicles and may be uploaded to and saved in a monitoring system.

A similar system, *Cooperative sensor-sharing vehicle traffic safety system*, [13], was patented in 2011 by Paul A. Avery, Joshua J. Curtis and Reda Laurent Bouraoui. The idea is to use V2V communication to provide information to one or more vehicles with an occluded view to of certain situations, such as VRU or other vehicles on the road, detected by one or several other vehicles. By using long range scanning sensors, forward sensors for object detection, mid-range sensors and long range sensors the occluded object as well as the second vehicle can be detected by the first vehicle. The detecting vehicle can provide the vehicle(s) with occluded view with GPS coordinates of the detecting vehicle, the GPS coordinates of the road features and GPS coordinates as well as heading and velocity information about the occluded object. Provided this information the vehicle with the occluded view is supposed to take appropriate action.

The *European 6th Framework Programme Integrated Project SAFESPOT*, [14], investigated several active cooperation systems based on vehicle and infrastructure sensing of the surroundings and ad-hoc communication networks among vehicles and the infrastructure. The *SAFESPOT* cooperative applications were developed to handle a number of specific use cases including occluded VRU collision avoidance, investigated in the *SCOVA* subproject, [15], which focuses on V2V communication solutions. The function *Vulnerable Road User Detection and Accident Avoidance* includes the use case where a road user is crossing the road and an accident is avoided based on an on-board detection system. The aim of the function is to inform/warn/recommend the driver of a vehicle about the presence of a VRU occluded by another vehicle. The VRU is occluded by vehicle 1. Vehicle 1 is equipped with an on-board VRU detection system. Vehicle 2 does not detect the VRU because vehicle 1 is occluding the view. Both vehicles are equipped with a communication system. The scenario steps include; vehicle 1 detects the presence of a VRU on the road, the *SAFESPOT* system broadcast the position of itself and the VRU to vehicle 2, the vehicle 2 receives the information analyses the situation based on its position and velocity, as well as the distance to vehicle 1 and the VRU. The system in vehicle 2 then informs/warns/recommend the driver about the risk.

Vanhoof et al., [16], include the challenge of an occluded pedestrian warning system in their summary of future applications of *KDubiq* which exploit the low-cost computing, big data and methods to extract and exploit it. The scenario includes a pedestrian in front of a parked vehicle on the side of the road who thus is occluded to following vehicles. They propose a solution which utilizes vehicle sensing system and V2V communication. The parked vehicle's sensors could be used to detect objects in front and behind it. Data streams containing the information about surrounding objects could be continuously fed to an *intelligence module* whose task is to determine if there is a pedestrian in front of it and a vehicle approaching from behind. Following the detection of the pedestrian and the approaching vehicle, a threat analysis is conducted to evaluate if there is a danger. A considered possibility is to send the data to an off-site data center which could share data on previous occluded pedestrian accidents at the specific location. The parked vehicle combines the historical and sensor data to analyze the situation and sends a warning message if the threat level is high enough. They also consider the possibility that the approaching vehicle can combine the data from the parked vehicle with its own information about the environment to evaluate the risk. Another considered solution is to use infrastructure sensing, for example a camera, such that the approaching vehicle can do the threat assessment without involving the parked vehicle.

In 2006 the *WATCHOVER* project, coordinated by *Centro Ricerche Fiat*, was initiated. The goal of the project was to avoid traffic accidents with VRUs by using communication between in-vehicle modules and devices attached to the VRU. Such devices could be inserted in helmets, clothes, electronics or in the motorcycle of the VRU. The in-vehicle module was supposed to detect the VRU equipped with the device as well as calculate their relative position, identify possible dangerous situations and, in case of a dangerous situation, provide the driver with an appropriate warning. The VRU device was supposed to send identification parameters and self-localization parameters upon the request from the vehicle as well as give feedback to the road user. The proposed system consisted of short range communication and vision sensors.

Communication between vehicles, V2V communication, to improve safety and support autonomous drive is widely discussed in the automotive industry. In IEEE systems journal article *Cloud-Assisted Safety Message Dissemination in VANET Cellular Heterogeneous Wireless Network*, [17], it is described how V2V communication can be improved by implementing Cloud-assisted Message Downlink dissemination Scheme for analysis and safety and traffic messages to the vehicle. By collecting data from sensors in individual vehicles and sending it to the cloud service, where it is analyzed and distributed first to local gateways and thereafter to neighbouring vehicles, congestion and accidents can be avoided. However, there are difficulties when using communication systems in road environments. Huang et al., [18], discuss how to maximize throughput, achieve fairness and reduce the message rate as well as achieve robustness are common problems in these situations. Further challenges include how often and how far the messages should be broadcasted.

There are several previous projects which utilize wireless communication between the pedestrian and the driver to avoid collisions between the same. Various projects have suggested to use the smartphone of the VRU and the driver for communication. In [19] Bagheri et al. the possibility of vehicle-to-pedestrian, *V2P*, communication by utilizing the smartphones of both the pedestrian and the driver was investigated. As opposed to solutions where infrastructure or in-vehicle components are used the approach of using smartphones was intended to reduce the market penetration time as well as reducing the adaptation costs. Information obtained from GPS regarding geolocation, velocity and heading of the road users is beaconed from the smartphones to the cloud where a threat assessment of every road user in a certain area is performed. If a risk is detected the cloud sends out a warning to the affected drivers and pedestrians. In order to not drain the battery of the smartphones a situation adapted beaconing, an adaptive multi-mode (AMM) approach, was implemented. Based on the level of risk from the surrounding traffic for the pedestrian AMM commands different beaconing frequency for pedestrian-to-cloud communication.

Limits in communication technology have previously shown to be crucial when it comes to time critical cooperative safety functions. The project *BikeCom* described by Boda et al. in [20] is an example where they found that the latency might be crucial for the benefit of the function. The BikeCom project was similar to the *WATCHOVER* project in which a cooperative smartphone application was developed. The purpose was to avoid accidents at intersections between bicyclists and vehicles by exchanging safety relevant information about their respective GPS data such as position, heading and velocity as well as a collision warning. The information was transmitted over the 3G network and the threat assessment was performed in the application on the respective smartphone. In case of a predicted accident based on the *time-to-stop*, TTS, an audio signal was used to warn the driver as well as the bicyclist. The function was tested through both simulation as well as in the field. In simulation the latency was set to 300 ms with the satisfactory results of 100 % sensitivity as well as specificity. On the other hand when the field were performed high latency as well as low positioning resolution from GPS and possibly slow processing caused 36 % late warnings and 54 % defaulted messages.

In [21] Thielen et al. also investigated the feasibility of cooperative safety system to avoid or mitigate collisions between vehicles and bicyclists at intersections. The considered scenario is an intersection where the vehicle is approaching in one direction and a bicyclist is approaching in the perpendicular direction while the driver's view is occluded. The bicyclist is equipped with a consumer mobile device with WLAN (802.11g) and the vehicle is equipped with vehicle-to-X communication technology (ETSI ITS G5). The mobile device used by the bicyclist has built in GPS as well as an accelerometer and gyroscope sensor. The vehicle is equipped with several sensors, but the most important sensors for the function are the GPS receiver, velocity sensor and brake pedal position sensor. The input to the threat estimation algorithm is UTM northing/easting and gps heading from the vehicle and mobile device, brake pedal position and velocity from the vehicle and the velocity (GPS), angular velocity and longitudinal acceleration from the bicyclist mobile device. The output is the time-to-collision, TTC, of the bicyclist and vehicle and the direction of the approaching objects (left or right). The trajectories of the bicyclist and vehicle are estimated by collecting a number of points and applying least square method. An intersection point is found and a safety area is created around it depending on the present accuracy of the GPS. The times for entering and leaving the area for the vehicle and bicycle respectively are calculated. If the time intervals of the vehicle and pedestrian are overlapping, there is considered to be a risk of collision. The time to collision is derived and a warning is given to the driver if it drops below 5 seconds. The strategy was to warn only the driver by an acoustic warning signal followed by a pictogram containing a cross with a warning triangle containing a bicyclist symbol in the middle of the digital instrument board. The paper concluded that the solution was feasible, however, the positioning accuracy was concluded to be too low and the update rate of the information from the mobile device too slow.

To warn VRU different methods can be used in terms of light and audio. Liu et al., [22], suggested an approach of using the smartphone of the road users both to estimate their position and motion through dedicated short range communication (DSRC) by using the cellphone GPS and give the user an audio or visual warning depending on how the smartphone is used.

Volvo Cars has previously collaborated with Ericsson and *POC*, [23], on a concept to avoid collisions between a vehicles and bicyclists in various situations. The concepts consists of a Volvo vehicle connected to the cloud and a helmet prototype. The bicyclists connect to the *Volvo Cloud* through some smartphone app and share its position while the vehicle can do the same. The driver and the bicyclists can then be informed if they approach each other, the driver via a head up display on the windshield and the bicyclist by a red alert light mounted on the helmet.

1.5 Structure of Report

The report is divided in the following six chapters.

- **Introduction**, chapter 1, page 1 where the background is given and the purpose is stated along with a description of previous work related to the project.
- **Theoretical Background**, chapter 2, page 9 where the theoretical background required to understand the thesis is described.
- **Methods**, chapter 3, page 21 where the main steps taken during the thesis, car set up, concept development, implementation and evaluation methods are explained.
- **Results**, chapter 4, page 47 where the simulation results are presented.
- **Discussion**, chapter 5, page 65 where the developed concept, its benefit and feasibility, the effect of the limitations and the evaluation methods applied are discussed. Suggestions for future work are also stated.
- **Conclusion**, chapter 6, page 75 where the main conclusions of the thesis are drawn.

2
Theoretical Background

In this chapter the researched and applied theory is presented. The main components of a general collision avoidance system including sensors, threat assessment and intervention along with vehicle communication used in the developed concept are described. Two driver models later used for development and evaluation of the function are described together with previous research of human preferences regarding timing of warning is presented. Last the Euro NCAP evaluation of pedestrian safety is presented.

2.1 Collision Avoidance and Mitigation Systems

The goal of a collision avoidance system is to aid the driver in avoiding or mitigating collisions while not disturbing the driver with unnecessary warnings or interventions. Brännström et al. described in [2] that a collision avoidance system in general can be divided into three parts;

- A sensor fusion system which use the information from the sensors to estimate the properties and motions of other road users and objects.
- A decision making algorithm which uses the previous acquired estimates to determine how and when to assist the driver.
- An actuation system which takes actions based on the decision making algorithm through warning and information to the driver or intervening by steering or braking the vehicle autonomously.

as depicted in figure 2.1.

If a threat is present and it is determined to be severe enough, an intervention might be necessary to avoid the collision. Depending on the severity different interventions can be executed; to inform or warn the driver, or even autonomous control of the vehicle. There are, however, limitations on when and how a collision can be avoided depending on for example the combination of TTC and the velocity of the vehicle. Brännström et al. developed a collision avoidance algorithm in [3] which estimates how the driver can brake and/or steer or to avoid a collision. This is illustrated in the figure 2.2.

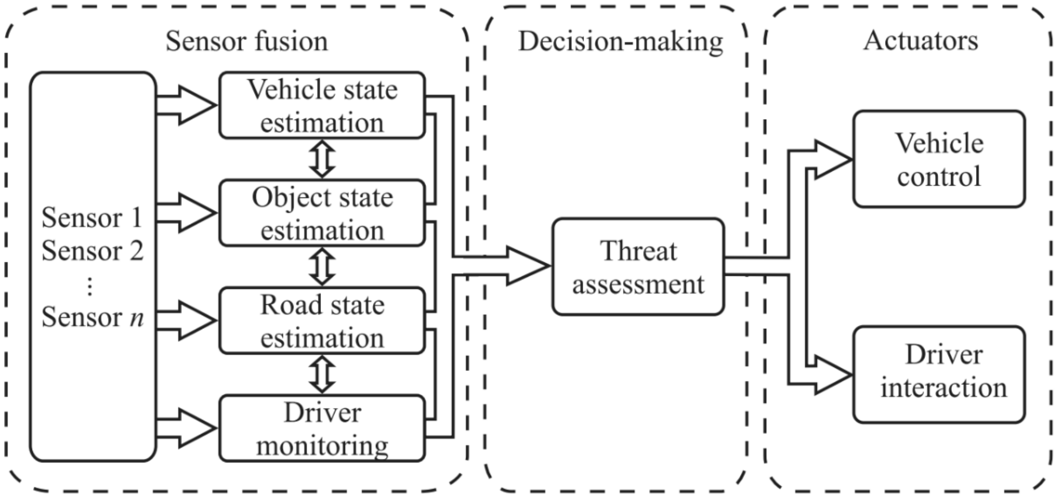


Figure 2.1: An overview of the principles of a collision avoidance system. The figured is from [2] and is included with permission from the copyright owner Mattias Brännström.

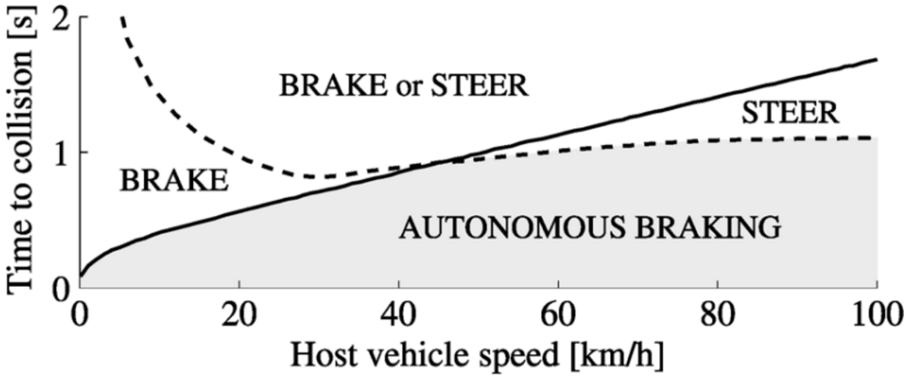


Figure 2.2: A figure from [3] which describes the developed algorithm's estimation if the driver can avoid the collision by braking and/or steering. The figured is included with the permission from the copyright owner Mattias Brännström.

2.2 Sensors

Sensors are used to estimate the vehicle state, identified objects state, road state and sometimes driver state. Common sensors used in active safety applications are for example radar, camera and GPS which will be described further.

2.2.1 Object Detection Systems

The *Radio Detection And Ranging* (Radar) is one of the most common tracking sensors. The basics of the radar is described by Skolnik in [24] and by Zolock et al. in [25]. Zolock et al. also discuss the radar's advantages as well as limitations. Radar is an electromagnetic system used to detect and locate objects. It is based on the transmission of a particular wave shape, for example a pulse-modulated sine wave.

The waves are reflected on objects in the surrounding environment and an echo of the transmitted waves are transmitted to the receiver in the radar unit. Based on the characteristics of the echo properties of the object such as the distance, the relative angle (the azimuth angle), the location and the heading of the objects can be determined. If there is a relative velocity between the object with the radar and the detected target, a shift in the carrier frequency occurs, referred to as Doppler effect, which can be used to determine if an object is moving or not as well as the relative velocity of the object and the radar.

The strength in the radar lies in its capability of detecting objects in conditions where the human eye cannot such as poor weather conditions and darkness, which also entails advantages relative other common automotive sensors as camera or LIDAR. While poor weather could be devastating for camera and LIDAR it might only attenuate the radar signal. The radar can also provide very accurate estimates of the distance to as well as the radial velocity of an object. The weaknesses in radar lies within the difficulty to track lateral motion, tracking of acceleration and object classification. In the road environment there is also the difficulty of detection of objects which are not of interest for the applications such as stationary objects at the side of the road or out of lane objects. General difficulties with radar systems also include echos, ghost objects and clutter.

The camera sensor is another common sensor which is gaining more popularity due to its characteristics of detecting and recognizing pedestrians, vehicles and other objects, [26]. The shortcomings of the camera lies within its reduced performance during poor weather conditions such as fog, heavy snowfall, rain, strong sunlight, darkness or reflections from ice or snow on the road which can reduce its vision and affect the ability of the camera to detect and classify objects, [25], [4].

Fusion of information from several different sensors result in that more redundant and thus robust information can be obtained. Sensor fusion of the information from radars and cameras is popular in automotive safety applications and is well used in various Advanced Driver Assistance Systems (ADAS) applications.

2.2.2 Positioning Systems

Xu et al. describes the navigation system Global Position System (GPS) in [27]. GPS has been applied in several areas such as land, sea and air navigation, low-orbit satellite determination, as well as static and kinematic positioning. It is based on satellite technology. The basic principle consists of measuring the range between the receiver and a few satellites which are observed simultaneously. Along with the GPS signal, the position of the satellites are broadcasted to the receiver. Based on the measured distance between the receiver and the satellites along with the satellites position, the position of the receiver can be determined. The velocity of the receiver may be determined by the change in position over time.

Madry has described the accuracy of GPS in [28]. The accuracy is affected by several factor; accuracy of anatomic clocks, ephermeris error (certainty of the satellite positions), atmospheric errors, relativistic timing adjustments and the receiver errors caused by the calculation of the position. The largest source of errors are the atmospheric errors, which cause the GPS signals to bend, making the satellites seem farther away than they are. Multipath interference is very common in urban areas; GPS signals can be reflected and bounce off large buildings. Using the standard civil capability alone a 15 m precision can be obtained, meaning that 95 % of the time the true position lies within a sphere with a diameter of 15 m. Almost all of the previous mentioned errors can be removed by differential GPS (DGPS) and other techniques. A stationary reference station whose location has been determined with high accuracy is used in DGPS. The received GPS signal is compared with the known position and the difference is calculated and then transmitted by a low frequency radio to other GPS receivers nearby. The precision is improved from 15 m to 3 - 5 m or even better. DGPS receivers are, however, expensive and not commercially used in vehicles.

2.3 Decision Making

To determine the presence and the severity of a threat, analysis can be conducted by evaluating different parameters and comparing them to thresholds. In this section metrics and formulas used for development and evaluation of the concept are presented.

2.3.1 Path Prediction

In order to predict linear motion basic equation of mechanics can be used as described by Johnson in [29]. Equation 2.1 describes the linear motion of an object travelling with constant velocity during a time interval t with the initial position r_0 and initial velocity v_0.

$$r = r_0 + v_0 t \tag{2.1}$$

Equation 2.2-2.3 describes the velocity and the linear motion respectively of an object travelling with constant acceleration a.

$$v = v_0 + at \tag{2.2}$$

$$r = r_0 + v_0 t + \frac{at^2}{2} \tag{2.3}$$

2.3.2 Time to Collision

A well used metric when designing the threshold within threat assessment is the time-to-collision, TTC, which is an estimate of the time until a potential crash, given that the actors continue with their current speed and direction. A simple definition of TTC is calculated as the fraction between the range, r, and the relative velocity, $\dot{r}$, between two following vehicles, as described by equation 2.4. [30]

$$TTC = -\frac{r}{\dot{r}} \tag{2.4}$$

Another well used metric is the enhanced-time-to-collision, ETTC, which as opposed to the TTC does not assume the acceleration to be constant [31]. ETTC is calculated as in equation 2.5.

$$ETTC = \frac{-\dot{r} - \sqrt{\dot{r}^2 - 2a_r r}}{a_r} \tag{2.5}$$

2.3.3 Required Deceleration to Avoid Collision

The required deceleration is a measurement of the longitudinal deceleration required to take the relative velocity of the ego vehicle to zero at the time of the collision. Jansson describes the equations to find the required deceleration in [32] with the assumption that the deceleration is constant. By setting the final range and velocity to zero in equation 2.6 and 2.7, the following system of equations can be solved to find the required longitudinal deceleration,

$$0 = v_0 + a_{req}t \tag{2.6}$$

$$0 = r_0 + v_0 t + \frac{a_{req}t^2}{2} \tag{2.7}$$

The required deceleration is thus given by,

$$a_{req} = -\frac{v_0^2}{2r_0} \tag{2.8}$$

with an initial relative acceleration the equation becomes,

$$a_{req} = -\frac{v_0^2}{2r_0} - a_0 \tag{2.9}$$

2.3.4 Required Jerk to Avoid Collision

Brännström et al. proposed a threat assessment algorithm based on required jerk in [3]. They parameterized potential braking as,

$$a(t) = a_0 + j_r\tilde{t_j} \tag{2.10}$$

where $\tilde{t_j} = min(t_j, t)$, a_0 is the initial longitudinal acceleration and j_r is the longitudinal jerk. The profile is a simple yet accurate description of a brake actuator with limited capacity as depicted in figure 2.3. t_j is defined based on the deceleration and jerk capabilities, a_{min} and j_{min} of the system or driver.
The time to reach the minimum acceleration from the initial acceleration is calculated by the formula in equation 2.11.

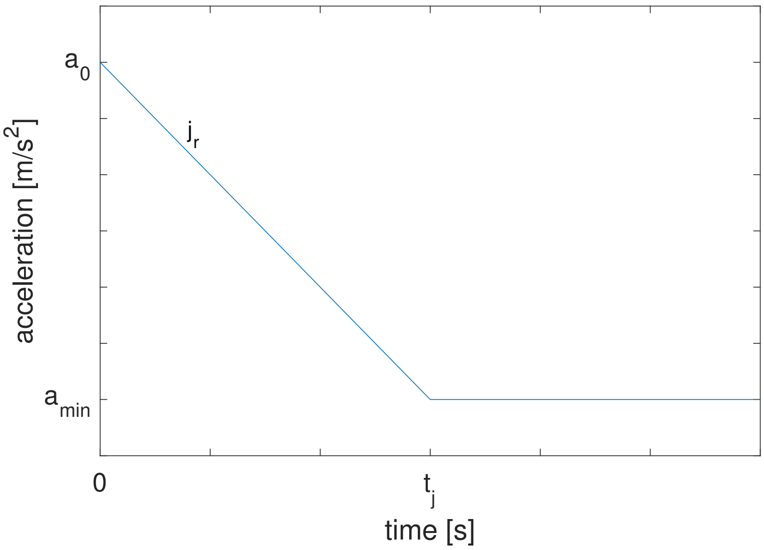


Figure 2.3: An approximation of a deceleration profile where a_0 is the initial acceleration, j the jerk, a_{min} the minimal acceleration and t_j the time for the acceleration to reach its minimum value from the initial acceleration.

$$t_j = \frac{a_{min} - a_0}{j_{min}} \tag{2.11}$$

The required jerk to avoid a collision at time $t_i = [0, T_{Max}]$ by braking is,

$$j_r \leq \frac{x_i - v_0 t_i - a_0 \frac{t_i^2}{2}}{\frac{\tilde{t_j}^3}{6} + (t_i - \tilde{t_j})\frac{t_i t_j}{2}} \tag{2.12}$$

where x_i is the minimal longitudinal distance to the obstacle. If the jerk $min(j_r(t_i))$ is below the jerk limit of the driver or system an intervention should be performed. The interested reader may refer to [3] for the full derivation.

2.4 Communication

For a cooperative time critical active safety function there are high requirements on the communication. A low latency and transmission time as well as a high quality of service and scalability is of high importance. In this section the mobile network standards and technologies as well as vehicle communication are addressed.

2.4.1 Mobile Network Standards and Technologies

Grigorik presents the main network technologies in [33]. There are four mobile network technologies on the market; 1G, 2G, 3G and 4G. The data rates and latency of the different technologies are presented in table 2.1. It is a complicated task to establish the true performance as it depends on the provider, the network configuration, number of active users in each cell, the radio environment, the device and other factors which affect wireless performance. In the real world it is thus more certain to assume a performance closer to the lower boundary of data rate and the higher boundary of latency. Further there is not one single technology for each generation, as long as a technology fulfills the set requirements it can be labeled as eg. 3G or 4G. LTE (Long Term Evaluation) fulfills many but not all of the requirements for 4G, it is deployed in Sweden and commonly marketed as 4G. A report from *Internetstiftelsen i Sverige*, [34], concluded that for the first quarter the average round trip time was 65 ms and for the year 2015-2016 77 ms for mobile users in Sweden who measured their phone's performance in the app *Bredbandskollen*.

Table 2.1: The theoretical data rate and latency for standards of mobile technologies.

Generation	Data rate	Latency
2G	100-400 Kbit/s	300 - 1000 ms
3G	0.5 - 5 Mbit/s	100 - 500 ms
4G	1-50 Mbit/s	<100 ms

Standards for 5G are currently being developed and are expected to be ready in 2020. 5G promises excellent performance in terms of data transfer rate, stability and low latencies. The vision of 5G is to provide a round trip latency of 1 ms, [35], [36], [37].

2.4.2 Vehicle Communication

Intelligent transportation systems and communication between cars to improve safety and support autonomous drive is widely discussed in the automotive industry. An intelligent Vehicle Area Network (VAN) is a network of vehicles which send and receive data from each other and the infrastructure, [38]. By collecting data from sensors in infrastructure, individual vehicles and distributing the information to the relevant vehicles congestion and accidents can be avoided. Functions could include obstacle detection, adaptive cruise control, cooperative collision avoidance, navigation data etc. which aid the driver in a complicated environment. VAN include; Vehicle-to-Vehicle (V2V) communication, Vehicle-to-Broadband Cloud (V2C) and Vehicle-to-Road Infrastructure (V2I). V2V communication could be used to broadcast and share warning and information messages, which can assist functions such as lane keeping, steering control, parking assistance, obstacle detection and useful information for vehicles travelling on the same road. The communication methods could include wireless communication such as cellular/WiFi. V2C communicates with a broadband cloud over cellular/Wifi for example a monitoring data center. This type of communication could be useful for active driver assistance functions and vehicle tracking. V2I communication could include information about the environment and weather.

In these sort of applications the robustness of the wireless network is of high importance, as pointed out by Chandra Dey et al. in [39]. Due to its low latency as well as its fast network connectivity, security and high speed communication Dedicated Short Range Communication, *DSRC*, has been the most discussed communication option for safety applications. The infrastructure for the DSRC technology may, however, be very costly and the shortcomings of DSRC when it comes to throughput and communication range have led to the consideration of other communication networks such as Wifi, LTE and WiMax, which allow longer range communication and can support several applications at once.

Araniti et al. evaluated the potential of LTE for vehicle networking in [40]. LTE provides high data rates and low latency and as a cellular network has a large coverage area and high penetration rate. The main drawback is that the data has to cross infrastructure nodes although the vehicular communication mainly requires local communication. Dense traffic with many vehicles sending periodic messages can create a heavy load for which LTE might not be able to support. There are ongoing projects researching the complementary roles of IEEE 802.11 p (Wifi), LTE and othe cellular technologies to support cooperative intelligent traffic safety applications The European Telecommunications Standards Institute (ETSI), the International Standards Organization (ISO), and the U.S. Department of Transportation (DOT).

ETSI, [41], have defined two types of messages: 1) Cooperative Awareness Message which is sent periodically within a small area and 2) Decentralized Environmental Notifications Message (DENM) which is event triggered. CAMs are short messages which distribute information about presence, position and kinematics periodically to its neighbours. DENM are short messages transmitted to alert road users of various hazards, [40]. CAM and DENM are recommended by ETSI to have a maximum transmission time of 100 ms. CAM should have an update frequency of 1 - 10 Hz depending on the use case.

2.5 Driver Model

Active safety systems are developed to aid the driver in avoiding and mitigating collisions. The interaction between the driver and vehicle is important for the effectiveness of the designed system. For a warning function it is important to give a warning at the right time; sufficiently early to avoid a potential collision but at a time such that the driver finds the warning relevant and not irritating. It is therefore important to design the system around the driver for the best performance.

A driver model describes the behavior of the driver by what she/he usually does and how she/he reacts to a specific situation. Driver models are important because they can be used to imitate human behavior. A driver model can also be used to evaluate the performance of a system. There are various developed driver models which can be used for different purposes.

The NHTSA CAMP report [42] concludes that for a collision warning and avoidance functions two fundamental parameters have to be modelled, firstly how long it takes for the driver to react to a warning, reaction time, and secondly how hard the driver can brake, the deceleration capability. The NHTSA CAMP driver model has been a base for driver models used in the industry. They estimated the driver brake reaction time to be 1.18 seconds, excluding the brake delay. The recommended reaction time corresponds to the 85^{th} percentile driver brake reaction time based on a surprise braking event study. The report present a deceleration equation dependent on velocity based on linear regression analysis of several trials where the drivers were instructed to do hard braking at the last moment to avoid colliding with a target. The deceleration formula is described by,

$$a_{est} = max(offset + c * v_{ego}, limit) \tag{2.13}$$

with the assumption of a stationary object. A constant deceleration level cannot physically be reached instantaneously, thus deceleration is commonly modelled as ramp with a constant jerk. Chen et al., [43], conducted a statistical study on driver brake parameters under naturalistic driving in risk scenarios with pedacyclists. The median was estimated to -4.4 m/s^3 and the 75^th percentile to -5.8 m/s^3. Two drivers are presented in table 2.2 where driver 1 is based on the parameters presented in the NHTSA CAMP report and driver 2 is based on values used in the industry. The 75^{th} percentile jerk is used for driver 1 and the median for driver 2. The deceleration level as a function of the velocity are plotted in figure 2.4.

Table 2.2: Deceleration capabilities of the two driver models.

Parameter	Driver 1	Driver 2
reaction time $[s]$	1.18	1.18
offset $[m/s^2]$	-4.6	-2.55
c	-0.0714	-0.0714
limit $[m/s^2]$	-7	-5
jerk $[m/s^3]$	-5.8	-4.4

The driver should have sufficient time to brake, but even if giving a warning as early as possible increases the chance of avoiding the collision the risk that the warning irritates the driver increases as well. Lubbe and Rosén researched the comfort boundaries of drivers in pedestrian crossing scenarios to guide intervention timings in [44]. At a test track 62 different drivers were instructed to drive at two different speeds; 30 kmph and 50 kmph and react to any traffic situation as they normally would have. A pedestrian dummy was launched from behind an obstructing building such that it moved towards the path of the vehicle when TTC was 4.5 s at a velocity of 1 m/s. TTC was defined as the distance to the collision point divided by vehicle speed. They found that TTC was a suitable measure of driver comfort in pedestrian crossing scenarios. TTC was independent of the speed ranging from 2.1 to 4.3 s with a median of 3.2 s. They concluded that at TTC equal to 2.5 s 90 % of the drivers had exceeded their comfort limit which would translate as a timely warning as most drivers would associate it to discomfort. The longitudinal distance at braking onset depended strongly on speed was 25.4 m for 30 kmph and 41.6 m for 50 kmph. Lubbe and Davidsson, [45], performed a similar study investigating drivers' comfort boundaries in pedestrian crossings as a function of pedestrian speed. 180 drivers

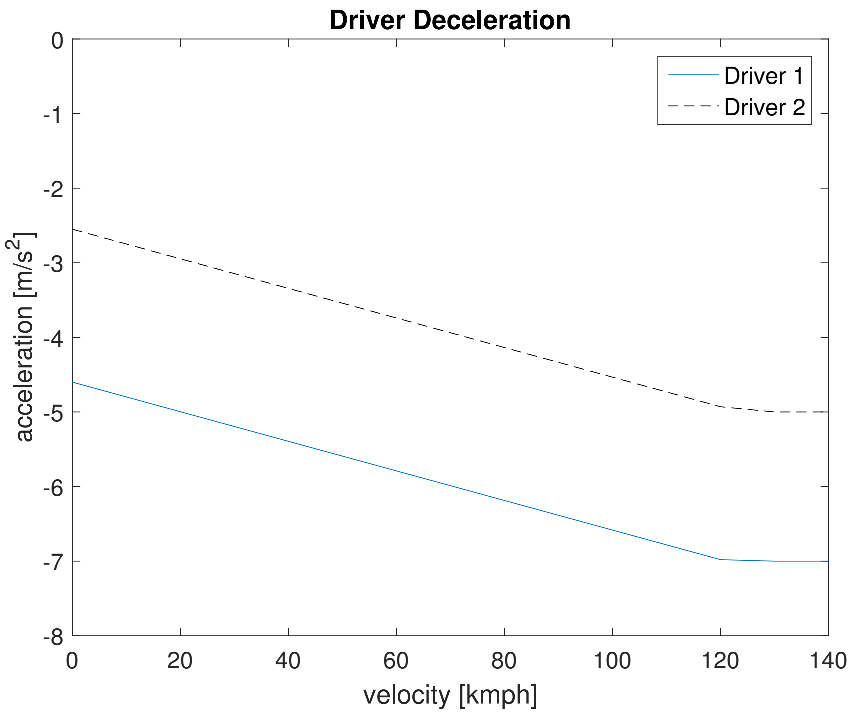


Figure 2.4: The driver deceleration as a function of velocity.

were instructed to drive at a speed 30 kmph in urban environments and experienced two animations of pedestrian crossing with a speed of 1 and 2 m/s. For pedestrians moving with a speed of 1 m/s and 2 m/s 90 % of the drivers braked before a TTC of 2.6 and 2.2 s respectively.

2.6 Euro NCAP Pedestrian Safety

The European vehicle safety rating program *Euro NCAP* was recently added to the assessment of pedestrian protection, [11]. The test Car-to-VRU Nearside Child, CVNC, is the most challenging of the tests and similar to the scenario of the occluded pedestrian. The test is illustrated in figure 2.5. In this test the child dummy is emerging from behind two parked vehicles directly into the ego lane. The child dummy is moving with a velocity of about 1.4 m/s and the collision point will be in the middle of the vehicle front if no action is taken. The test is conducted for velocities of 20 kmph and incremented with 5 kmph to a maximum velocity of 60 kmph. The autobrake system is awarded with pass/fail based on if the vehicle avoid the collision with the dummy or not for velocities up to 40 kmph, for higher velocities points are given if the velocity is reduced with at least 20 kmph from the initial velocity. *Volvo V90* tested in 2017 avoided collisions up to 40 kmph and mitigated collisions up to 60 kmph, [46].

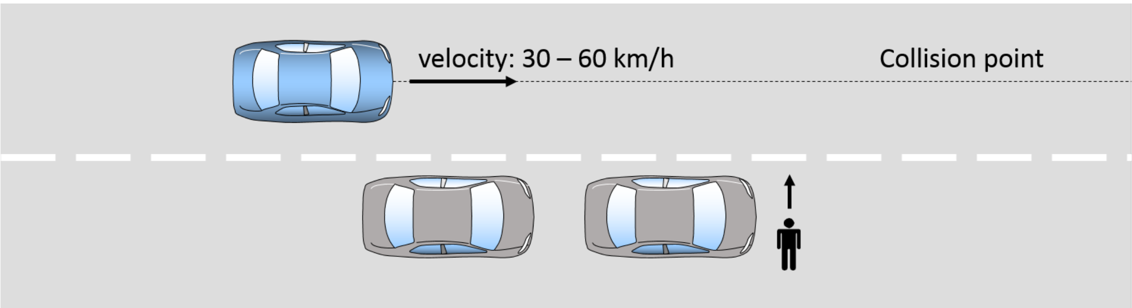


Figure 2.5: The set up of the NCAP CVNC test.

3
Methods

This chapter describes the methods applied in the project to develop and evaluate a concept of an occluded pedestrian warning and collision mitigation function. The steps taken in this project are presented in figure 3.1. In the beginning of the project a field data acquisition was performed in real traffic environment where pedestrians crossed a zebra crossing in front of the vehicle and vehicles drove by in the adjacent lane. This was done to give an understanding of the scenario and the car set up. Based on the field data acquisition concept development was performed where different approaches were considered which resulted in two main concepts which utilized the hardware and software set-up of a *Volvo XC90*. One of the concepts was chosen and further developed in a *Simulink* simulation environment which included models of the two vehicles, the driver and the pedestrian. The performance of the concept was evaluated through two different simulations. The first simulation was conducted in an ideal simulation environment where the performance of the concept was tested over a wide range of parameter combinations to investigate the benefit. In addition the effect of communication latency could be analyzed. The second simulation was conducted in a test bench with cloud communication and sensor data collected from scenarios reconstructed at the proving ground. This simulation was conducted to better understand the real world effects and the feasibility.

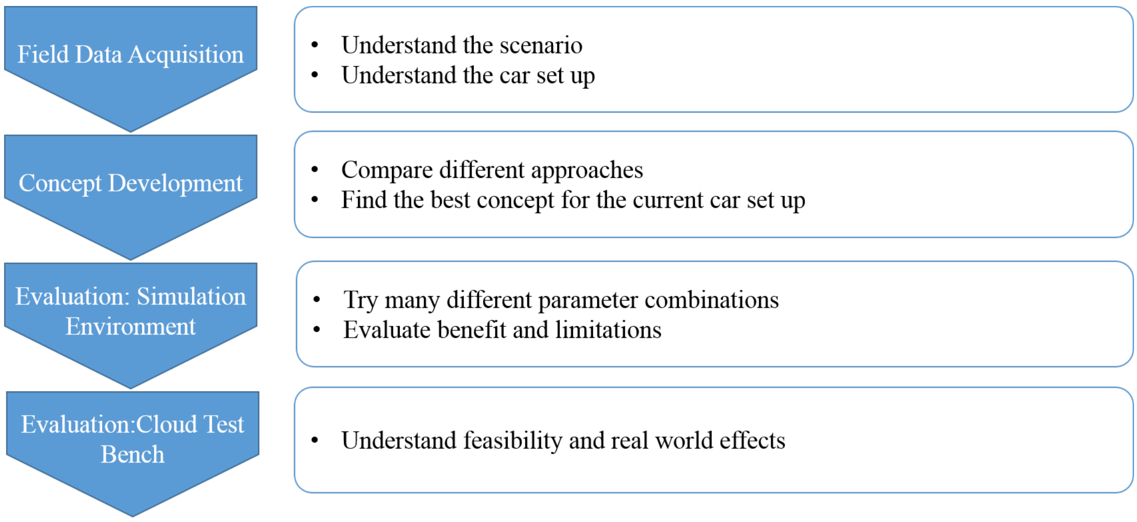


Figure 3.1: The main steps taken during the project to investigate the benefit, limitations and feasibility of the concept.

3.1 Car Set Up

The vehicle considered in the development of the concept was *Volvo Cars'* SUV *XC90*. With its height, width and length of 1776, 2008 and 4950 mm it is a big vehicle with up to 7 seats [47]. As in all Volvo Cars' new cars the *XC90* is equipped with the safety technologies *Intellisafe*, [48]. *Intellisafe* is divided into five areas which all together assist the driver when driving as well as prevent accidents and protect the passengers if one would occur. Some of the functions in *Intellisafe* are standard and others are optional. One of the five areas of *Intellisafe* is *City Safety* which includes *Volvo Cars'* collision avoidance and mitigation technologies which are standard in *XC90*, [9], [4]. City Safety provides a combined warning and auto braking strategy which provides braking assistance in the situations when the driver does not manage to brake sufficiently in order to avoid a collision after a warning is given. In order to assist the driver and prevent accidents *Intellisafe* may also provide functions such as *Adaptive Cruise Control*, *Lane Keeping Aid*, *Blind Spot Information System* and *Forward Collision Warning* which uses sensors around the car in order to keep both the passengers of the vehicle and other road users safe.[48]

The sensors which were considered in the project were the rear and side detection system, consisting of two radar units placed in the rear bumper on the right and left side, a combined radar and camera unit placed near the back mirror, GPS, and sensors determining the velocity and acceleration of the car. In addition the vehicles were connected with a Cloud via the mobile network which has an update frequency of 10 Hz.

The vehicle GPS has a sample time of 1 s and the position estimate has an uncertainty of several meters. The GPS sensor is used in functions where the position of the vehicle does not require a high precision.

There is a radar camera sensor mounted in the front of the vehicle which estimates the kinematic properties of the object and other useful properties such as object type, the size, different confidences based on how certain the sensor is of the object by processing the fused radar and camera data. The sensor may also be used to identify and measure road properties such as lane markings and road edges. The field of view of a typical active safety systems are typically between 70° to 90°. During some circumstances the performance of the sensor can decrease. As mentioned in section 2.2.1 disadvantageous weather conditions, darkness and reflections can affect the view of the of the camera, [4].

The vehicle is also equipped with a rear and side detection system which can detect and track objects behind and to the side of the vehicle. The rear and side detection system consists of two radars and has the same limitations as the radars in the radar camera unit, i.e. the performance may be limited if the object is occluded or if the relative velocity is large, [4].

Figure 3.2: The placement of the radar camera unit in Volvo Cars' *XC90* taken from [4].

3.2 Software Tools

The concept was developed in *Simulink* which is produced by Mathworks [49]. *MATLAB*, also developed by Mathworks, was used to analyze field data. The simulations were performed on the simulation environment developed by Volvo Cars in *Simulink*. The simulation environment includes models of the road, the dynamics of the vehicles and pedestrian as well as systems such as powertrain, brakes, steering and ideal sensors.

In order to include more factors from real world the concept was implemented in a cloud test bench. The cloud test bench was an open-loop simulation environment developed by Volvo Cars in *Simulink* where vehicle datalogs from field data acquisition were used and information could be transmitted over a real cloud.

3.3 Considered Concepts

The threat of the scenario depends on the likelihood of a collision between V_2 and the pedestrian. In order to estimate the risk it is necessary to know the kinematic properties of V_2 and the pedestrian relative each other. As the concept aims to warn and mitigate collisions the timing and kinematic estimates have to be precise. Three sensors described in previous sections were considered to estimate object kinematic estimates and properties: radar camera, rear and side detection system and GPS. In addition each vehicle has sensors estimating the ego kinematics.

The original attempt to determine the applicability of the sensors was to perform a field data acquisition in real traffic. A field data acquisition was performed in two urban traffic environments where the host vehicle was parked in front of a zebra crossings where pedestrians passed and the other vehicles drove by. The field data acquisition was performed during a sunny day providing good weather conditions.

The radar camera images were analyzed and proper kinematics were observed. The corresponding data logs, however, contained no useful or applicable information which assumed to be due to some conversion error rather than poor performance of the sensors. The review of the radar camera and rear and side detection system was complemented by internal reports from Volvo Cars and discussions with employees having experience with the sensors from function development and verification.

The radar camera performs well in classification and estimation of the kinematic properties of front objects. The rear and side detection system is generally useful for detection of following objects, but it is less capable of object classification and kinematics estimation compared t the radar camera. The kinematic estimates of rear objects are fuzzy, in particular when an object is close range. Additionally there is no certain information about further information such as object type.

Two main concepts were considered in the project. The strategy with the corresponding pros and cons of both concepts are described in the following two subsections.

Threat Assessment by Occluding Vehicle V_1

The first concept is based on the occluding vehicle V_1 performing the threat assessment and giving the warning to the following vehicle V_2. The occluding vehicle would detect and estimate the pedestrian state with the radar camera and the following vehicle by the rear and side detection system as illustrated in figure 3.3. The threat assessment would then be performed in the occluding vehicle V_1. If the situation would be determined to be dangerous a warning message would be sent over cloud and/or the occluding vehicle would flash rear lights to alert the driver in the following vehicle.

The occluding vehicle has a fair estimation of the state of the pedestrian as the uncertainties in the radar camera are capable of object identification and tracking. The estimates from the rear and side detection system are relatively uncertain compared to the radar camera. As the threat assessment is done in another vehicle which has a poor estimate of the state of the vehicle which pose a threat, the threat assessment might be inaccurate and result in wrongly timed warnings or interventions.

If the threat assessment is done by the occluding vehicle and the warning is communicated by rear lights, the following vehicle does not have to be equipped with an active safety system. A warning by rear lights by the occluding vehicle is, however, not informative of what kind of threat is present. In some cases flashing lights could be misinterpreted as that the occluding vehicle has broken down or similar. In this case the warning could be replaced with a warning message transferred over cloud which could result in a more informative warning to the driver and some warnings could be suppressed based on V_2. It is, however, difficult to determine if the warning is relevant for that particular vehicle or not. Cloud communication would introduce latency which would result in more uncertainties and a warning could be outdated

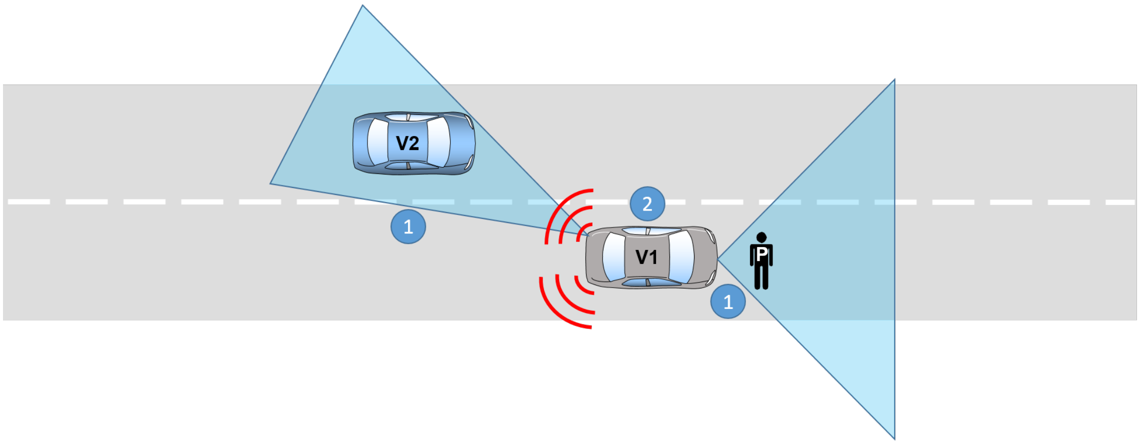


Figure 3.3: Concept which utilizes the radar camera and rear and side detection system in V_1 for pedestrian and V_2 state estimation respectively (blue fields). 1) V_1 detects a pedestrian and the following vehicle V_2, 2) V_1 performs a threat assessment and flashes the rear lights to warn the driver in V_1. Note: The sensor field of view is only schematic.

when it reaches V_2. The sharing of a warning can, however, not result in more than just a warning to the driver. If it is not known how much the vehicle needs to decelerate or steer to avoid the pedestrian, autonomous support and/or intervention is difficult to apply in a appropriate manner. A summary of the pros and cons of the concept are presented in table 3.1 and 3.2 respectively.

Table 3.1: Pros and cons of concept with threat assessment in V_1 using the warning lights as warning to alert the driver.

Pros	**Cons**
Good estimate of pedestrian state	Poor estimate of V_2 state
Immediate warning	Uninformative warning method
Drivers of vehicles without active safety systems can be warned	

Table 3.2: Pros and cons of concept with threat assessment in V_1 using a cloud transferred warning to alert the driver.

Pros	**Cons**
Good estimate of pedestrian state	Poor estimate of V_2 state
Informative Warning Method	Difficult to identify which vehicle the warning was meant for
	Possibly outdated warning
	Difficult to apply appropriate autonomous support and interventions

Threat Assessment by Following Vehicle V_2

The second concept is based on the threat assessment being performed by V_2. In this case V_1 will act as a sensor and transmit information about the most critical pedestrian to the cloud which will distribute the information to the vehicles within a certain range behind V_1. The cars receiving the information will perform their own threat assessment using the knowledge about its own behavior as well as the information about the pedestrian received from V_1 to apply a proper intervention.

To approximate the V_1 state in the V_2 frame the GPS position of each vehicle could be compared, as illustrated in figure 3.4. However, as GPS measurements have large uncertainties it is not appropriate for functions where the precision is important as it is this type of function, therefore it was decided to use the radar camera in V_2 to approximate the V_1 state.

One significant limitation of the concept is the possibly long latency due to communication via the cloud. A long latency could entail wrongly timed warnings or result in that the received information about the pedestrian states is outdated as pedestrians can change their kinematic state rapidly. On the other hand the following vehicle has a good perception of both its own behavior, good estimates of its own kinematics such as its velocity, acceleration and range as well as a fair estimate about the states of the occluding vehicle V_1 from the radar camera data as long as V_1 is in its field of view. This gives the following vehicle a good perception of the situation which can aid to compensate for the communication latency. The good estimate of its own behavior is useful to suppress false warnings. With an active safety system in V_2 the warning message displayed to the driver can be made informative. Performing threat assessment in V_2 enables possible assistance from the system in the vehicle, such as brake support or autobrake to assist the driver if the brake applied is insufficient to avoid a collision. Pros and cons of the second concept

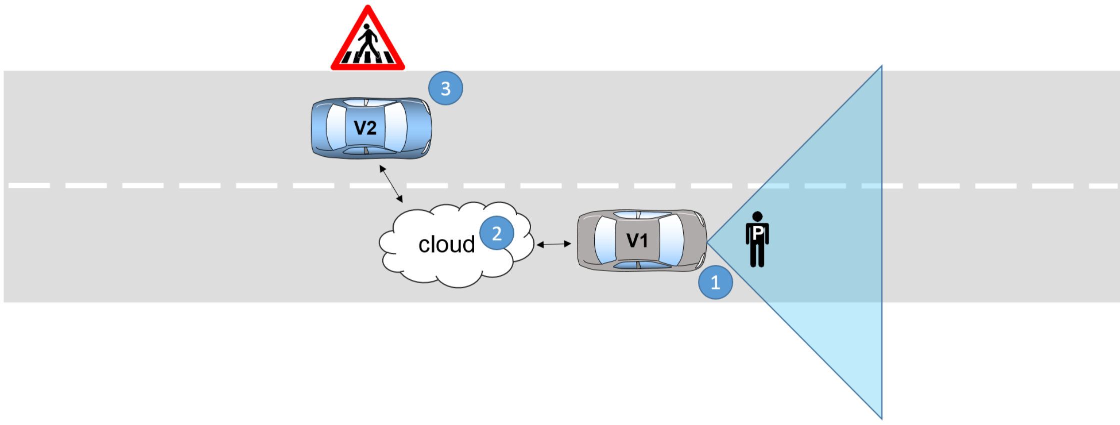


Figure 3.4: Concept in which V_1 detects and tracks the pedestrian state (light blue fields). The V_1 state in the V_2 frame is approximated by comparing the GPS positions. The threat assessment is performed by V_2. 1) V_1 detects a pedestrian on the road and starts to transmit pedestrian and GPS information via cloud, 2) The cloud transfers the information to relevant following vehicles, 3) V_2 receives the information and performs threat assessment and a warning is presented to the driver if deemed necessary. Note: The sensor field of view is only schematic.

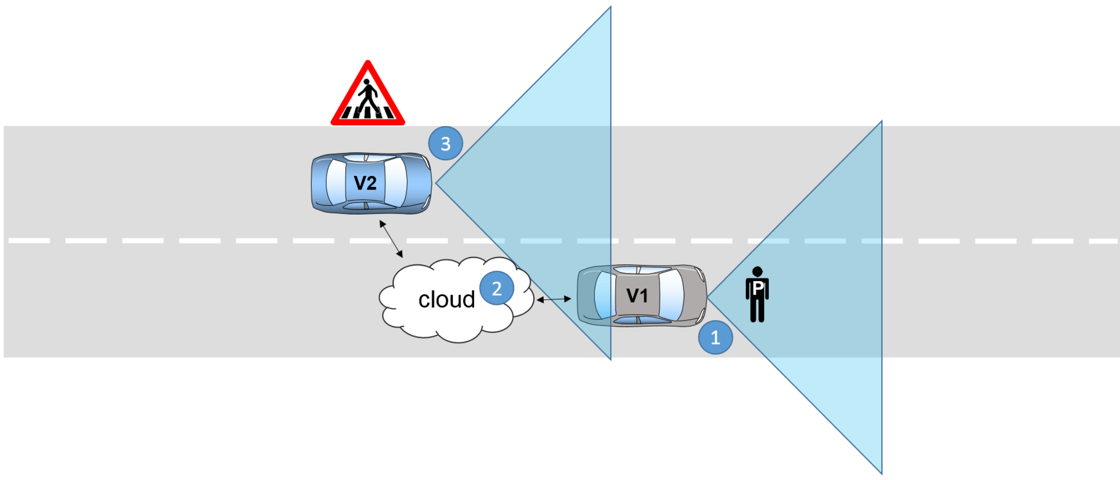


Figure 3.5: Concept in which V_1 and V_2 detect and track the pedestrian state and V_2 state with radar camera respectively (light blue fields). The threat assessment is performed by V_2. 1) V_1 detects a pedestrian on the road and starts to transmit pedestrian information via cloud, 2) The cloud transfers the information to relevant following vehicles, 3) V_2 receives the information and performs threat assessment and a warning is presented to the driver if deemed necessary. Note: The sensor field of view is only schematic.

are presented in table 3.3.

Table 3.3: Pros and cons of concept with threat assessment in V_2 using an informative warning to alert the driver.

Pros	**Cons**
Good estimate of V_2 states	Possibly outdated pedestrian state
Good estimate of V_1 states	V_1 might be occluded
Informative warning method	
Enables autonomous driver aid	

3.4 Developed Concept

The concepts were analyzed in terms of potential performance and feasibility. Since the following vehicle V_2 has a good estimate of its own behavior the prediction of its own behavior will be more accurately performed by V_2 than by the occluding vehicle V_1. The threat assessment was thus expected to be better performed by V_2. The warning through the Human Machine Interface, HMI, can be informative and the driver aid more advance and thus the performance of the concept better. Therefore the second concept was further developed which included object processing, threat assessment, cloud communication and decision making. The concept was developed iteratively through simulation. A high collision avoidance rate was prioritized over the suppression of false warnings.

As illustrated in figure 3.5 V_1 identifies the pedestrian and transfers the detected pedestrian range and velocity over cloud along with its ego GPS information. V_2 receives the information and estimates the pedestrian range and velocity relative itself by combining the pedestrian info with the observed kinematics of V_1. The concept intervention timeline is presented in figure 3.6 where the severity of the intervention increases with time. If a critical situation is identified an informative warning is given to the driver who is expected to brake. In case the driver starts to brake, but is not braking enough the required deceleration is added on top of the driver braking through brake, however, not exceeding the level of what a good driver could brake. If a collision is obvious such that the pedestrian is in the vehicle lane but the driver and brake support is not enough to avoid the collision, full autobrake is activated as a last resort to avoid or mitigate the collision.

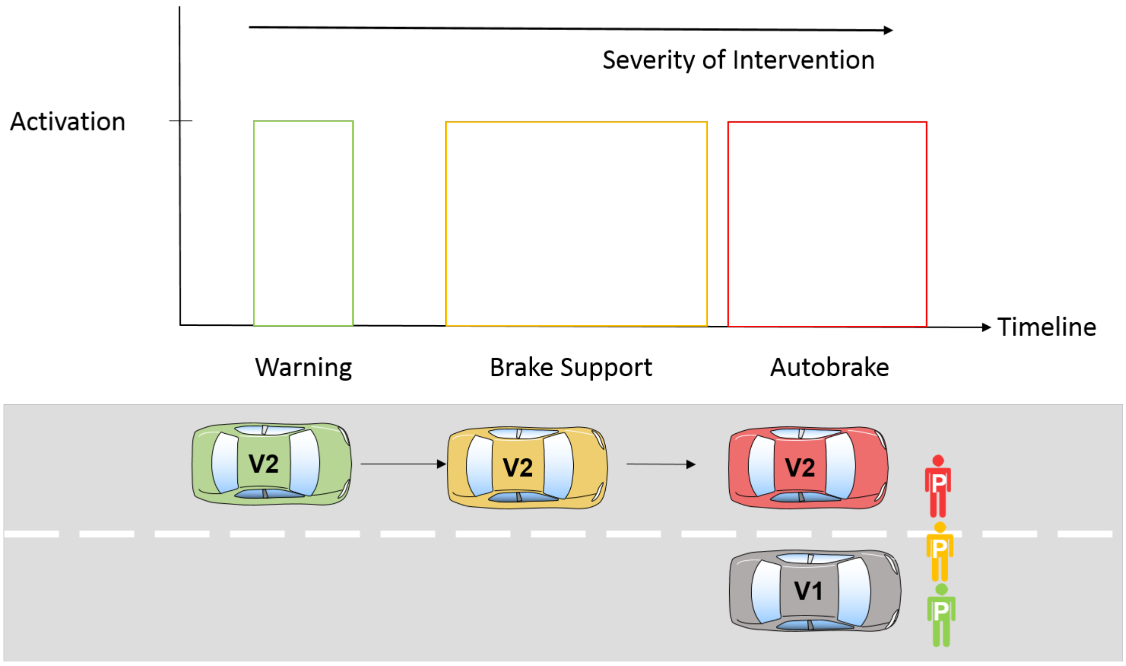


Figure 3.6: A timeline describing the intervention of the concept in a critical situation where the severity of the intervention increases with time and decreased range to the pedestrian.

3.4.1 Common Object Processing

The object processing and selection is common for the function in V_1 and V_2 and consists of two parts. The objects detected by the radar camera go through a valid object check which removes the objects that are 1) within the vehicle frame, 2) not on the road (outside the road edges), 3) neither pedestrians nor vehicles and 4) have a low or no confidence level set by the radar camera. Next the valid objects are sorted based on how difficult it is to brake as well as the range. The objects which have the lowest required deceleration are chosen and if the ego vehicle would be stationary the objects which are nearest. Since the project is limited to include the occluding vehicle V_1, the following vehicle V_2 and one pedestrian a more advanced object processing was not considered.

3.4.2 Function in V_1

The role of V_1 is to detect and track pedestrians crossing its field of view and transmit the information over cloud to following vehicles which potentially could be a danger to the pedestrian. The function is described in figure 3.7. V_1 uses the radar camera to estimate the lane and road marking distances as well as pedestrian state; the longitudinal and lateral range to the pedestrian as well as its relative lateral velocity. The longitudinal range is compensated with the distance to the rear of the vehicle. V_1 also sends a timestamp in order for V_2 to evaluate the age of the information, which in the ideal simulation environment is simplified and set by a digital clock. The flow chart of the function in V_1 is explained in figure 3.7. The pedestrian and GPS data is coded in order to fit into pre-defined fields when the function is to be implemented in the cloud test bench, which puts a limit to the range and precision of the transmitted data.

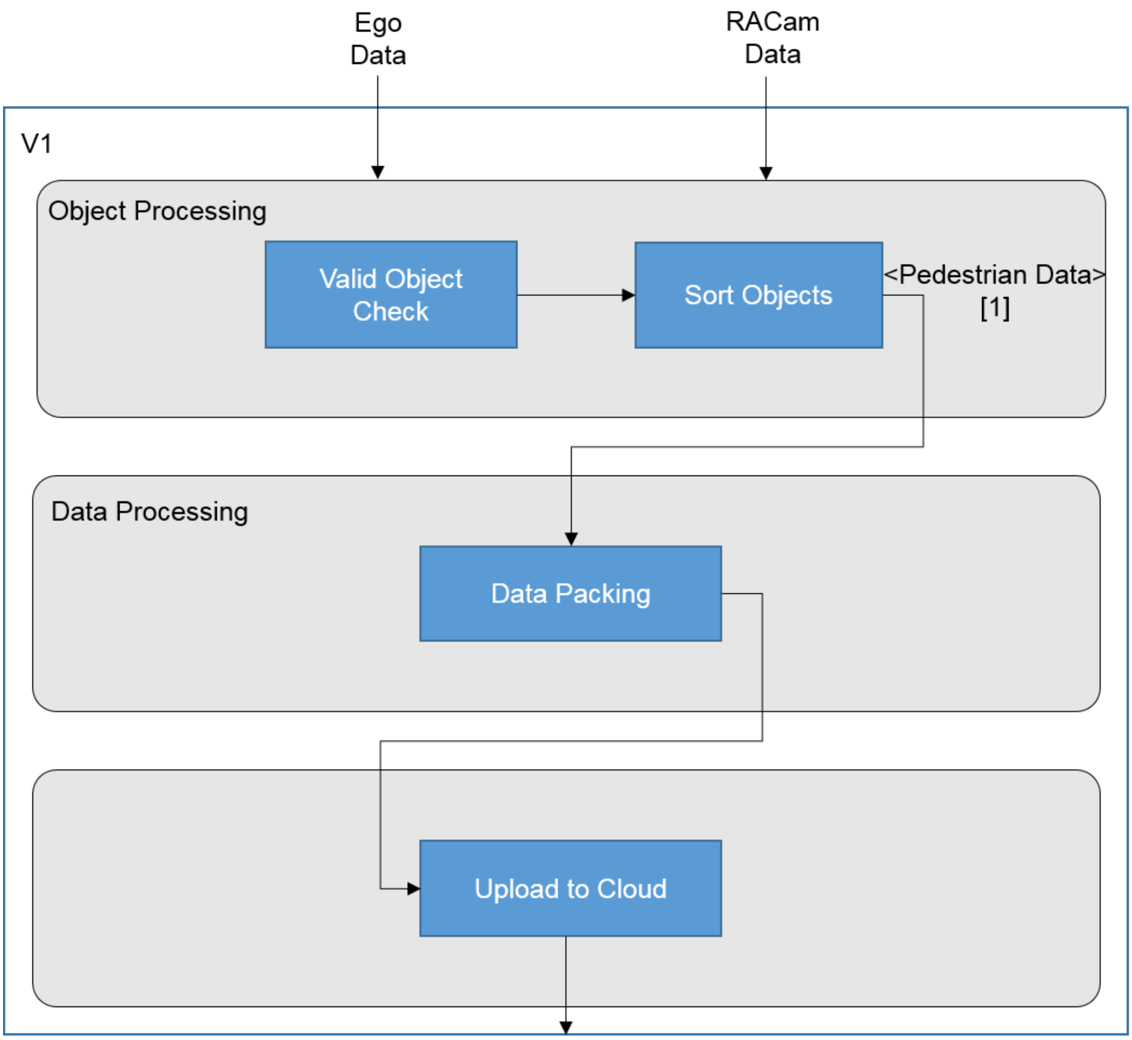


Figure 3.7: A flow chart describing the function in the occluding vehicle V_1.

3.4.3 Cloud Communication

Since there is a data limitation over the cloud the transmitted data was limited accordingly. The precision and range of the transmitted data are presented in table 3.4.

The longitudinal and lateral range of the pedestrian together with the velocity and acceleration of the vehicle affects the timing of the warning. Since the vehicle in critical scenarios will travel with several meters per second, a precision in whole meters for the longitudinal range of the pedestrian was concluded to be sufficient. The longitudinal range of the pedestrian was thus packed in an integer and has a limitation of 0-100 m with a precision of 1 m.

Table 3.4: Information transmitted over cloud from V_1 to V_2.

Parameter	Range	Precision
Longitudinal range to pedestrian	0 - 100 [m]	1 [m]
Lateral range to pedestrian	-6.3 - 6.3 [m]	0.1 [m]
Lateral relative velocity	-2.0 - 2.0 [m/s]	0.2 [m/s]
Timestamp	- [s]	0.025 [s]

Since the timing of the warning is affected by where the pedestrian is located on the road the precision of the lateral range of the pedestrian is important and it was therefore packed with a precision of 0.1 m.

The lateral velocity of the pedestrian was mainly used to estimate the movement of the pedestrian in order to compensate for the communication latency. The movement of a pedestrian is difficult to predict and may change suddenly. For the pedestrian velocity a precision of 0.2 m/s was considered sufficient to be used in the compensation.

The timestamp was used in the compensation to determine the age of the information and thus make an appropriate data compensation. In the ideal simulation environment the timestamp is not limited but simply transmitted as the actual timestamp in V_1 since the start of the simulation.

3.4.4 Function in V_2

V_2 determines if and when a warning will be given to the driver based on the information it receives about the pedestrian from V_1 and the estimation of the V_1 state by the ego radar camera. An overview of the function in V_2 is described by the flow chart in figure 3.8.

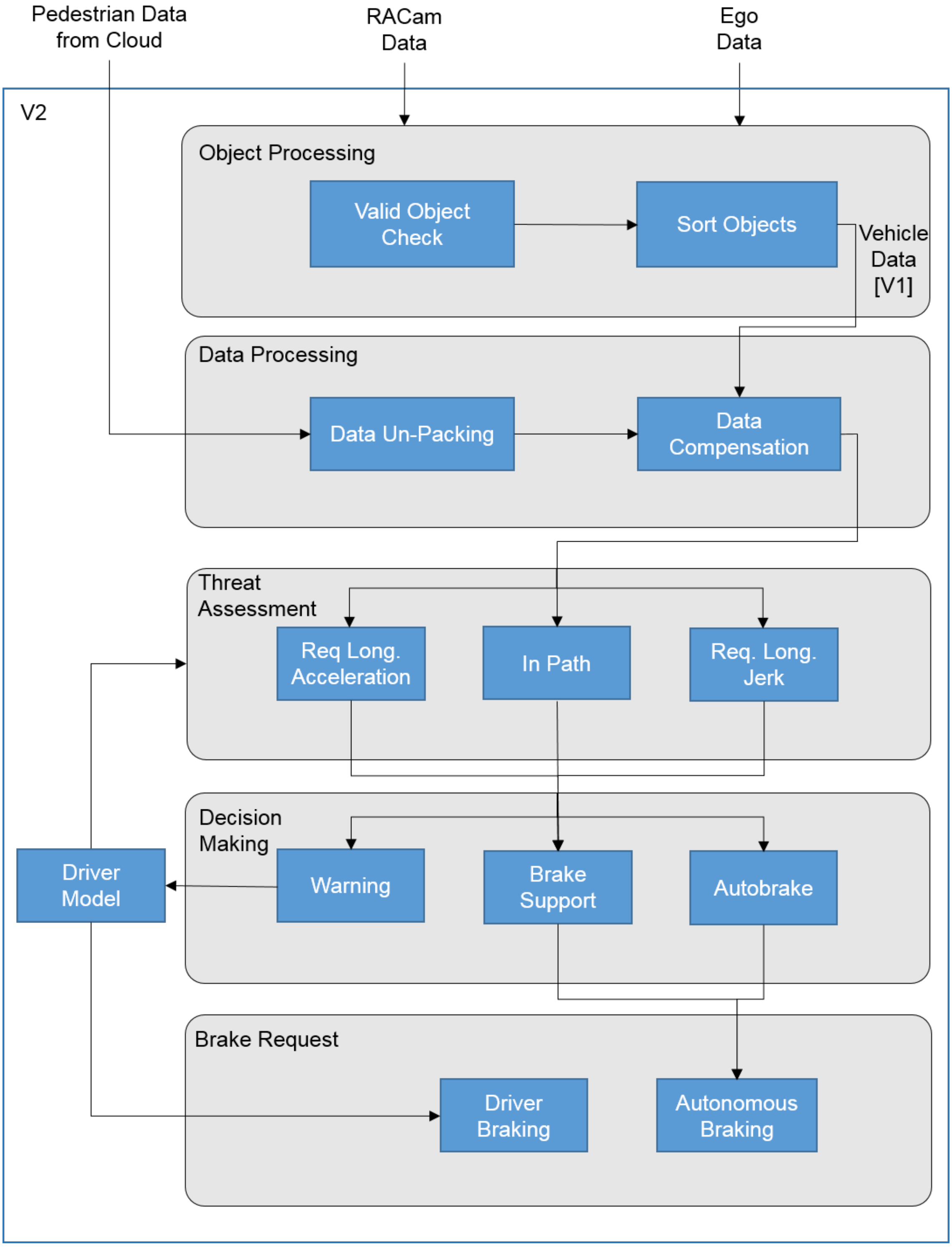


Figure 3.8: A flow chart describing the function in the following vehicle V_2.

Data Processing

The object selection in the following vehicle is performed as described in 3.4.1. As discussed previously, communication will introduce latency. Based on the difference between the current time in V_2 and the received timestamp from V_1, the data received from V_1 is compensated based on the assumption that the actors have kept a constant velocity since the data was transmitted.

The time difference was derived by comparing the current timestamp in V_2 when receiving the data with the corresponding timestamp in V_1 when the estimation of the pedestrian was conducted. In the simulation it was done by comparing the timestamp from a digital clock in the transmitting and receiving vehicle respectively.

In the scenarios the occluding vehicle V_1 was assumed to be stationary and, hence, the longitudinal range was not compensated as the longitudinal range between V_1 and the pedestrian thus was constant. The pedestrian was assumed to be moving perpendicularly over the road and thereby the longitudinal range of the pedestrian was constant as well. The longitudinal range between the following vehicle V_2 and the pedestrian was calculated as described by equation 3.1 where $r_{long,tot}$ is the total longitudinal range between V_2 and the pedestrian, r_{long,V_1} is the longitudinal range to V_1 and $r_{ped,long}$ is the longitudinal range between V_1 and the pedestrian.

$$r_{long,tot} = r_{long,V_1} + r_{long,ped} \tag{3.1}$$

The estimated total range to the pedestrian is illustrated in figure 3.9.

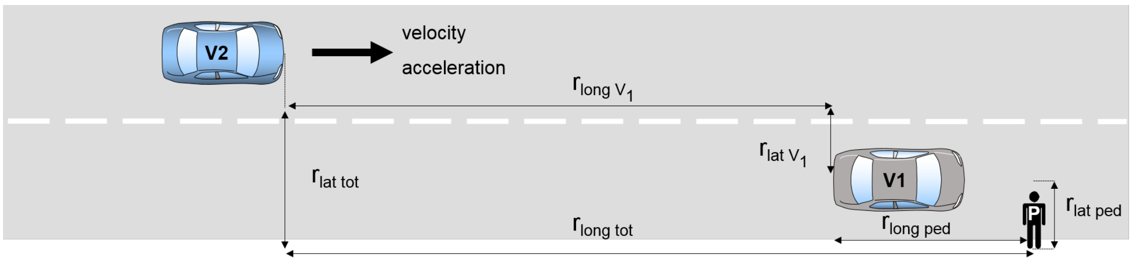


Figure 3.9: An illustration of the estimation of the longitudinal and lateral range of the pedestrian in V_2 frame.

The predicted lateral range of the pedestrian was calculated as the sum of the lateral range between V_2 and V_1, $r_{V_1 lat}$, and a prediction of the pedestrian position based on the pedestrian information from V_1. Using the relative velocity, $r_{ped,vel}$, and the lateral range between V_1 and the pedestrian, $r_{ped,lat}$, the compensation for the pedestrian movement during the transmission time can be performed in V_2. The time difference used is either the difference between the vehicle timestamps or, during the executions when no new data and thereby no new timestamp is received, the sample time. The pedestrian lateral range can then be calculated as described in equation 3.2.

$$r_{lat,tot} = r_{lat,V_1} + r_{lat,ped} + \sum r_{ped,vel} t_{diff} \tag{3.2}$$

In the case when the pedestrian passes the edge of the occluding vehicle and is in line of sight of V_2, the ego radar camera observations are used in the threat assessment instead of the radar camera estimation from V_1.

Threat Assessment

The threat assessment is based on three parameters; 1) the required deceleration to stop the vehicle before a collision, 2) the required jerk to stop the vehicle before a collision and 3) that the pedestrian is within a specified lateral area.

Equation 2.9 in section 2.3.3 is applied to calculate the required deceleration for the ego vehicle travelling at a velocity $v_{ego,0}$ to avoid the collision with a stationary object at the total longitudinal range $r_{long,tot,final}$. The required jerk to avoid a collision with a front vehicle by braking is calculated through equation 2.12 in section 2.3.4.

For a warning the longitudinal range is compensated by considering that some range will be lost during the reaction time of the driver, , t_r, and the brake delay, t_d, of 100 ms. The lost range used for brake support and autobrake, however, only includes brake delay. The lost range r_{lost} is calculated by applying linear prediction described in equation 2.7 in section 2.3.1 where $t = t_r + t_d$ for the warning and $t = t_d$ for the brake support and autobrake. It is preferred to stop with a clearance between the pedestrian and the vehicle for safety reasons, thus a safety margin of one meter is included. The considered range is thus $r_{long,tot,final} = r_{braking} = r_{long,tot} - r_{lost} - 1$ as illustrated in figure 3.10. The estimated required jerk to avoid a collision is compared to the capability of the driver and the system.

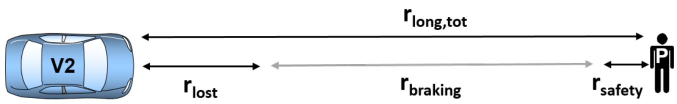


Figure 3.10: The lost range due to delays and safety margin.

Decision Making

A substantial latency was to be expected and the decision making was thus designed with this uncertainty in mind. The lateral risk area was chosen rather large as it was observed that the warning had to be given early for high velocities and considering the likely long latency due to communication the pedestrian position would be uncertain. Taking both lanes into account partly made the lateral compensation redundant. The severity of the interventions were also considered and it was decided autonomous braking would only be applied only if it was clearly necessary.

The warning is based on that the required jerk should not exceed the driver's preference and capability with,

$$j_{req} < j_{min,driver} \tag{3.3}$$

and that the pedestrian is in either V_1 or V_2 lane. If the required jerk decreases below the driver's preferences and the pedestrian is in the lateral risk area, an informative warning is presented to the driver. An upper limit of 4 s were set for the TTC to make sure warnings were not given too early. The parameters used for the threat assessment for the warning are illustrated in figure 3.11.

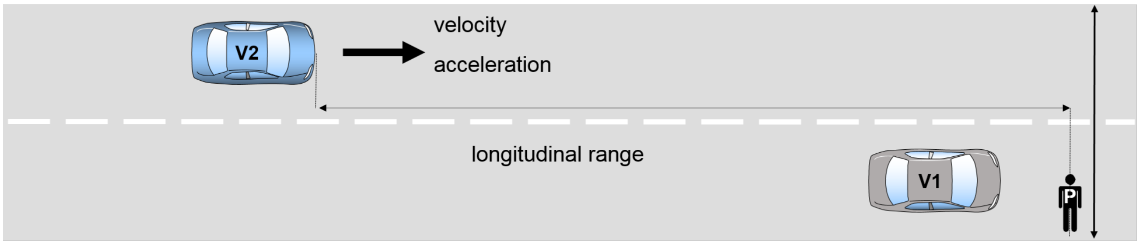


Figure 3.11: Threat Assessment for a warning based on required jerk and the pedestrian being in either lane.

The driver might not brake as much as estimated and thus not hard enough to avoid the collision. In this case the brake system supports the driver by adding the rest of the required deceleration up to a set limit based on driver capability. The brake support is not activated if the driver is not braking. The driver is estimated to not brake hard enough if after a warning is given and the driver has reached a constant deceleration level which is still not enough to avoid the collision. The deceleration is considered to be not strong enough if the calculated required deceleration is higher than the present deceleration taking 1 m safety margin into account. The brake support is then increased to up to a minimum of -4 m/s^2. The driver and brake support deceleration does not exceed -7 m/s^2 in total which is the highest deceleration level for driver 1. It is important the the brake support only aids the driver and does not work as an autobrake if the pedestrian is not visible.

Autobrake is the most severe intervention and is only applied if a collision is imminent, by the pedestrian being in the lane of the ego vehicle and thereby visible by the ego radar camera as illustrated in figure 3.12. Emergency autobrake is applied if the jerk decreases below -12 m/s^3, which is the brake limit of the system, with the full deceleration of -9.6 m/s^2.

$$j_{req} < j_{min,system} \tag{3.4}$$

If a warning has been given and the driver is braking with or without brake support the autobrake may activate earlier if the pedestrian is in the ego lane, with the remaining estimated required for a smoother braking rather than a late intensive braking.

Brake Request

The deceleration request profiles passed on to the brake system are modelled as ramps. The deceleration requests are based on a simple yet accurate brake model described by for example Brännström et al in [50], also similar to the one described in [3] used for the required jerk calculation. The brake requests is presented in figure 3.13,

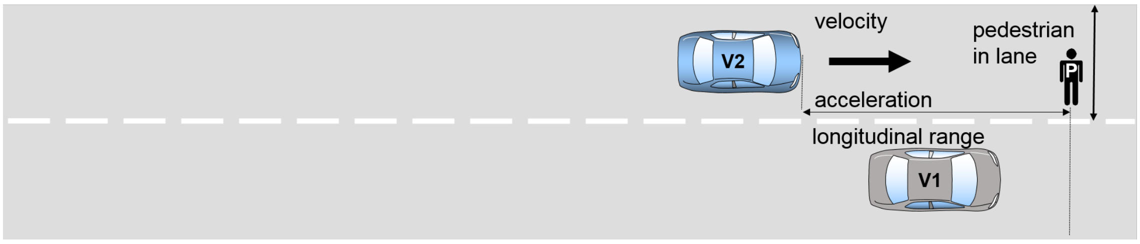


Figure 3.12: Threat Assessment for autobrake based on required jerk and deceleration as well as the pedestrian being in lane.

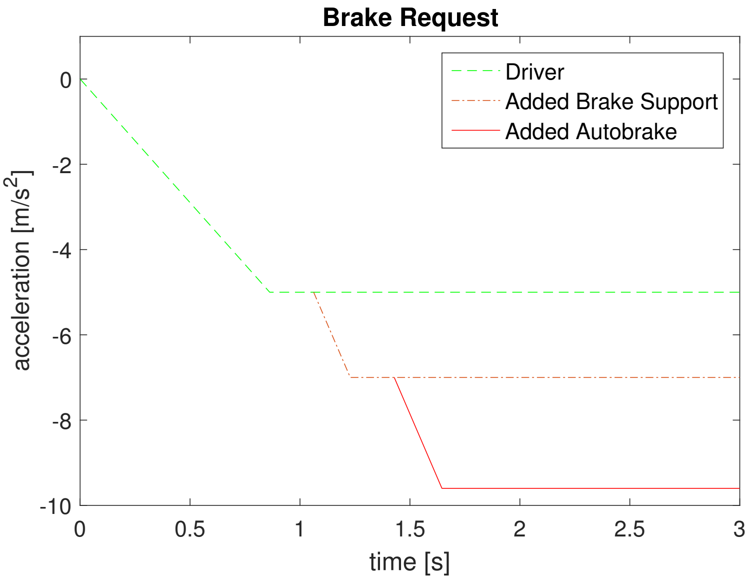


Figure 3.13: An illustration of the brake requests passed to the brake system for the driver, driver with brake support and with added autobrake.

3.5 Implementation

The concept was first implemented and developed in a closed loop simulation environment. Thereafter the concept was implemented in an open loop cloud test bench environment with limitations which had to be taken into account.

3.5.1 Simulation Environment

The simulation environment includes models of the road, the dynamics of the vehicles and pedestrians involved as well as vehicle systems such as powertrain, brakes, steering and ideal sensors. The function for V_1 and V_2 were implemented in one *Simulink* model respectively. In the simulation the cloud communication was modelled with a UDP block in the function of the leading and following vehicle respectively. The risk of data packet loss and receiving messages in the wrong order were considered very slim for the implementation of the cloud communication, therefore latency was the only modelled communication uncertainty. The latency from communication was modelled with a delay block and the update frequency of 10 Hz of data from cloud modelled with a rate transition block in the function of the receiving vehicle. Figure 3.14 illustrates of the simulation environment describing the interaction of V_1, V_2 and the pedestrian. To visualize the simulated scenarios and the performance of the concept a Volvo Cars developed tool was used. The tool visualizes the objects as rectangles and the road in 2D, see figure 3.15.

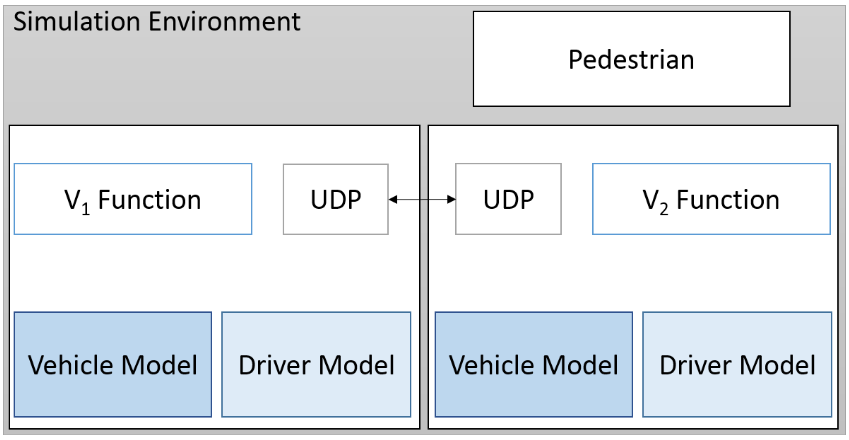


Figure 3.14: An illustration of the simulation environment.

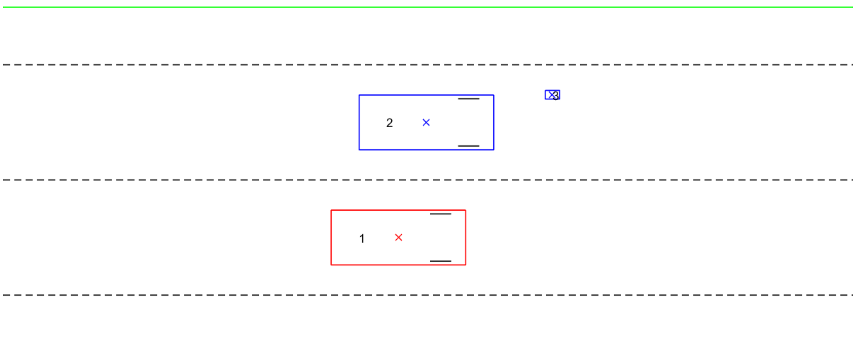


Figure 3.15: The visual tool illustrating the two vehicles and the pedestrian in the simulation environment where V_2 has come to a stop as a result of the concept.

3.5.2 Cloud Test Bench

The concept was implemented in a cloud test bench simulation environment developed in *Simulink* within Volvo Cars. The environment utilized vehicle datalogs collected in reality and was connected to cloud through the computer internet connection which could be WiFi with broadband or WiFi with LTE for example. No dynamic models of the vehicles are included in the environment, thus only the information flow can be observed and no braking interventions can be tested.

Developed Concept

The function in V_1 and V_2 which were separated in the simulation environment, had to be implemented and merged in the same function model as illustrated in the flow chart presented in figure 3.16. The estimation and information of the objects in front of the vehicle are given by sensor fusion of the radar camera data from the datalog. Information about the own vehicle is passed as ego data which contains the velocity and GPS position of the vehicle. Data from the cloud is also passed into the function. The information and estimations from the radar camera sensor fusion is processed in the object processor where the most critical pedestrian and vehicle, if there are any, are chosen. The case selector decides if the vehicle is V_1, V_2 or neither. The environment had some limitations which led to that the concept had to be simplified slightly. The acceleration of the vehicle was not incorporated as an ingoing signal, thus the acceleration could not be incorporated in the threat assessment.

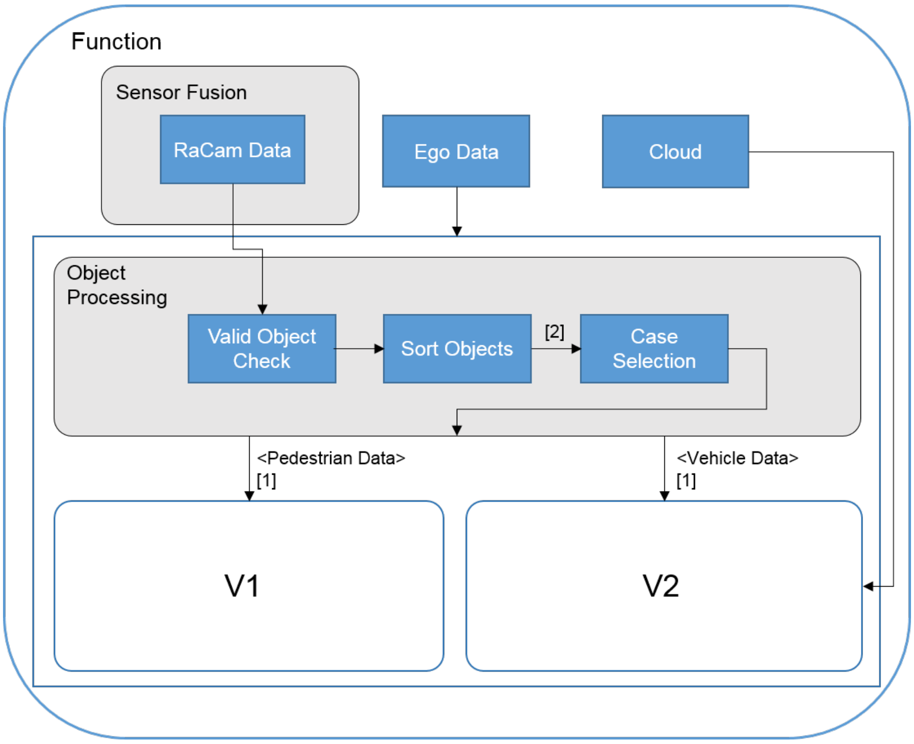


Figure 3.16: A flow chart describing the overview of the merged function, including the common object processing, implemented in the cloud test bench.

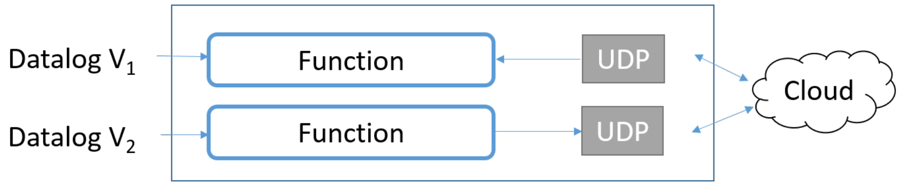


Figure 3.17: The scheme of the cloud test bench. The function described in figure 3.16 is duplicated and used for both vehicles and there is a connection between the functions over cloud via the computer internet connection (UDP blocks). Vehicle datalogs are used as input to the functions.

Bit packing of Cloud Data

In order to transmit the required information about the pedestrian from V_1 to V_2 the data was coded to fit the four fields available with space for four integers which sums up to 3 bytes; one unsigned integer in the range of 0-100 and 2 bytes in form of 3 unsigned integers with different limits. The data packing was performed by coding the pedestrian information into two bytes in order to represent all data within the available fields.

The bits in each byte of the fields were used for certain pedestrian data, as described by table 3.5. Four bits were allocated for the timestamp and the lateral velocity respectively, six bits were allocated for the lateral velocity, two bits for the respective signs of the lateral velocity and the lateral range and the integer in a range of 0-100 was used to transmit the longitudinal range. The number to bit conversion was performed with the *MATLAB* function *dec2bin*. After the data had been coded into bits and packed into the two bytes the data were decoded into one unsigned integer using the *MATLAB* function *bin2dec*.

Initially the sign of the lateral range as well as the lateral velocity was saved in separate bits saved in the first respective the last bit of the first byte. The signs were represented with a 0 and 1 for positive and negative numbers respectively.

In order to get a precision of one decimal the lateral range was multiplied with a factor of 10 and rounded to the nearest integer. To guarantee no overflow the result was saturated to 63 in order to fit into the allocated six bits. The obtained bits of the lateral range is coded into bit 2-7 of the first byte.

The lateral velocity was limited to 4 bits, which may represent values in a range between 0-15. The value was multiplied with a factor of $\frac{10}{2}$. As for the lateral range the lateral velocity was multiplied with a factor of 10 and rounded to the nearest value in order to get a precision of one decimal. The factor of 2 was included in order to represent velocities of higher values than 1.5. Since velocities higher than 2.0 m/s have not been tested the final range for the relative velocity is set to -2.0 - 2.0 m/s with a precision of 0.2 m/s. The value was saturated in order to avoid overflow.

The timestamp of the leading vehicle was derived as the sum of the received GPS timestamp from V_1 and the timestamp with a precision of 100 ms transmitted in the information package. The current time in V_1 is calculated as the sum of the current timestamp in the internal clock of the vehicle with a precision of 1 s and an additional timestamp with a precision of 100 ms implemented as a counter which was incremented at each sample time up to 900 ms with and integer from 0 to 9 representing the time with a precision of 100 ms. When an increment in the GPS timestamp is detected the counter was reset to zero. The timestamp was saturated before transmission to ensure no overflow.

The unpacking in the receiving vehicle was a reversed version of the packing. The received integer was decoded into bits and each field of the bytes were separated as described by 3.5 and multiplied or divided with an integer in order to obtain the original value.

Table 3.5: Number of bits used for transmission of pedestrian information from V_1 to V_2 over cloud.

First byte		**Second byte**	
Lateral range	**Signs**	**Lateral velocity**	**Timestamp**
6	2	4	4

Table 3.6: Information transmitted over cloud from V_1 to V_2.

Parameter	**Range**	**Precision**
Timestamp from GPS	0-86400 [s]	1 [s]
Additional timestamp	0-900 [ms]	100 [ms]
Longitudinal range to pedestrian	0-100 [m]	1 [m]
Lateral range to pedestrian	-6.3 - 6.3 [m]	0.1 [m]
Lateral relative velocity	-2.0 - 2.0 [m/s]	0.2 [m/s]

3.6 Evaluation

The concept was evaluated through two different simulations. The first simulation was conducted in an ideal simulation environment which allowed testing in a safe environment where changes easily could be made which enabled iterative testing and development. Testing in simulation also provided time efficient yet extensive testing and evaluation in an ideal environment with a large range of parameters to cover a large set of scenarios to evaluate the benefit and effect of communication latency. The ideal conditions of the simulation environment were, however, not what can be expected in a real traffic environment where various disturbances may arise. In order to understand how the concept would perform in reality a field data acquisition was performed at *Hällered Proving Ground* and the field data collected was used in a second simulation which had the cloud in the loop over WiFi with broadband and WiFi with LTE network, described i section 3.5.2.

3.6.1 Simulation Environment

Extensive tests were conducted in the simulation environment covering a wide range of parameter combinations through permutation.

Permutations

In order to evaluate the concept a set of parameter combinations was generated. The so-called permutation parameters were varied over a range, permutated, to create relevant test cases and localize the inadequacies of the algorithm.

Figure 3.18 describes the set up of the vehicles and the pedestrian in the simulation environment. V_1 is stationary in the right lane with a longitudinal distance d_2 to the crossing pedestrian. V_2 drives with a constant velocity in the left lane of the road approaching the crossing line of the pedestrian. The road was 12 m wide consisting of two lanes and the road edge of 4 m and 2 m width respectively. The vehicles are driving in the middle of their respective lane. Laterally the pedestrian started 1 meter outside the road at a lateral distance d_3 from V_1, to the right of the driving direction, and then crosses the road perpendicularly with a constant velocity. d_1 is the lateral distance of 2.1 m between V_1 and V_2.

The virtual collision point (vcp) is the point where V_2 and the pedestrian would collide if no action would be taken in the scenario. Only the positive performance was tested and thus only vcp with V_2 and the pedestrian colliding were considered. Three vcp were chosen: vcp_1, vcp_2 and vcp_3 which corresponds to the right corner, the middle and the left of the front of V_2 respectively. The collision point, the velocity of the pedestrian and d_2 affect the time that V_1 have to detect and track the pedestrian, thus send data, and also the time when the pedestrian passes the edge of V_1 to be in the field of view of V_2. This together with the velocity of V_2 result in that the driver will receive a warning at different TTC which affects the possibility for the driver to avoid or mitigate the collision. vcp_1 is thereby the most critical collision point since the pedestrian will be seen later and therefore there will be less time for intervention. Note that vcp_2 corresponds to the same collision point which is used in the Euro NCAP test described in 2.6.

Bohannon, [51], and Costa, [52], concluded in their studies on the human gait that the usual comfortable walking velocity varies between 1.2 and 1.6 m/s. In order to cover the extremes the pedestrian velocity was permutated over the interval 1 m/s to 1.8 m/s. The velocity of V_2 was varied between 30 to 70 kmph as the urban and suburban traffic typically varies between these limits. Table 3.7 displays the evaluated permutations. The combinations of the velocity of V_1 and the pedestrian resulted in 81 velocity combinations. In addition to the permutation combinations the drivers described in section 2.5, the virtual collision point and the length of the latency were varied which resulted in a total number of 5346 simulations. Running

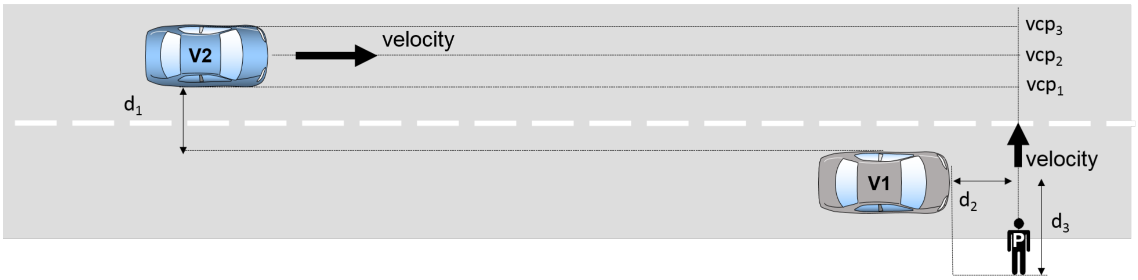


Figure 3.18: The set up of the permutation scenario describing the set up of V_1, V_2 and the pedestrian. d_1 is the lateral distance between the edges of the vehicles, d_2 the longitudinal distance and d_3 is the lateral distance between V_1 and the pedestrian. V_1 is stationary, V_2 is driving at a constant velocity and the pedestrian is crossing the road with a constant velocity. The virtual collision points are vcp_1, right corner of V_2, vcp_2, middle of V_2, and vcp_3, left corner of V_2.

the scenario with permutations of only one of these variables facilitated the evaluation of the effect on the performance from the specific variable.

The permutations were run for the drivers with and without the concept. This was done to compare the performance of the concept with the performance of the driver and the present collision avoidance performance of a Volvo vehicle in the Euro NCAP test described in 2.6 to establish the benefit of the concept.

Table 3.7: Permutation variables and their set of values.

Parameter	**Values**
V_2 velocity	30 35 40 45 50 55 60 65 70 [kmph]
Pedestrian velocity	1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 [m/s]
Virtual collision point	vcp_1 vcp_2 vcp_3
d_1	2.1 [m]
d_2	3.0 [m]
d_3	3.0 [m]
Driver	Driver 1, Driver 2
System	Only driver, Concept
Latency	0 100 200 300 400 500 600 700 800 900 1000 [ms]

Evaluation Parameters

When evaluating the simulation results the outcome regarding some key parameters were examined in order to evaluate the benefit of the concept. Each of the 81 combinations were simulated with the different drivers in order to see what scenarios the driver would be able to handle on its own.

For the scenarios where the driver could not handle the situation on its own, the main parameter to evaluate was the occurrence of a collision between the following vehicle V_2 and the pedestrian. In the cases when the following vehicle V_2 collide with the pedestrian with its front bumper a collision is obvious. A situation where V_2 passes the pedestrian with a low marginal such that the pedestrian very likely feels uncomfortable is classified as a failed intervention; the cases where the vehicle passes the crossing line of the pedestrian are thus classified as collisions even if the vehicle and pedestrian were not in physical contact. During the permutations the velocity of the pedestrian is constant and the heading perpendicular to the road. In reality the movement of a pedestrian might be very unpredictable with sudden changes in velocity and heading and the constant velocity model used in the simulations is not entirely accurate an applicable to the reality. With an unpredictable pedestrian it might have reached the following vehicle V_2's trajectory by the time V_2 passes the trajectory of the pedestrian.

In case of a collision the velocity at impact as well as the reduced velocity were evaluated. Even if the concept does not prevent a collision there is still a benefit of the concept if the collision has been mitigated to a low velocity at impact. The chance of surviving being hit by a vehicle increase significantly if the velocity at impact is 30 kmph compared to 50 kmph.

The TTC when the warning is given is evaluated to determine if the warning was given at an appropriate time.

3.6.2 Cloud Test Bench

Further evaluation of the concept was performed by testing the concept with collected field data and having the cloud in the loop, by this testing method the uncertainties in the sensors and communication could be evaluated.

Field Data Acquisition

Datalogs were collected by reconstructing the scenario at a proving ground. The data was collected at *Hällered Proving Ground* at a straight road with two parallel lanes with clear lane markings. Two vehicles of the *XC90* model and a static pedestrian child dummy *4activePS* from *4active* were used during the field data acquisition. Vehicle V_1 was stationary parked in the right lane and vehicle V_2 started further back in the left adjacent lane. The pedestrian dummy was fastened to a board which was connected to a rope. The starting position was in front and to the right of V_1. The pedestrian dummy was manually pulled from a starting position across the road to create critical scenarios. Many scenarios resulted in V_2 colliding with the pedestrian, where the forward collision warning and the autobrake could not avoid the collision. The test set up is depicted in figure 3.19 where d_2 is the constant longitudinal distance between V_1 and the pedestrian and d_1 is the lateral distance between V_1 and V_2.

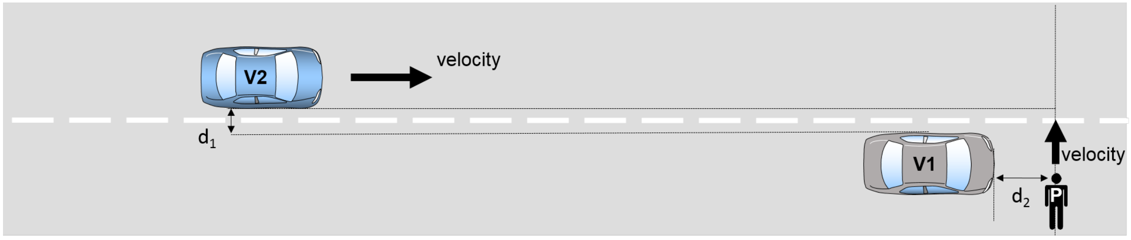


Figure 3.19: Set up of the scenario during the data acquisition for simulation in the cloud test bench where d_1 is the lateral distance between the vehicles and d_2 is the longitudinal distance between V_1 and the pedestrian dummy.

The goal of the data acquisition was to collect some relevant scenarios to prove the concept. The pedestrian dummy was pulled manually and it was thus not possible to make it have any specific velocity or collision point with V_2.

The data acquisition was performed during good weather conditions, i.e. in clear weather with limited disturbances on the road. The velocities of V_2 was varied in a range 30-70 kmph and the distance between the pedestrian and V_1 was varied between 3 and 4 m respectively. A summary of the scenario variables are presented in table 3.8.

Table 3.8: Variables during data acquisition.

Parameter	**Values**
V_2 velocity	40, 50, 60, 70 [kmph]
Longitudinal range between V_1 and pedestrian	3, 4 [m]
Lateral range between V_1 and V_2 [d3]	$\sim$ 2 [m]

52 datalogs were collected during the data acquisition with several critical scenarios at various velocities and collision points. Each vehicle had an installed DGPS *RT3000* V_2 from *OxTs* which uses the base station at *Hällered Proving Ground* as reference. V_1 sent its GPS data to V_2 which performed various calcuations. The logs were supposed to be synchronized in time by comparing the DGPS timestamp between the logs from the two vehicles, however, due to technical issues the DGPS did not collect any GPS data. The logs were instead synchronized by matching visual events in the radar camera video footage.

Testing

The pair of data logs from a collected scenario were fed into the functions; V_1 data into one and V_2 data into the other. The functions were connected to the cloud via UDP blocks which used the connection of the computer. The data was transferred with WiFi with broadband and WiFi with LTE network.

One scenario was chosen for testing as time limitations of the project limited the amount of testing which could be conducted. In the chosen scenario V_2 drove with 50 kmph. The simplified concept was tested with selected datalogs from the collection at *Hällered Proving Ground* for driver 1.

As the cloud test bench did not include any model of the vehicles, the chain of warning, brake support and autobrake could not be tested online. What could be tested was when a warning would be given. The TTC at warning was saved and compared to the TTC in the simulation environment where the deceleration of the vehicle was modelled.

4

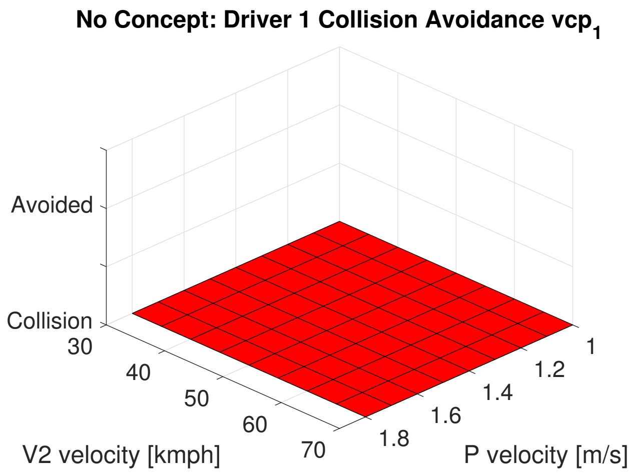
Results

This chapter presents the results from evaluation of the two simulations. First the performance of the driver models used in the concept and evaluation in the simulation environment, described in 3.7, without any system are presented as a reference for the benefit the concept might have. This is followed by the performance of the concept with the drivers in the same simulation environment for a wide range of parameter values. Finally the performance of the concept in the cloud test bench is presented.

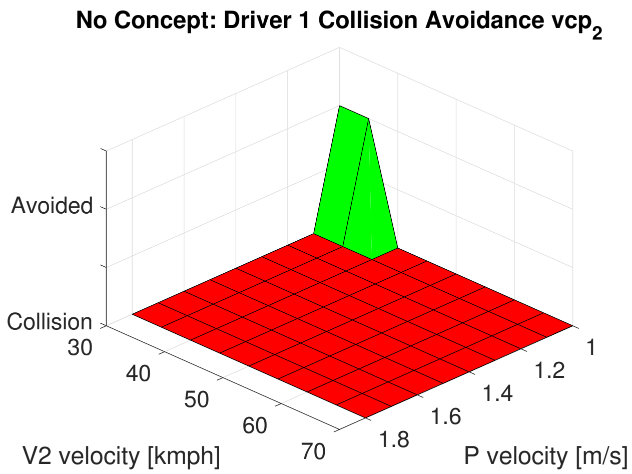
For analysis of the result the collision avoidance and velocity at impact were two important parameters as they have a direct effect on the severity of the injury. A velocity at impact of 30 kmph is also important as the chance of survival decreases dramatically above. The comfortable walking velocity is in the range of 1.2 - 1.6 m/s, as described in section 3.6.1, the upper limit was used as a guideline for where the concept should perform well. Another guideline is the pedestrian velocity 1.4 m/s used in the Euro NCAP CVNC test.

4.1 Driver Performance without Concept in Simulation Environment

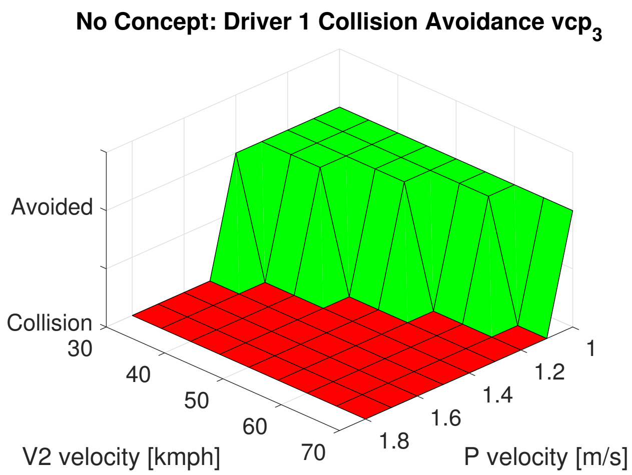
The two driver models, described in 2.5, were tested for vcp_1, vcp_2 and vcp_3 for all velocity combinations described in section 3.6.1. The two drivers performed poorly for vcp_1 and vcp_2 which can be seen in figure 4.1 and 4.2 having a 0 % collision avoidance. The red color indicates a collision and green an avoided collision. Mitigation is not illustrated in the plots, however, the mitigation is higher in the proximity of the green area compared to further into the red area. For vcp_2 driver 1 manage to avoid collisions at very low velocities with a success rate of modest 2 %, see figure 4.1b. Driver 2 does not avoid any of the collisions. The results are slightly better for vcp_3 where driver 1 avoids 31 % and driver 2 avoids 9 % which can be seen in figure 4.1c and 4.2c. As the collision avoidance rate is low, especially for high velocities, there is potential to produce benefit for all vcp.



(a) Driver 1 performance for vcp_1 resulting in 0 % collision avoidance.

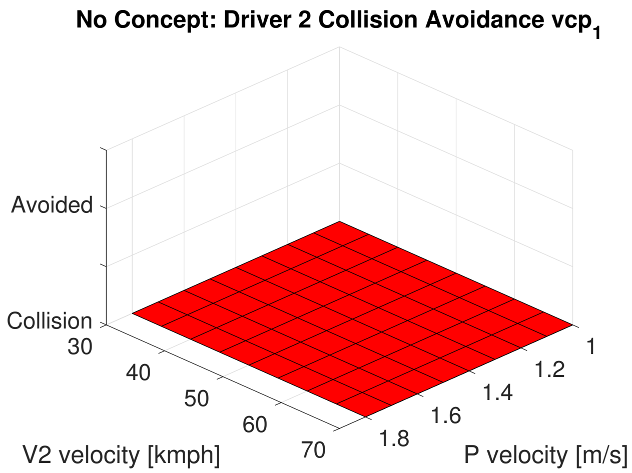


(b) Driver 1 performance for vcp_2 resulting in 2 % collision avoidance rate

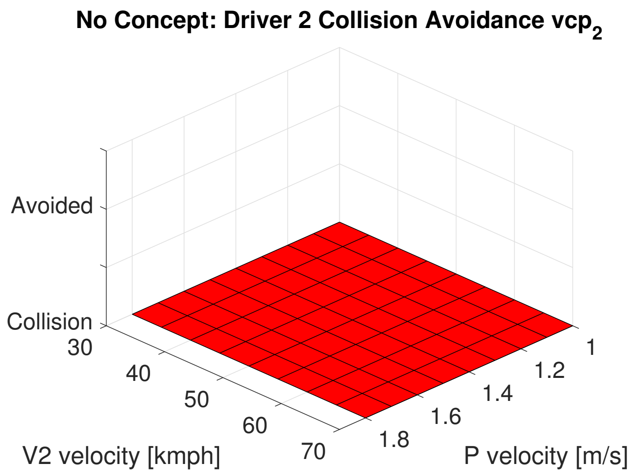


(c) Driver 1 performance for vcp_3 resulting in 31 % collision avoidance rate

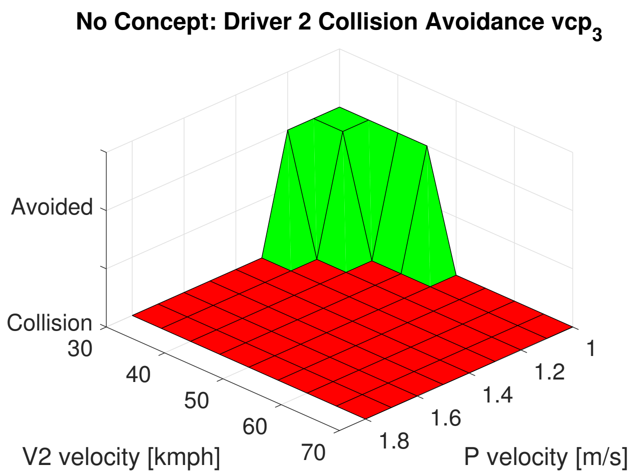
Figure 4.1: Driver 1 braking without the concept for the three vcp.



(a) Driver 2 performance for vcp_1 resulting in 0 % collision avoidance rate



(b) Driver 2 performance for vcp_2 resulting in 0 % collision avoidance rate



(c) Driver 2 performance for vcp_3 resulting in 9% collision avoidance rate

Figure 4.2: Driver 2 braking without the concept for the three vcp.

4.2 Performance with Concept in Simulation Environment

This section presents the performance of the developed concept in the simulation environment with ideal sensors. The evaluated parameters can be seen in table 3.7. The full simulation results can be found in appendix section A.1.

For the case with no latency the result of the concept were successful for most scenarios as can be seen in figure 4.3 describing the performance for both driver 1 and driver 2. For vcp_1 collisions with the pedestrian were avoided for all V_2 velocities when the pedestrian had a velocity up to 1.6 m/s. Pedestrian velocities of 1.8 m/s and 1.7 m/s resulted in collisions for V_2 velocities from 60 and 65 kmph respectively. The collision avoidance for vcp_1 is 93 % which can be seen in figure 4.3a. The concept performs similar for both drivers. The velocity at impact were all below 30 kmph. For vcp_2 and vcp_3 the collision avoidance is 100 % (see figure 4.3b and 4.3c), due to the fact that the pedestrian is in V_1's field of view earlier the threat assessment can be performed earlier in V_2. The proper interventions can thus be applied in time.

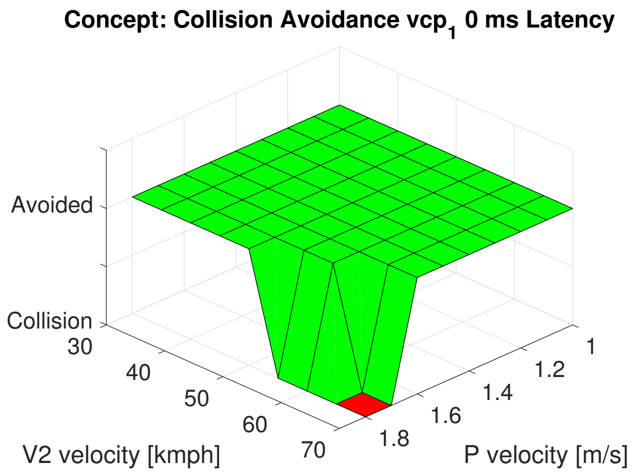
The average, min and max TTC and stop range for the avoided collisions are presented in table 4.1 and 4.2. For driver 1 the average stop range is about 2 m and the average TTC is 3 s. For driver 2 the stop range (r_s) is similar while the TTC for warning is a bit longer as the driver requires a longer range to brake.

Table 4.1: The min, average and max TTC and stop range for driver 1 for the cases where a collision was avoided.

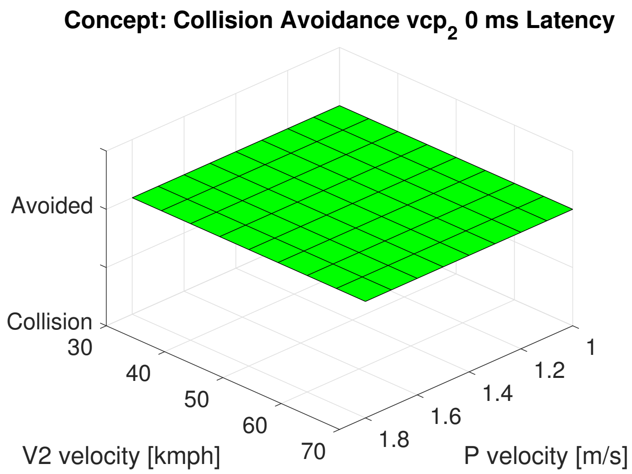
	$\mathbf{TTC}_{min}$	$\mathbf{TTC}_{average}$	$\mathbf{TTC}_{max}$	$\mathbf{r}_{s,min}$	$\mathbf{r}_{s,average}$	$\mathbf{r}_{s,max}$
vcp_1	2.6	3.0	3.4	0.6	1.8	2.2
vcp_2	2.6	3.0	3.4	1.4	1.9	2.2
vcp_3	2.5	3.0	3.4	1.0	1.6	1.9

Table 4.2: The min, average and max TTC and stop range for driver 2 for the cases where a collision was avoided.

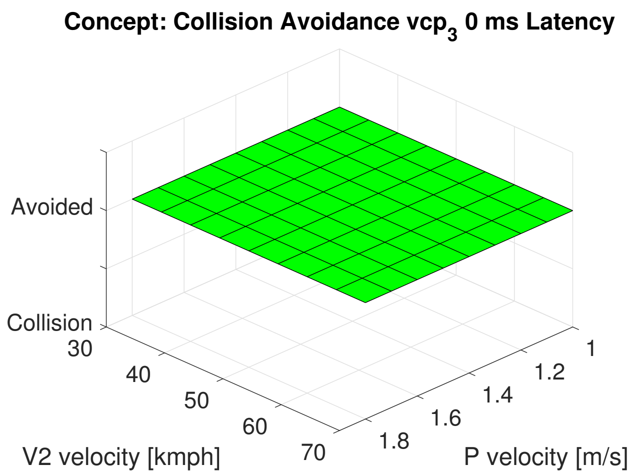
	$\mathbf{TTC}_{min}$	$\mathbf{TTC}_{average}$	$\mathbf{TTC}_{max}$	$\mathbf{r}_{s,min}$	$\mathbf{r}_{s,average}$	$\mathbf{r}_{s,max}$
vcp_1	2.6	3.1	4.0	0.6	1.7	2.2
vcp_2	3.1	3.5	4.0	0.9	1.5	1.8
vcp_3	3.1	3.6	4.0	1.1	1.3	1.7



(a) Driver 1 and 2 performance for vcp_1 resulting in 93 % collision avoidance



(b) Driver 1 and 2 performance for vcp_2 resulting in 100 % collision avoidance



(c) Driver 1 and 2 performance for vcp_3 resulting in 100 % collision avoidance

Figure 4.3: Driver 1 and 2 collision avoidance performance for the developed concept with no latency.

The negative effect on the performance due to the latency increases with its length. The result implies that even a latency of a few hundred ms affects the performance significantly. However, compared to the driver performance the concept still yields some benefit for high latency. Figure 4.4 presents the collision avoidance performance of the concept with 0 to 1000 ms latency. The collision avoidance performance for vcp_1 decreased close to linearly. For driver 1 the collision avoidance performance was constant at 100 % for vcp_3 up to 1000 ms, while the performance for vcp_2 started to decrease after a latency of 400 ms. With driver 2 the concept had a 100 % collision avoidance rate for vcp_2 up to a latency of 300 ms and 900 ms for vcp_3.

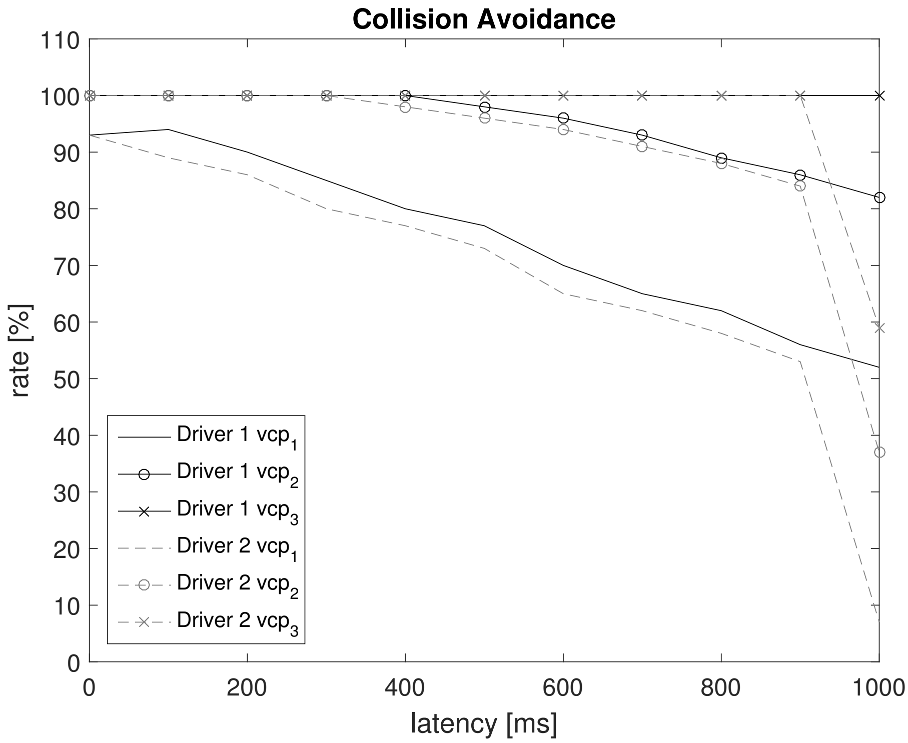


Figure 4.4: Collision avoidance rate for latency ranging from 0 to 1000 ms.

The collision avoidance and the min, average and max velocity at impact and TTC respectively are presented in table 4.3 - 4.5 for driver 1. The severity of a collision depends on the velocity at impact. With an increasing latency the collision avoidance performance degrades and the velocity at impact increases. With a long latency the min and average TTC decreases to such levels that for high V_2 velocities the car cannot stop in time. For vcp_1 the collision avoidance is above 80 % and the average velocity at impact is close to 30 kmph up to a latency of 400 ms. The collision avoidance is 100 % for vcp_2 up to 400 ms and the average velocity at impact is below 30 kmph up to 1000 ms. In all scenarios with vcp_3 the collision avoidance performance is 100 %. Considering vcp_1 a latency of 200 ms for a pedestrian velocity of 1.6 m/s all collisions are avoided for the range of tested V_2 velocities which can be confirmed in figure 4.5. The total collision avoidance is 90 % which only is a small decrease from the case with no latency. For a latency up to 500 ms the velocity at impact is lower than 30 kmph for the same pedestrian velocity. The collisions with the average pedestrian velocity of 1.4 m/s are avoided for a latency up to 600 ms, which can be seen in figure 4.6.

It can be seen that the collision avoidance is 1 % higher with 100 ms latency than with 0 latency for vcp_1 in table 4.3. This difference is caused by that the collision for the case of V_2 velocity of 65 kmph and pedestrian velocity 1.7 m/s is avoided with the latency. The reason is that the lateral compensation of the pedestrian position overestimates the pedestrian to be in the lateral risk zone earlier as the pedestrian velocity is rounded off to 1.8 m/s as the precision is 0.2 m/s as described in section 3.4.3. The stop range is, however, close to 30 cm and thus the margin is small.

Table 4.3: Driver 1 vcp_1 statistics of velocity at impact and TTC at warning for the scenarios with latency and the driver alone.

Latency	**CA [%]**	$\mathbf{V}_{I,min}$	$\mathbf{V}_{I,avg}$	$\mathbf{V}_{I,max}$	$\mathbf{TTC}_{min}$	$\mathbf{TTC}_{avg}$	$\mathbf{TTC}_{max}$
0	93	3.4	16.8	29.4	2.6	3.0	3.4
100	94	12.5	21.9	34.8	2.6	3.0	3.4
200	90	12.0	24.6	41.1	2.5	2.9	3.4
300	85	7.7	26.1	46.2	2.5	2.9	3.4
400	80	7.7	28.3	51.3	2.4	2.9	3.4
500	77	12.5	30.7	49.1	2.3	2.8	3.4
600	70	7.2	30.2	51.7	2.2	2.8	3.4
700	65	7.2	30.6	54.1	2.1	2.7	3.4
800	62	5.5	32.0	56.2	2.0	2.7	3.4
900	56	2.6	31.8	58.1	1.1	2.6	3.4
1000	52	12.0	33.5	59.8	1.1	2.5	3.4
Driver	0	28.0	49.7	69.9	-	-	-

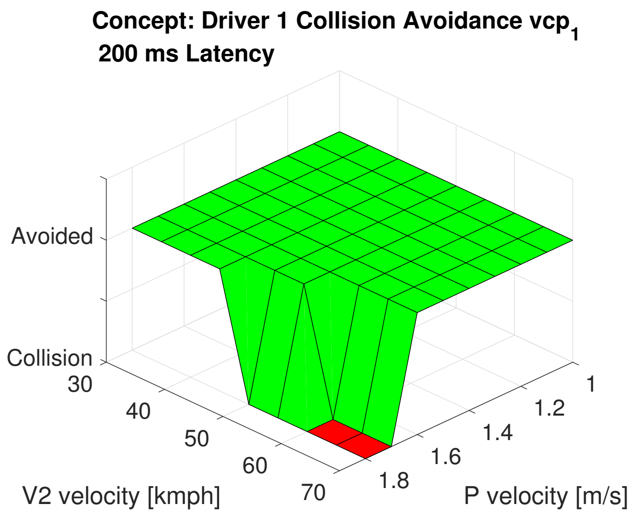


Figure 4.5: Performance of the concept with driver 1 for vcp_1 and a communication latency of 200 ms resulting in 90 % collision avoidance. Collision avoidance is 100 % up to a pedestrian velocity 1.6 m/s.

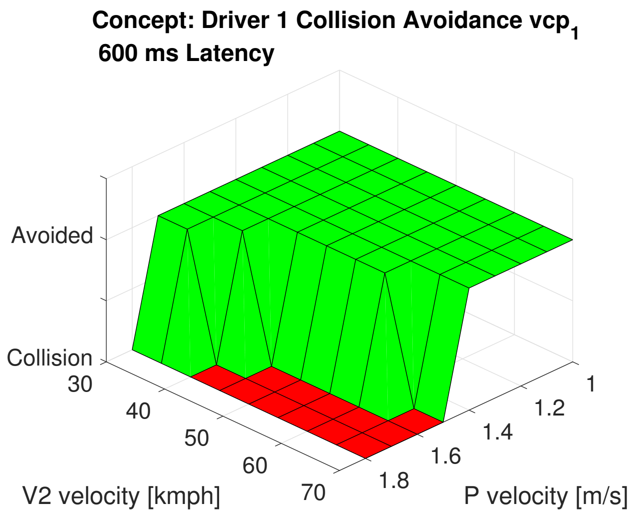


Figure 4.6: Performance of the concept with driver 1 for vcp_1 and a communication latency of 600 ms resulting in 70 % collision avoidance. Collision avoidance is 100 % up to a pedestrian velocity 1.4 m/s.

For vcp_2 all collisions for a pedestrian velocity of 1.6 m/s are avoided for a latency up to 800 ms which can be confirmed in figure 4.7. The velocity at impact never exceeds 30 kmph for the same pedestrian velocity up to a latency of 1000 ms. All collisions with a pedestrian velocity of 1.4 m/s are avoided which can be confirmed by examining the plots in appendix. At a latency of 1000 ms driver 1 still performs considerably well for vcp_2 with 82 % while it only avoids 52 % of the collisions for vcp_1 which can be seen in figure 4.8.

Table 4.4: Driver 1 vcp_2 statistics of velocity at impact and TTC at warning for the scenarios with latency and the driver alone.

Latency	**CA [%]**	$\mathbf{V}_{I,min}$	$\mathbf{V}_{I,avg}$	$\mathbf{V}_{I,max}$	$\mathbf{TTC}_{min}$	$\mathbf{TTC}_{avg}$	$\mathbf{TTC}_{max}$
0	100	0.0	0.0	0.0	2.6	3.0	3.4
100	100	0.0	0.0	0.0	2.6	3.0	3.4
200	100	0.0	0.0	0.0	2.6	3.0	3.4
300	100	0.0	0.0	0.0	2.6	3.0	3.4
400	100	0.0	0.0	0.0	2.6	3.0	3.4
500	98	16.8	16.9	17.1	2.6	3.0	3.4
600	96	16.6	23.6	27.3	2.6	3.0	3.4
700	93	12.5	23.5	34.8	2.6	3.0	3.4
800	89	7.7	25.2	41.1	2.5	2.9	3.4
900	86	12.5	29.5	46.2	2.4	2.9	3.4
1000	82	7.7	28.2	51.3	2.3	2.9	3.4
Driver	2	7.2	43.0	69.4	-	-	-

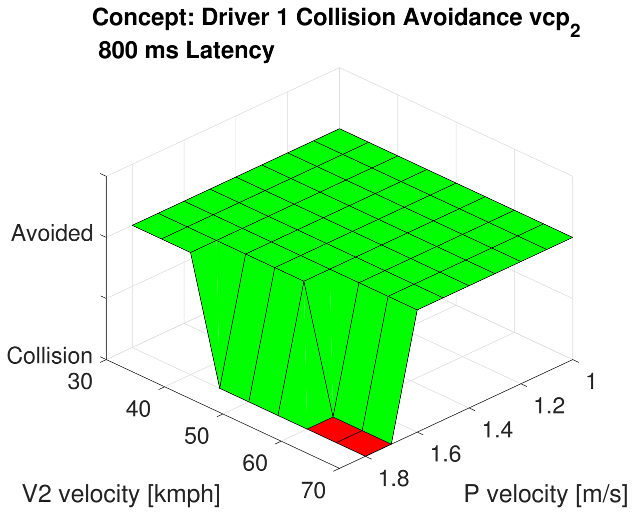
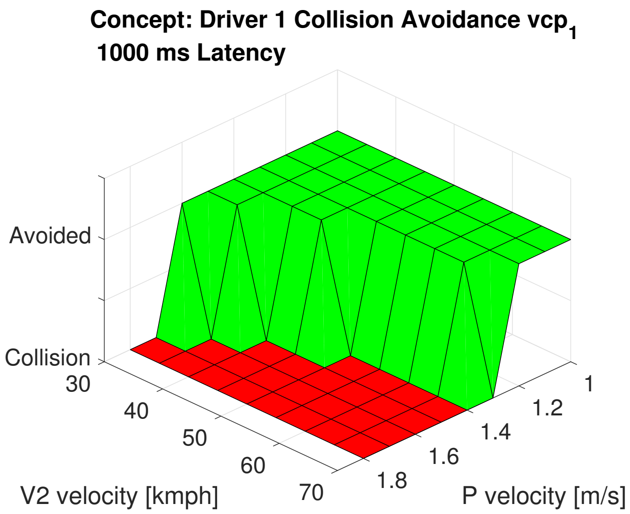


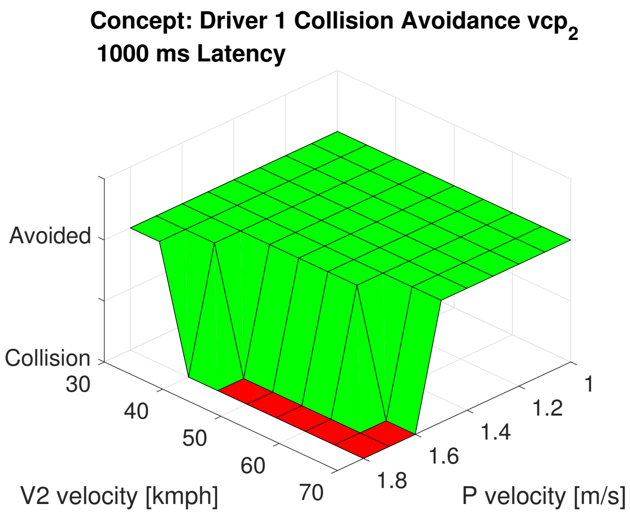
Figure 4.7: Performance of the concept with driver 1 with a latency of 800 ms for vcp_2 resulting in 89 % collision avoidance, where all collisions for a pedestrian velocity of 1.6 m/s are avoided.

Table 4.5: Driver 1 vcp_3 statistics of velocity at impact and TTC at warning for the scenarios with latency and the driver alone.

Latency	CA [%]	$V_{I,min}$	$V_{I,avg}$	$V_{I,max}$	TTC_{min}	TTC_{avg}	TTC_{max}
0 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
100 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
200 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
300 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
400 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
500 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
600 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
700 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
800 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
900 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
1000 ms	100	0.0	0.0	0.0	2.5	3.0	3.4
Driver	31	0.1	32.9	63.1	-	-	-



(a) Performance of the concept with driver 1 for vcp_1 with a latency of 1000 ms resulting in 52 % collision avoidance.



(b) Performance of the concept with driver 1 for vcp_2 with a latency of 1000 ms resulting in 81 % collision avoidance.

Figure 4.8: Performance of the concept with driver 1 with a latency of 1000 ms.

The driver 2 statistics of the collision avoidance and the min, average and max velocity at impact TTC for vcp_1-vcp_3 are presented in table 4.6-4.8 respectively. As with driver 1 the performance decreases notably with increasing latency. For a combined high pedestrian and high vehicle velocity and the critical collision point vcp_1 collision avoidance is difficult even in the case with no latency, as can be seen in figure 4.3a.

The collision avoidance for vcp_2 is 100 % in all cases with latency below 400 ms and 900 ms for vcp_3, which is the limit of when the collision avoidance performance start to decrease for vcp_2 and vcp_3, see figure 4.10 and 4.12. Up to a latency of 400 ms the average velocity at impact is kept below 30 kmph for all vcp, as can be seen in table 4.6 representing vcp_1. All collisions up to latency 500 ms can be mitigated to a maximum velocity at impact below 30 kmph for vcp_2 and 900 ms for vcp_3, which can be observed in table 4.7 and 4.8 respectively.

For the pedestrian velocity 1.4 m/s collisions can be avoided for all scenarios with latency up to 300 ms, see figure 4.9. For all scenarios with the average maximum pedestrian walking velocity at 1.6 m/s collision can be avoided for all vcp only with no latency which can be seen in 4.3. The maximum velocity at impact for vcp_1 is below 30 kmph for a pedestrian velocity of 1.6 m/s up to a latency of 300 ms, presented in 4.6. For vcp_2 and vcp_3 all collisions could be avoided for the same pedestrian velocity with a latency up to 900 ms, see figure 4.11.

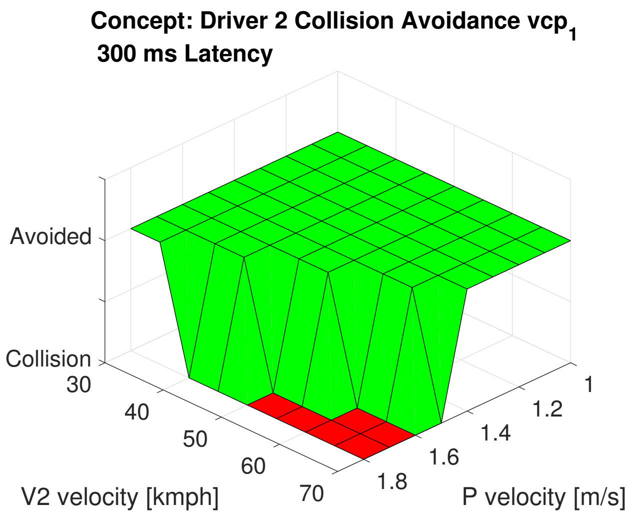


Figure 4.9: Performance of the concept with driver 2 for vcp_1 with a latency of 300 ms. Collision avoidance is 100 % up to a pedestrian velocity 1.4 m/s.

At a latency of 1000 ms the performance drastically decreases for driver 2 which can be seen in figure 4.4. The most evident effect can be seen in the difference between latency 900 and latency 1000 ms. For vcp_1 and vcp_2 there is a significant decrease in performance with a with a drop of 50 percentage, as can be seen in the statistics tables 4.6 and 4.7. The dramatic decrease in performance for a latency of 1000 ms

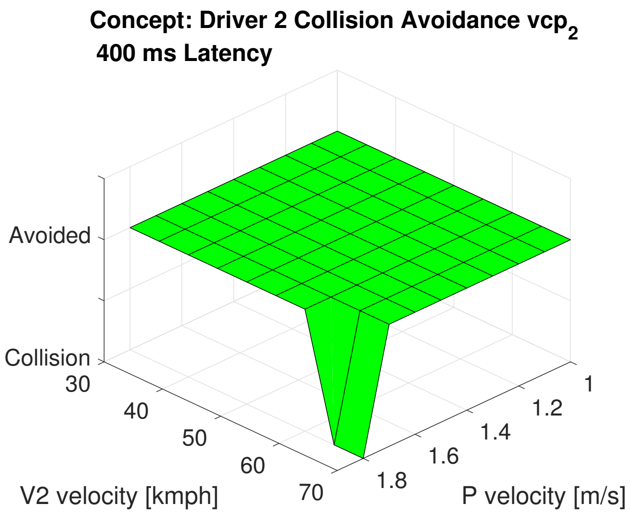


Figure 4.10: Performance of the concept with driver 2 for vcp_2 with a latency of 400 ms. At a latency of 400 ms the collision avoidance performance start to depart from 100 % for vcp_2.

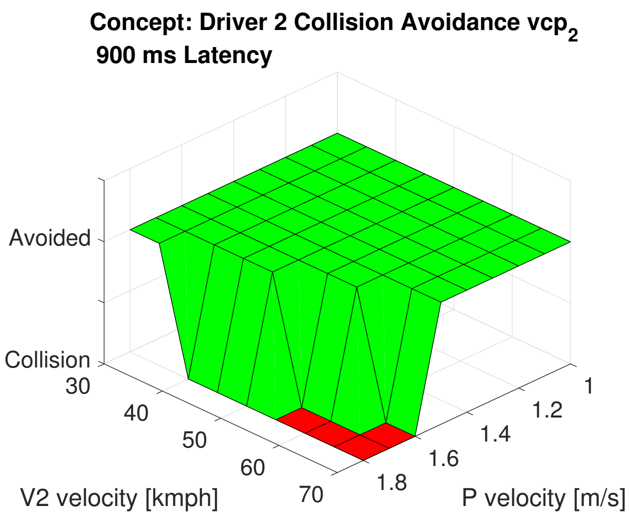


Figure 4.11: Performance of the concept with driver 2 for vcp_2 with a latency of 900 ms. The collision avoidance performance is 100 % up to a pedestrian velocity of 1.6 m/s.

can be explained by that the driver does not have time to react to the warning and the main intervention is autobrake which is not as effective and aggressive which could be expected based on most industrial autobrake performance.

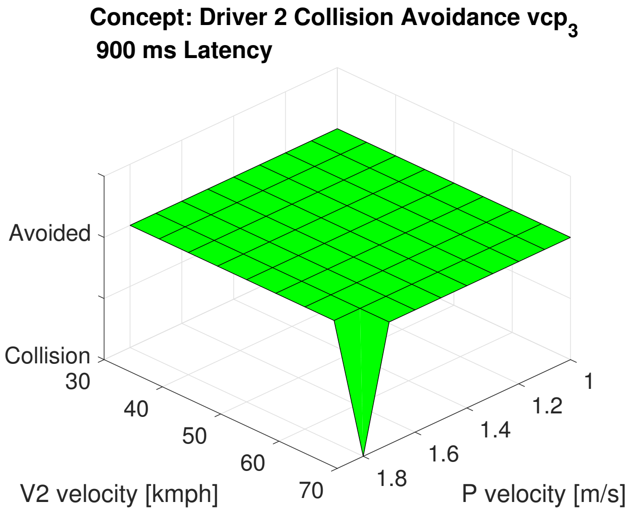


Figure 4.12: Performance of the concept with driver 2 for vcp_3 with a latency of 900 ms. At a latency of 900 ms the collision avoidance performance starts to decrease for vcp_3.

Table 4.6: Driver 2 vcp_1 statistics of velocity at impact and TTC at warning for the scenarios with latency and the driver alone.

Latency	CA [%]	$V_{I,min}$	$V_{I,avg}$	$V_{I,max}$	TTC_{min}	TTC_{avg}	TTC_{max}
0 ms	93	3.4	16.8	29.4	2.6	3.1	4.0
100 ms	89	4.0	21.1	39.1	2.7	3.3	4.0
200 ms	86	9.6	26.1	44.7	2.6	3.3	4.0
300 ms	80	0.1	25.1	49.5	2.5	3.2	4.0
400 ms	77	6.0	28.9	54.1	2.4	3.1	4.0
500 ms	73	1.5	30.8	52.3	2.3	3.1	4.0
600 ms	65	5.4	30.5	54.5	2.2	3.0	4.0
700 ms	62	5.7	31.7	56.4	2.1	2.9	4.0
800 ms	58	2.7	32.6	58.1	2.0	2.9	4.0
900 ms	53	6.9	33.5	59.6	1.1	2.8	4.0
1000 ms	7	10.0	37.7	64.1	1.1	1.5	2.1
Driver	0	28.5	49.7	69.9	-	-	-

Table 4.7: Driver 2 vcp_2 statistics.

Latency	**CA [%]**	$\mathbf{V}_{I,min}$	$\mathbf{V}_{I,avg}$	$\mathbf{V}_{I,max}$	$\mathbf{TTC}_{min}$	$\mathbf{TTC}_{avg}$	$\mathbf{TTC}_{max}$
0 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
100 ms	100	0.0	0.0	0.0	3.1	3.5	4.0
200 ms	100	0.0	0.0	0.0	3.1	3.5	4.0
300 ms	100	0.0	0.0	0.0	3.0	3.5	4.0
400 ms	98	9.7	10.2	10.8	2.9	3.5	4.0
500 ms	96	11.4	19.5	24.1	2.8	3.4	4.0
600 ms	94	9.7	21.4	32.4	2.7	3.4	4.0
700 ms	91	11.4	26.2	38.8	1.9	3.3	4.0
800 ms	88	10.8	28.0	44.7	2.5	3.3	4.0
900 ms	84	6.9	29.6	49.5	2.4	3.2	4.0
1000 ms	37	1.8	24.4	50.6	1.6	2.2	3.1
Driver	0	13.7	44.5	69.5	-	-	-

Table 4.8: Driver 2 vcp_3 statistics.

Latency	**CA [%]**	$\mathbf{V}_{I,min}$	$\mathbf{V}_{I,avg}$	$\mathbf{V}_{I,max}$	$\mathbf{TTC}_{min}$	$\mathbf{TTC}_{avg}$	$\mathbf{TTC}_{max}$
0 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
100 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
200 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
300 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
400 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
500 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
600 ms	100	0.0	0.0	0.0	3.1	3.6	4.0
700 ms	100	0.0	0.0	0.0	3.0	3.5	4.0
800 ms	100	0.0	0.0	0.0	3.0	3.5	4.0
900 ms	99	0.1	0.1	0.1	3.0	3.5	4.0
1000 ms	63	6.3	27.5	51.5	2.2	2.9	4.0
Driver	9	1.3	35.3	64.8	-	-	-

4.3 Performance with Concept in Cloud Test Bench

In this section the results from the simulations in the cloud test bench using the data collected at *Hällered Proving Ground* and with cloud in the loop are presented with two different connections; WiFi with broadband and WiFi with LTE mobile network.

The pedestrian estimation before it is sent to cloud and after it is received is plotted in figure 4.13 with WiFi broadband network and in figure 4.14 with WiFi LTE network. The latency is similar for both network technologies and is about 100 - 200 ms. The WiFi latency is slightly shorter in the size of 10 ms. This does not include the latency due to processes before the transmission and when it is received which also will add a few hundred ms.

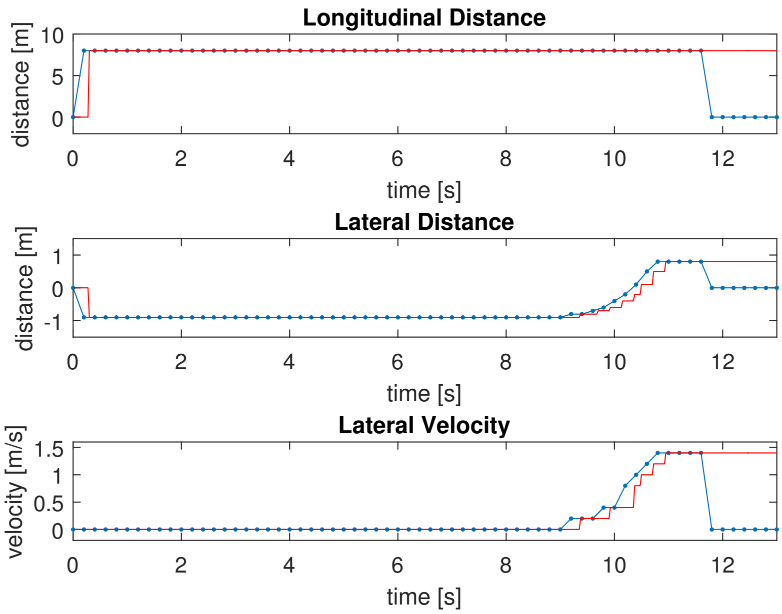


Figure 4.13: The data before (blue) it is transmitted to cloud and after (red) it is received over WiFi network.

The estimated pedestrian state is plotted in figure 4.15 when using a WiFi broadband and WiFi with LTE network respectively. The result is very similar as per expectation as the latency was observerd to be similar. The initial latency is due to the time it takes to establish the data flow from V_1 to V_2 over cloud. The TTC, based on the pedestrian estimation, for which the warning is given is 3.1 s similarly to the simulation environment for the same V_2 velocity. With the designed concept it is likely that the driver would be able to stop in time as the driver was able to in the simulation.

The views from V_1 and V_2 when a warning is given are captured in figure 4.16.

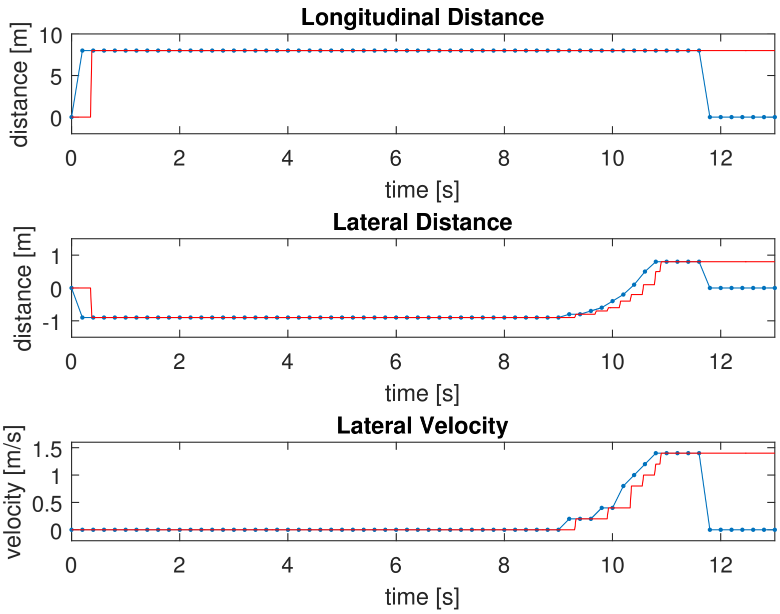


Figure 4.14: The data before (blue) it is transmitted to cloud and after (red) it is received over LTE network.

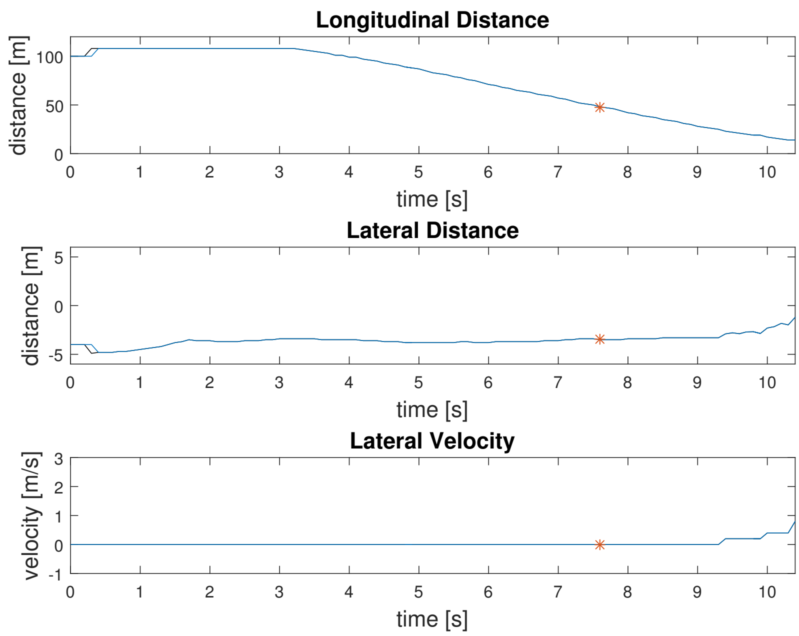


Figure 4.15: Estimated pedestrian state for the scenario used in the threat assessment by V_2 with a WiFi with broadband (black) and a WiFi with LTE network (blue) respectively. The red star annotate when the warning would have been given to the driver.

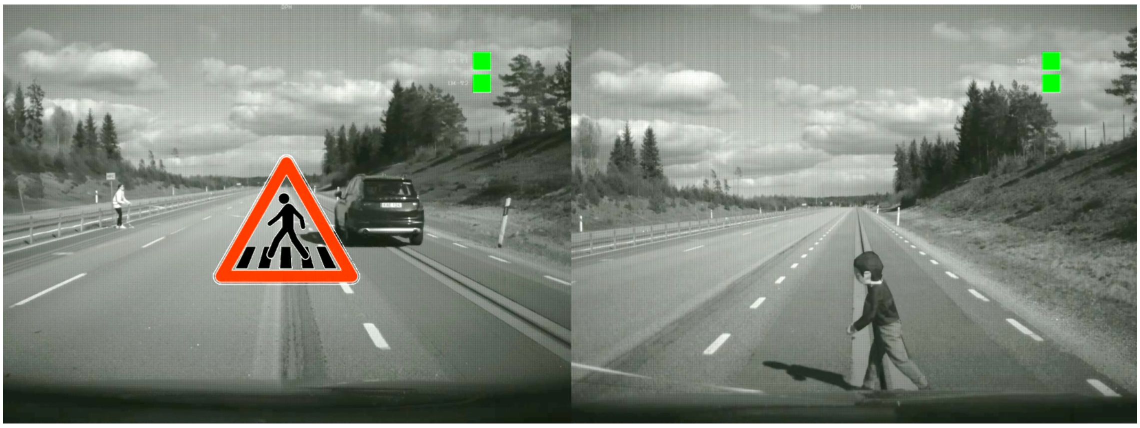


Figure 4.16: A snap from V_1 (right) and V_2 (left) point of view when the warning is given to the driver in the considered concept.

5
Discussion

In this chapter the results of the thesis are discussed. First the methods used during development and evaluation are discussed. Followed by a discussion of the developed concept and its performance addressing the challenges due to uncertainties and other limitations. The concepts benefit, limitations and feasibility are summarized. Finally the possibilities enabled by future technology are presented and suggestions for further work are given.

5.1 Driver Models

The type of driver model which considers reaction time and deceleration capability are commonly used for the design of collision avoidance functions. The driver models are based on studies with drivers reacting to forward collision warnings and braking vehicles where the driver can see the threat which is being warned for. The same reaction time were used for the both drivers, a longer reaction time, however, is comparable to longer latency which results in additional time before an intervention is performed. Little research has been conducted on human factors for critical warnings which the driver cannot confirm with his/her own senses. When the threat cannot be seen the driver might need longer time to interpret the warning and the level of deceleration might be lower because the seriousness of the threat is not understood.

5.2 Developed Concept

A series of assumptions about the scenario were made to limit the scope of the project and thus the requirements of the concept. The only actors present were assumed to be one pedestrian, one occluding vehicle V_1 and one following vehicle V_2. It was assumed that the pedestrian crosses the road perpendicularly with a constant velocity. V_2 is approaching with a constant velocity in the adjacent lane. The occluding vehicle was assumed to be stationary to simplify the creation of scenarios. The environment was limited to a straight road with a specific width and two lanes in the same driving direction without any additional road users or infrastructure and with perfect weather conditions. The assumptions simplified the object processing and the threat assessment. The collision avoidance performance was the prime focus in the design development and not false warnings.

The sensors utilized in the concept were the radar camera for object detection and tracking. The pedestrian and V_1 were successfully detected and tracked by V_1's and V_2's radar camera respectively. The threat assessment was satisfactory conducted on the collected sensor data with the cloud communication. The function is limited by the sensor capability for example the radar camera sensor have some limitations. The sensor field of view is 90 °: if the pedestrian is crossing very close to the front of V_1 it will not be in field of view of the sensor until it is far into the ego lane which might result in a too late warning and intervention. Disadvantageous weather conditions will also affect the performance of the radar camera and, hence, the performance of the function.

The objects of interests were found by sorting the objects on required deceleration and/or distance, but it is likely not enough in more complex traffic scenarios involving more vehicles and several pedestrians. A normal traffic environment would require a more advanced processing and selection to determine the relevant objects for the function. The pedestrian which actually crosses the road might be difficult to identify, more analysis on the lateral movement of the pedestrians could improve the selection and threat assessment. In scenarios with additional vehicles on the road the object selection in V_2 would need to be more advanced to correctly identify the occluding vehicle V_1 which is transmitting the relative pedestrian data. As radar camera obviously requires a clear line of sight of the object of interest it is problematic if V_2 cannot identify and track the vehicle which transmits the pedestrian data; for example if there are other vehicles between V_1 and V_2 or the road is curved, V_1 might not be visible. In the case of V_2 identifying the wrong vehicle the pedestrian state would be incorrect and thereby the threat assessment would be based on false information and the resulting intervention likely inappropriate. A sensor which does not require a clear line of sight would be useful such as a positioning system utilizing methods, for example satellites or wireless communication. The traditional GPS systems have unacceptable precision, while a precise DGPS would not be financially feasible.

The threat assessment based on required jerk and deceleration as well as the lateral position of the pedestrian was successful in avoiding and mitigating collisions as long as the estimate of V_1 and the pedestrian were precise and the scenario predictable.

A pedestrian is unpredictable as the acceleration and velocity can change abruptly. Determining if a pedestrian will cross a road for certain only based on its kinematic information can thus be difficult. Additional methods could be applied for example images analyses of the radar camera images of the pedestrian could be performed to determine if the pedestrian has stepped off the pavement and onto the road, to improve the certainty of the pedestrian crossing. The lateral threat assessment consider that if the pedestrian is in one of the lanes there is a risk. However, if the pedestrian steps on the road when V_2 is near to the crossing line, there is a high chance that the pedestrian will not be in V_2's path before the vehicle passes. If a warning would be given in this case it would be considered unnecessary and irritating. The warnings could be suppressed by decreasing the lateral area and analyses of the likelihood of the pedestrian being in the path of V_2.

The behavior of V_2 can also be analyzed to suppress false warnings, for example if the driver has started to decelerate or started to steer a different direction the driver might intend to turn or slow down when approaching a zebra crossing. A confidence based on the measured latency could be applied to determine the intervention. If the information would be old, the warning could be less intense and rather be information about a pedestrian being on the road. The confidence could also be based on the environment, if there is a zebra crossing and V_1 is at stand still the chance would be high that there would be a pedestrian on the road which would proceed into the lane of V_2.

When several following vehicles are on the road the threat assessment is more complicated and the same intervention might not be suitable for all vehicles. More information would be required to handle a complex traffic scenario, for example lane information, motion history, precise positioning and communication between the vehicles to map out the scenario. One method which was considered in the project was to compare the received vehicle GPS positions and lane information with the radar camera observation of the leading vehicles to determine if one of them indeed was the occluding one. The GPS precision is however poor and thereby the idea was scrapped.

The threat assessment could be further tuned in order to improve the performance. The function was tuned for low latency with the combination of driver braking, brake support and autobrake to yield a consistent performance for many velocity combinations and the two driers. When some deceleration is already applied but the deceleration is not enough the autobrake might not activate in all situations due to it not reaching the threshold set. The brake request given to the system is the estimated required deceleration to stop the vehicle with 1 m clearance which might not be correct due to jerk and other factors. Efforts were made to decrease the threshold when braking was done, however, more tuning would be required.

In the concept the warning is given to only the driver in V_2, however, the vehicle is moving faster and it takes longer time to decelerate it to a stop compared to a pedestrian. In related work a warning has been given to the pedestrian through their smartphone, either by vision or audio depending on how the smartphone is being used. A pedestrian is able to change its motion rapidly and there could be a benefit to make sure the pedestrian does not step into the V_2 lane, even if this kind of warning only would be possible if the pedestrian is using his or her smartphone. Connecting the pedestrian to the cloud through their smartphone could be an additional feature of the function. The alternative of V_1 honking to the pedestrian could cause unpredictable reactions and the driver in V_1 might feel bypassed into an aggressive manner. For the thesis the only intervention considered was braking, but if the environment allows it could also be possible to avoid the collision by steering. A steering intervention can avoid an accident at lower TTC compared to braking, thus a braking and steering intervention could be combined to avoid collisions when it is too late to brake in time. There are possible scenarios where the current developed interventions would not be ideal, for example if V_2 is approaching V_1 in the same lane the risk might be that it will try to overtake V_1 by changing to the adjacent lane close to V_1, in this case information about the pedestrian should be given to the driver in time.

A big challenge for collision warnings functions is to balance the performance with the suppression of undesired warnings. The earlier a warning is given, the higher is the possibility to avoid injuries but the lower is the risk of a situation resulting in a collision. If a collision could be avoided between the pedestrian and vehicle without a system intervention a given warning could be considered irritating, however, a warning given at a higher TTC could be useful if the driver need more time to understand the warning given. As the driver in V_2 is unaware of the crossing pedestrian currently occluded by V_1 until very late it is important to have an informative HMI. An informative HMI warning and possibly a haptic warning could prove useful to get the driver's attention earlier.

Also the communication could be optimized. In the current implementation of the concept, V_1 sends data continuously to the cloud when it sees a pedestrian which would be unnecessary consumption of resources if no other vehicles are around. If the vehicles in an area would beacon their position continuously to the cloud, V_1 could know if there are vehicles on the same road and it would be useful to send data at all. An additional method could be to observe if any vehicles are detected with the rear side and detection system sensor. Additional work should be done to optimize the transfer of data.

There have been earlier ideas on solutions similar to the developed concept aiming to solve the problem with occluded pedestrians as described in section 1.4. No solution has however been fully developed and released to the market.

5.3 Evaluation Method

The driver performance was tested by applying the corresponding deceleration profile and reaction time after the pedestrian has passed the edge of V_1 and estimated visible to the driver in V_2. To understand how reals drivers would perform testing would need to be done in a driver simulator or on the test track. Testing the driver model, however, give an approximation of where the occluded warning function would have the potential of yielding benefit.

The benefit and limitations of the functions were thoroughly addressed by combining a wide range of velocities of V_2 and the pedestrian and should cover the most common kinematic combinations in an urban and suburban area. The velocity and behavior of the actors had constant velocity and heading, how the function would handle sudden variations was not tested. The velocity combinations fundamentally resulted in a combinations of timings when the pedestrian enters the road and when it is visible to the sensors and driver in V_2. The design of an active safety function is a balance between effective performance avoiding critical situations with a low occurrence of warnings and interventions which are considered unnecessary by the driver.

In the simulations only scenarios which would have resulted in a collision were evaluated, however, to address false warnings testing with scenarios which would not result in a collision would need to be conducted. The scenarios tested were all for constant and predictable movements of each actor. The function was designed for the respective driver and was also tested with the same. The tests were thus done with perfect combination of driver and function. One can expect that the driver most likely would not perform exactly as per expectation. The brake support aids the driver if it does not decelerate enough, however, if the reaction time to the warning is long the function cannot perform fully.

The modelling of the communication errors was simply a delay to model the latency in the communication. In reality there will be other difficulties such as aperiodic update frequency. The considered cloud should, however, have solutions for packets received in the wrong order and lost packages by queues and acknowledgements between the transmitter and the receiver. A wide range of latency lengths with a transmission frequency of 10 Hz were tested by delaying the data from V_1 to V_2 which gave a fair approximation how the function would be affected by the main communication uncertainty. Additional communication difficulties such as error in transmission and data loss were not modelled, thus all communication issues were not addressed. If V_1 and V_2 would lose the communication with cloud for an extensive time the function would not work.

The function was tested in simulation with real sensor data from the test track with cloud in the loop in the cloud test bench. Time limitations unfortunately restricted the amount of testing. To fully understand the effects of the cloud it would be required to implement and test the function in a real vehicle. Problems such as scalability, fairness and other communication issues which may arise in reality with several transmitting vehicles in the same area would need to be addressed to understand the feasibility. The collection of datalogs, which were used in the cloud test bench, was conducted at *Hällered Proving Ground* and the pedestrian was hit in almost all scenarios such that it would be certain that a critical situation would occur. The pedestrian dummy was placed such that it was in the field of view of V_1 from the beginning of logging due to the fact that it was complicated to pull the pedestrian manually and time a collision with the approaching V_2. It meant that V_1 would transmit data earlier than it might have had if a pedestrian walked from the sidewalk and onto the road close to when V_2 was closing in. When V_1 transmit data early V_2 can give an appropriate warning to the driver even with long latency as long as it receives the first data package in time. This was observed in the cloud test bench.

The warning was given at the same TTC as in the simulation environment which showed that the function worked well with the sensor data collected in favorable conditions, the tests did however not cover any situations which are sensitive to latency. Testing with collected sensor data which resulted in a successful threat assessment decision similar to simulation the radar camera sensor precision could be concluded as appropriate for the function.

It is difficult to determine the true performance of the concept without testing it in reality. Testing the function on a test track would be the first important step to determine if the whole chain would work as there are many critical links; sensor errors, threat assessment algorithm, communication and actuators. In addition to the technical aspects the human interaction with the function is vital as the performance of the function relies on the driver responding to the warning. The conditions on a test track are however ideal and not all scenarios would be possible to recreate. Testing in real traffic is required to address the true performance, in particular the occurrence of false warnings.

5.4 Performance

The drivers' performance showed that there is a significant room for benefit for a function which can warn the driver before the pedestrian is visible. The most critical scenario is for vcp_1 which is expected as the driver has a shorter time before collision to acknowledge the pedestrian. The driver performs rather poor for vcp_2 and vcp_3 as well. By using an autobrake system which is available in the vehicles of today more collisions can, however, be avoided. In the Euro NCAP test, described in 2.6, Volvo V90 managed to avoid all collisions with the appearing child dummy up to a velocity of 40 kmph as per 2017 test results. The collision point for the Euro NCAP test is comparable with vcp_2 for pedestrian velocity of 1.4 m/s. The scenario is, however, not completely comparable as the distance between the vehicles is smaller.

The autobrake can be expected to have better performance for vcp_3 as the pedestrian is visible earlier and the main benefit of the system can likely be expected for the higher velocity combinations. For the more critical vcp_1 it can be assumed that some collisions likely will occur for velocities below 40 kmph as well as the pedestrian will be visible later.

In simulation environment with 0 latency the performance of the system was similar for the two drivers with 93 % collision avoidance in total and 100 % for pedestrian velocity up to 1.6 m/s for vcp_1. The collision avoidance is 100 % for vcp_2 and vcp_3. With an increasing latency the performance decreased slightly, but not drastically, and the performance of the drivers diverted. The collision avoidance for pedestrian velocity of 1.6 m/s were avoided up to 400 ms for vcp_1 for driver 1. For vcp_2 collisions were avoided for all velocities up to a couple of hundred milliseconds, and the collision avoidance for pedestrian velocity 1.4 m/s was 100 % for all V_2 velocities up to 1000 ms latency for driver 1. A velocity at impact of 30 kmph has shown to be an important boundary with regard to the severity of injury for vulnerable road users. The latency which was found to be critical for velocity at impact being max 30 kmph for a pedestrian velocity of 1.6 m/s was 500 ms for driver 1 and 300 ms for driver 2.

Comparing to the driver alone a large benefit could be observed, but even comparing the current active safety system a clear benefit can be seen. For vcp_2 a benefit can clearly be established for scenarios with velocities above 40 kmph considering that the autobrake only can avoid the collisions below. Both drivers avoid collisions for all V_2 velocities for vcp_2 when the pedestrian is walking with 1.4 m/s up to 900 ms latency. The velocity at impact never exceeded 30 kmph for a pedestrian velocity of 1.6 m/s for driver 1 for vcp_2. Although the autobrake can avoid many of the collisions for the lower V_2 velocity for vcp_2 and vcp_3, the concept can yield benefit of comfort considering that it can be perceived as more comfortable to be warned before the threat appears than the activation of a full autobrake. Further testing would be required to compare the performance of the concept with the current active safety system for each vcp. However, one can assume that the benefit would be even larger for vcp_1 and as the collision avoidance and mitigation for vcp_1 is so high even for long latency a clear benefit could be assumed for most V_2 velocities.

Even if the concept still yields benefit for the tested cases even with a long latency the estimates made by the system in V_2 are based on outdated data and the pedestrian might change its kinematics rapidly. In these cases the concept might produce false warnings and unnecessary interventions. The performance for a long latency can thus not be used to conclude that the concept actually would be able to handle this latency in reality. As mentioned in section 2.4.2 *The European Telecommunication Standard Institute* recommend the maximum latency for cooperative functions to be 100 ms which is wise considering the uncertainties which are present.

Both the drivers have similar performance for lower latency and the concept is thus not that dependent on the driver's braking capability, which can be explained by the brake support and autobrake which supports the driver when it is not applying the deceleration required in order to avoid a collision. The concept performed a bit uneven when latency was added; for some V_2 velocities a high pedestrian velocity would yield no collision while a lower pedestrian velocity would, this is likely due to various combinations can produce odd results in the threat assessment due to tuning of the thresholds for activation. It is evident that the concept performs worse for vcp_2 and vcp_3 compared to the autobrake for higher latency. This is because the autobrake tuning was done for the whole chain of interventions: driver deceleration as a reaction to the warning, brake support and finally autobrake. When the driver is braking and brake support are not effective for long enough the autobrake does not activate in an optimal way. This is particularly evident in the performance of driver 2 with a latency of 1000 ms. With a later tuned autobrake the concept yielded more benefit for these challenging cases as well.

In the scenario with no latency the average stop distance is slightly below 2 m which can be considered a comfortable distance between the pedestrian and the vehicle. The average TTC when the warning is given is close 3 s for driver 1 for all vcp while it is 3.6 s for driver 2. According to a study described in section 2.5 the median

TTC for braking to a pedestrian launched from an obstruction was 3.2 s which is similar to the average TTC for the concept. the warning is timely for a front collision warning. The performance of the concept would need to be further assessed by testing with real drivers on the test track and in real traffic scenarios.

The concept performed in a similar way with collected sensor data from the test track giving the warning at the same TTC as in the simulations. The latency over cloud with Wifi and LTE network was observed to be similar and about 100 - 200 ms for the implementation. However, with processes the latency increases to several hundred ms which is expected to be a too long latency. It is difficult to estimate the process time as it may vary on different computers, also the specific implementation affects the process time as well.

It is important to note that false warning suppression was not the prime focus in the design process, if the design would be made more conservative in order to suppress false warnings the collision avoidance performance might decrease for the more critical cases.

5.5 Feasibility and Prospects of Future Technology

The function has been proved to have a large benefit for constant, predictable scenarios through simulations. However, aspects which have been discussed previously affect the performance of the current solution.

The function has high demands on precision for positioning, fully working communication with a short latency and a properly developed threat assessment method. Using the radar camera of V_1 to measure the pedestrian state is a reliable and effective way of estimating the pedestrian state, however, utilizing the radar camera in V_2 to determine the V_1 state to translate the pedestrian information to its own frame demands a clear line of sight. In traffic there will often be many actors on the road and a clear line of sight could be difficult to maintain. Thus a positioning system applying wireless communication would be useful. The project *High Precision Positioning for Cooperative ITS Applications*, [53], is investigating better positioning by combining traditional satellite systems with the use of on-board sensors and infrastructure based wireless communication. The technology is to be used in cooperative intelligent transportation solutions which include traffic safety for VRU and autonomous driving. The goal is to develop a European positioning service platform based on local dynamic map and built on European standards. Another aim is to push for standardization of the developed solutions in the project.

In addition sensors similar to the radar camera with an increased field of view are expected to be released in a soon future. This would enable earlier detection of the pedestrian even if it passes near to the vehicle.

It is necessary that the two (or more) vehicles which are involved in the situation both are equipped with cloud communication systems for the concept to work. The current penetration rate of vehicles with cloud communication is low and would need to be increased to see a benefit on the overall statistics. The report [54] concluded that the overall market registered 5.1 million shipped connected cars during 2015 and it is expected to increase to 37.7 million cars by 2022. Another report, [55], claim that the penetration rate for connected systems will increase from 14 % in 2013 to 50 % by 2020 driven by the growth of smartphone integrated systems segment and advancement in vehicle embedded system. It is also important that standardization bodies commit to creating standards which can be followed by car makers to cooperate in the traffic as the chance of two vehicles of the same car brand being involved in the occluded pedestrian scenario is slim.

The latency of the function depends on two major sources 1) process time in the transmitting/receiving module and in cloud and 2) the transmission time in the mobile network. The network available today is LTE in the best cases and in many areas 3G network. LTE has a latency below 100 ms or even lower in Sweden. 3G can have a latency of 100 - 500 ms which would be too long for the function. The time it takes to process the information up, through cloud and down can be a couple of 100 ms. With the current implementation the sum of the communication latency and the process time is likely not feasible for the function to yield enough benefit and work properly. Another drawback is that the LTE communication has limitations in the effectiveness with many users. As discussed in the previous section better positioning systems and networks are expected to emerge the coming years. When the standards for 5G are released in 2020 the latency theoretically should be 1 ms up and down, if the processes were made slightly more effective the total latency could easily be kept to acceptable levels matching the limit recommended by *ETSI*.

The developed concept can yield benefit now for the type of scenarios which were tested. The potential of the concept would grow by implementing soon expected technology shifts enabling improvement on positioning and communication.

5.6 Future Work

The development of an active safety function can take several years; handle sensor and communication errors, balance a high collision avoidance with a low amount of false warnings, tune the activation of intervention, investigate how the users perceive and interact with the function. It is relative easy to design a function which works for ideal scenarios, but to develop a function which works at all times for all scenarios is a complex task. To be certain that a function perform as per expectation in all situations require extensive testing to verify the true performance. The developed concept need to be made more robust and be further tested.

The natural next steps are the following:

- Evaluate concept for more scenarios and parameters
- Further testing in the cloud test bench
- Improve the object processing to handle more actors on the road
- Develop logic to trigger the function for V_1 or V_2 as the functions are combined in one in the cloud test bench and vehicle software
- Further develop the brake support by predicting the driver deceleration to make it possible to apply brake support earlier. The brake support should also be removed if it is not required anymore to make the vehicle stop in time
- Tune the thresholds and brake request for autobrake such that it works efficiently for all scenarios
- Investigate how human drivers react to a warning about a threat they cannot perceive to design the warning and the system in the most appropriate way
- Implement the concept in a vehicle and test it on the proving ground with real drivers using a pedestrian dummy controlled by a robot instead of manually
- Expose the function to real traffic situations
- In the future apply positioning systems not dependent on a clear line of sight and 5G network

6
Conclusion

In this thesis a concept of an occluded pedestrian warning and collision avoidance concept was developed and evaluated through simulations in order to investigate the benefit, the limitations and the feasibility for this type of function. The aim of the concept was to prevent collisions between a following vehicle and a crossing pedestrian which initially is occluded by a leading vehicle. The developed concept was cooperative and utilized the sensors of both vehicles with cloud communication between them.

The concept was evaluated in two different simulation environments. The first simulation environment was closed loop with vehicle models and ideal sensors where a wide range of parameters could be tested to establish the benefit and the effect of communication latency. The second simulation environment used real sensor data and cloud communication where the feasibility and real world effects could be evaluated. The simulations of the concept showed a collision avoidance of 93 - 100 % in ideal conditions without latency depending on the scenario. Benefit was observed even for a long latency up to several hundred ms. Comparing the performance of the driver models with and without the concept as well as with the ratings of a Euro NCAP test proved that there is a benefit of such a concept. The benefit of the concept is also different for the three collision points on the following vehicle; a collision point closer to the pedestrian has higher benefit as the pedestrian enters the following vehicle lane at a later stage. The concept performed similarly with collected sensor data. Considering the performance and uncertainty a maximum latency of 100-200 ms is recommended.

The currently available mobile network and the communication implementation result in a latency longer than recommended. The promising 5G standards are expected to be released in 2020 which would decrease the latency to a satisfactory level. The radar camera estimated the relative distance between the vehicles well in the evaluated scenarios, however it would not be feasible in dense traffic. Ongoing research projects are investigating vehicle positioning systems which complement traditional satellite technology with wireless communication and vehicle sensors.

To conclude, a benefit for our cooperative function was shown for a wide range of parameters and scenarios. Long latencies limit the effectiveness of such system but benefit can still be observed. The current function can yield benefits for the type of scenarios which were tested. With soon expected technology shifts, the benefit of our function in more complex scenarios would increase.

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A

Appendix 1

A.1 Simulation Results

In the following tables various parameters for all the simulations are presented. V_2 Vel. and P Vel. are the velocities of V_2 and the pedestrian respectively, Outcome presents if the collision is avoided or not, V_I is the velocity at impact, TTC_W the time to collision when the warning is given to the driver and r_s the stop range.

A.1.1 0 ms Communication Latency

Table A.1: Driver 1 with 0 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.6
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7

40	1.5	Avoided	0.0	2.9	1.7
40	1.6	Avoided	0.0	2.9	1.7
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.8	1.6
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	2.9	1.8
45	1.8	Avoided	0.0	2.7	1.1
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9
50	1.7	Avoided	0.0	3.0	1.8
50	1.8	Avoided	0.0	2.8	1.1
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.1	1.8
55	1.7	Avoided	0.0	3.0	1.2
55	1.8	Collision	7.9	2.7	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.2	2.0
60	1.6	Avoided	0.0	3.1	1.2
60	1.7	Avoided	0.0	2.9	0.6
60	1.8	Collision	19.4	2.7	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0

65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.3	2.0
65	1.6	Avoided	0.0	3.1	1.1
65	1.7	Collision	3.4	2.9	0.0
65	1.8	Collision	20.0	2.8	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.1	0.6
70	1.7	Collision	21.1	2.9	0.0
70	1.8	Collision	29.4	2.8	0.0

Table A.2: Driver 1 with 0 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.7
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.9	1.8

40	1.8	Avoided	0.0	2.9	1.8
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	3.0	1.9
45	1.8	Avoided	0.0	3.0	1.9
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9
50	1.7	Avoided	0.0	3.1	1.9
50	1.8	Avoided	0.0	3.1	1.9
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.2	1.9
55	1.7	Avoided	0.0	3.2	1.9
55	1.8	Avoided	0.0	3.2	1.9
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.3	2.0
60	1.6	Avoided	0.0	3.3	2.0
60	1.7	Avoided	0.0	3.3	2.0
60	1.8	Avoided	0.0	3.2	2.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.4	2.0
65	1.6	Avoided	0.0	3.4	2.0

65	1.7	Avoided	0.0	3.4	2.0
65	1.8	Avoided	0.0	3.3	2.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.4	2.2
70	1.7	Avoided	0.0	3.4	2.2
70	1.8	Avoided	0.0	3.3	1.4

Table A.3: Driver 1 with 0 ms latency for vcp_3.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4
30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6

45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6
55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9

70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.4: Driver 2 with 0 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.6
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7
40	1.5	Avoided	0.0	2.9	1.7
40	1.6	Avoided	0.0	2.9	1.7
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.8	1.6
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9

45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	2.9	1.8
45	1.8	Avoided	0.0	2.7	1.1
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9
50	1.7	Avoided	0.0	3.0	1.8
50	1.8	Avoided	0.0	2.8	1.1
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.1	1.8
55	1.7	Avoided	0.0	3.0	1.2
55	1.8	Collision	7.9	2.7	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.2	2.0
60	1.6	Avoided	0.0	3.1	1.2
60	1.7	Avoided	0.0	2.9	0.6
60	1.8	Collision	19.4	2.7	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.3	2.0
65	1.6	Avoided	0.0	3.1	1.1
65	1.7	Collision	3.4	2.9	0.0
65	1.8	Collision	20.0	2.8	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2

70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.1	0.6
70	1.7	Collision	21.1	2.9	0.0
70	1.8	Collision	29.4	2.8	0.0

Table A.5: Driver 2 with 0 ms latency for vcp_2.

$\mathbf{V_2}$ **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	$\mathbf{V_I}$ **[kmph]**	$\mathbf{TTC_W}$ **[s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.1	1.8
30	1.7	Avoided	0.0	3.1	1.8
30	1.8	Avoided	0.0	3.1	1.8
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	3.3	1.6
35	1.7	Avoided	0.0	3.3	1.6
35	1.8	Avoided	0.0	3.3	1.6
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.4	1.4
40	1.6	Avoided	0.0	3.4	1.4
40	1.7	Avoided	0.0	3.4	1.4
40	1.8	Avoided	0.0	3.3	1.4
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.5	1.4
45	1.6	Avoided	0.0	3.5	1.4
45	1.7	Avoided	0.0	3.5	1.4

45	1.8	Avoided	0.0	3.3	1.4
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.7	1.3
50	1.5	Avoided	0.0	3.7	1.4
50	1.6	Avoided	0.0	3.7	1.4
50	1.7	Avoided	0.0	3.5	1.4
50	1.8	Avoided	0.0	3.3	1.3
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.8	1.4
55	1.5	Avoided	0.0	3.8	1.4
55	1.6	Avoided	0.0	3.7	1.4
55	1.7	Avoided	0.0	3.6	1.4
55	1.8	Avoided	0.0	3.4	1.3
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.9	1.5
60	1.4	Avoided	0.0	3.9	1.5
60	1.5	Avoided	0.0	3.9	1.5
60	1.6	Avoided	0.0	3.7	1.5
60	1.7	Avoided	0.0	3.5	1.3
60	1.8	Avoided	0.0	3.3	1.1
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	4.0	1.7
65	1.4	Avoided	0.0	4.0	1.7
65	1.5	Avoided	0.0	3.9	1.7
65	1.6	Avoided	0.0	3.7	1.6
65	1.7	Avoided	0.0	3.5	1.4
65	1.8	Avoided	0.0	3.3	1.3
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	4.0	1.8
70	1.5	Avoided	0.0	4.0	1.8
70	1.6	Avoided	0.0	3.8	1.7

70	1.7	Avoided	0.0	3.5	1.2
70	1.8	Avoided	0.0	3.3	0.9

Table A.6: Driver 2 with 0 ms latency for vcp_3.

$\mathbf{V_2}$ **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	$\mathbf{V_I}$ **[kmph]**	$\mathbf{TTC_W}$ **[s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.1	1.7
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2
35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.3	1.5
35	1.8	Avoided	0.0	3.3	1.5
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.4	1.2
40	1.8	Avoided	0.0	3.4	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.5	1.1
45	1.8	Avoided	0.0	3.5	1.1
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1

50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.7	1.1
50	1.7	Avoided	0.0	3.7	1.1
50	1.8	Avoided	0.0	3.7	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.8	1.1
55	1.7	Avoided	0.0	3.8	1.1
55	1.8	Avoided	0.0	3.8	1.1
60	1.0	Avoided	0.0	3.8	1.2
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.9	1.2
60	1.6	Avoided	0.0	3.9	1.2
60	1.7	Avoided	0.0	3.9	1.2
60	1.8	Avoided	0.0	3.8	1.2
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	4.0	1.4
65	1.6	Avoided	0.0	4.0	1.4
65	1.7	Avoided	0.0	4.0	1.4
65	1.8	Avoided	0.0	3.9	1.4
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	4.0	1.5
70	1.7	Avoided	0.0	4.0	1.5
70	1.8	Avoided	0.0	3.9	1.4

A.1.2 100 ms Communication Latency

Table A.7: Driver 1 with 100 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.6
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7
40	1.5	Avoided	0.0	2.9	1.7
40	1.6	Avoided	0.0	2.9	1.7
40	1.7	Avoided	0.0	2.8	1.6
40	1.8	Avoided	0.0	2.7	1.3
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	2.9	1.8
45	1.7	Avoided	0.0	2.8	1.7
45	1.8	Avoided	0.0	2.7	1.2
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9

50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.0	1.8
50	1.7	Avoided	0.0	2.9	1.5
50	1.8	Avoided	0.0	2.7	0.7
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.1	1.9
55	1.6	Avoided	0.0	3.1	1.8
55	1.7	Avoided	0.0	2.9	1.1
55	1.8	Collision	12.5	2.7	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.2	2.0
60	1.6	Avoided	0.0	3.0	1.2
60	1.7	Avoided	0.0	2.8	0.4
60	1.8	Collision	16.6	2.7	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.3	2.0
65	1.6	Avoided	0.0	3.0	0.8
65	1.7	Avoided	0.0	2.9	0.3
65	1.8	Collision	27.0	2.7	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.3	1.9
70	1.6	Avoided	0.0	3.1	0.7
70	1.7	Collision	18.7	2.9	0.0
70	1.8	Collision	34.8	2.7	0.0

Table A.8: Driver 1 with 100 ms latency for vcp_2.

V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.7
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.9	1.8
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	3.0	1.9
45	1.8	Avoided	0.0	3.0	1.9
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9

50	1.7	Avoided	0.0	3.1	1.9
50	1.8	Avoided	0.0	3.1	1.9
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.2	1.9
55	1.7	Avoided	0.0	3.2	1.9
55	1.8	Avoided	0.0	3.1	1.9
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.3	2.0
60	1.6	Avoided	0.0	3.3	2.0
60	1.7	Avoided	0.0	3.3	2.0
60	1.8	Avoided	0.0	3.2	2.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.4	2.0
65	1.6	Avoided	0.0	3.4	2.0
65	1.7	Avoided	0.0	3.4	2.0
65	1.8	Avoided	0.0	3.2	1.9
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.4	2.2
70	1.7	Avoided	0.0	3.4	2.2
70	1.8	Avoided	0.0	3.3	1.9

Table A.9: Driver 1 with 100 ms latency for vcp_3.

V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.10: Driver 2 with 100 ms latency for vcp_1.

V_2 **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	V_I **[kmph]**	TTC_W **[s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8

30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.0	1.4
30	1.7	Avoided	0.0	2.9	1.4
30	1.8	Avoided	0.0	2.8	1.3
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.2	1.4
35	1.6	Avoided	0.0	3.1	1.4
35	1.7	Avoided	0.0	2.9	1.4
35	1.8	Avoided	0.0	2.7	1.1
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.3	1.4
40	1.6	Avoided	0.0	3.1	1.4
40	1.7	Avoided	0.0	2.9	1.2
40	1.8	Avoided	0.0	2.7	1.7
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.5	1.3
45	1.3	Avoided	0.0	3.5	1.3
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.3	1.4
45	1.6	Avoided	0.0	3.0	1.2
45	1.7	Avoided	0.0	2.8	2.2
45	1.8	Avoided	0.0	2.7	1.2
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.8
50	1.4	Avoided	0.0	3.5	1.4
50	1.5	Avoided	0.0	3.3	1.3
50	1.6	Avoided	0.0	3.1	1.1
50	1.7	Avoided	0.0	2.9	2.0
50	1.8	Collision	7.6	2.7	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.7	1.8

55	1.4	Avoided	0.0	3.6	1.9
55	1.5	Avoided	0.0	3.3	1.2
55	1.6	Avoided	0.0	3.1	1.2
55	1.7	Avoided	0.0	2.9	0.8
55	1.8	Collision	19.9	2.7	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.9
60	1.3	Avoided	0.0	3.8	1.9
60	1.4	Avoided	0.0	3.5	1.4
60	1.5	Avoided	0.0	3.3	1.2
60	1.6	Avoided	0.0	3.0	1.5
60	1.7	Collision	16.6	2.8	0.0
60	1.8	Collision	24.6	2.7	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	2.1
65	1.3	Avoided	0.0	3.8	2.1
65	1.4	Avoided	0.0	3.5	1.4
65	1.5	Avoided	0.0	3.3	1.0
65	1.6	Avoided	0.0	3.0	0.1
65	1.7	Collision	17.9	2.9	0.0
65	1.8	Collision	32.1	2.7	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	2.2
70	1.2	Avoided	0.0	4.0	2.2
70	1.3	Avoided	0.0	3.8	2.1
70	1.4	Avoided	0.0	3.5	1.3
70	1.5	Avoided	0.0	3.3	1.0
70	1.6	Collision	4.0	3.1	0.0
70	1.7	Collision	28.3	2.9	0.0
70	1.8	Collision	39.1	2.7	0.0

Table A.11: Driver 2 with 100 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.1	1.8
30	1.7	Avoided	0.0	3.1	1.8

30	1.8	Avoided	0.0	3.1	1.8
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	3.3	1.6
35	1.7	Avoided	0.0	3.3	1.6
35	1.8	Avoided	0.0	3.2	1.4
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.4	1.4
40	1.6	Avoided	0.0	3.4	1.4
40	1.7	Avoided	0.0	3.4	1.4
40	1.8	Avoided	0.0	3.3	1.4
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.5	1.4
45	1.6	Avoided	0.0	3.5	1.4
45	1.7	Avoided	0.0	3.4	1.4
45	1.8	Avoided	0.0	3.2	1.4
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.7	1.3
50	1.5	Avoided	0.0	3.7	1.4
50	1.6	Avoided	0.0	3.6	1.4
50	1.7	Avoided	0.0	3.5	1.4
50	1.8	Avoided	0.0	3.3	1.4
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.8	1.4
55	1.5	Avoided	0.0	3.8	1.4
55	1.6	Avoided	0.0	3.7	1.4

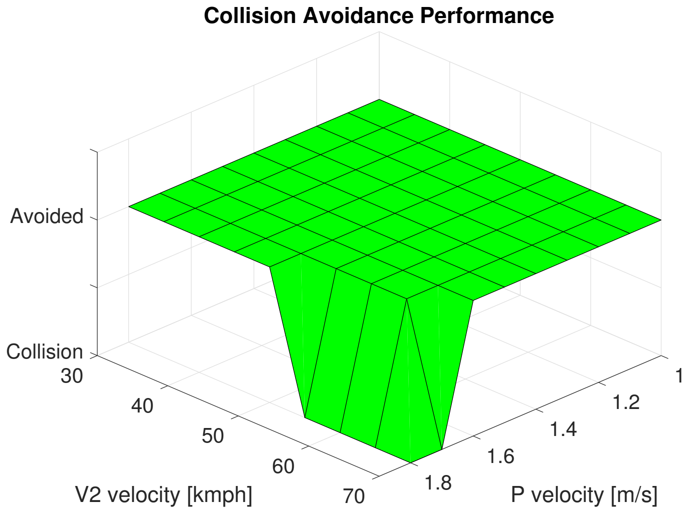
55	1.7	Avoided	0.0	3.5	1.4
55	1.8	Avoided	0.0	3.3	1.3
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.9	1.5
60	1.4	Avoided	0.0	3.9	1.5
60	1.5	Avoided	0.0	3.8	1.5
60	1.6	Avoided	0.0	3.7	1.5
60	1.7	Avoided	0.0	3.4	1.3
60	1.8	Avoided	0.0	3.2	1.3
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	4.0	1.7
65	1.4	Avoided	0.0	4.0	1.7
65	1.5	Avoided	0.0	3.9	1.7
65	1.6	Avoided	0.0	3.7	1.6
65	1.7	Avoided	0.0	3.4	1.3
65	1.8	Avoided	0.0	3.2	1.1
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	4.0	1.8
70	1.5	Avoided	0.0	3.9	1.8
70	1.6	Avoided	0.0	3.7	1.6
70	1.7	Avoided	0.0	3.5	1.3
70	1.8	Avoided	0.0	3.3	1.0

Table A.12: Driver 2 with 100 ms latency for vcp_3.

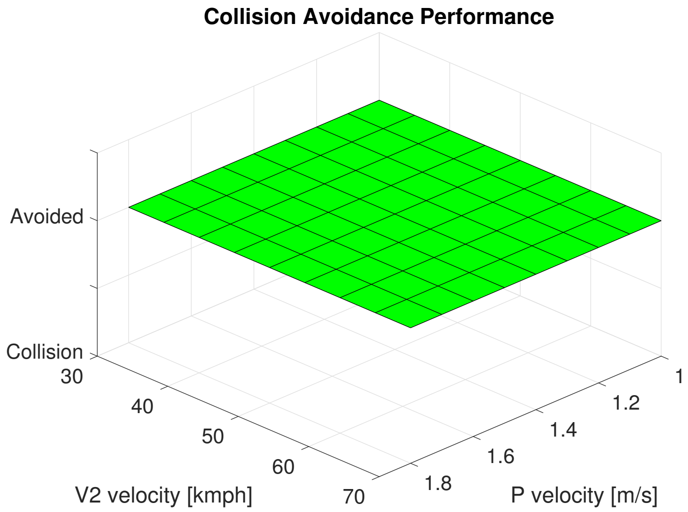
V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.1	1.7
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.3	1.5
35	1.8	Avoided	0.0	3.3	1.5
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.4	1.2
40	1.8	Avoided	0.0	3.4	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.5	1.1
45	1.8	Avoided	0.0	3.5	1.1
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.7	1.1
50	1.7	Avoided	0.0	3.7	1.1
50	1.8	Avoided	0.0	3.7	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.8	1.1
55	1.7	Avoided	0.0	3.8	1.1
55	1.8	Avoided	0.0	3.8	1.1
60	1.0	Avoided	0.0	3.8	1.2

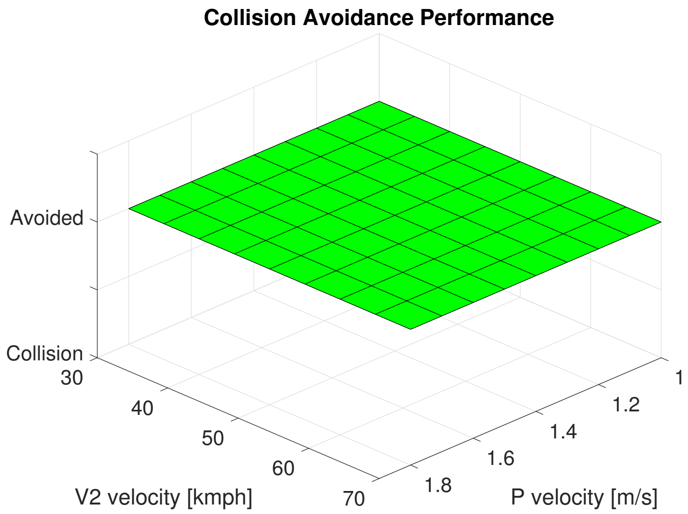
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.9	1.2
60	1.6	Avoided	0.0	3.9	1.2
60	1.7	Avoided	0.0	3.9	1.2
60	1.8	Avoided	0.0	3.8	1.2
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	4.0	1.4
65	1.6	Avoided	0.0	4.0	1.4
65	1.7	Avoided	0.0	3.9	1.4
65	1.8	Avoided	0.0	3.8	1.4
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	4.0	1.5
70	1.7	Avoided	0.0	4.0	1.5
70	1.8	Avoided	0.0	3.8	1.4



(a) vcp_1

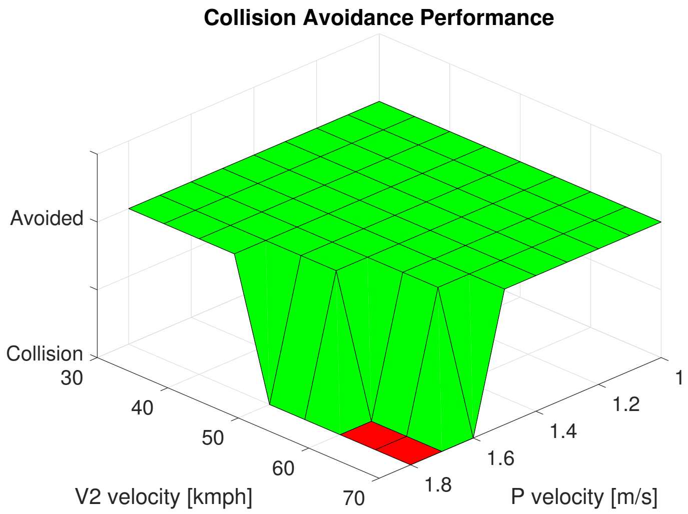


(b) vcp_2

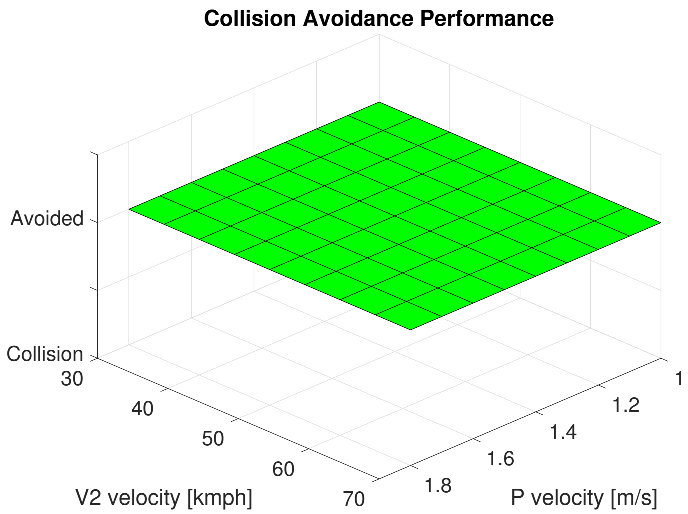


(c) vcp_3

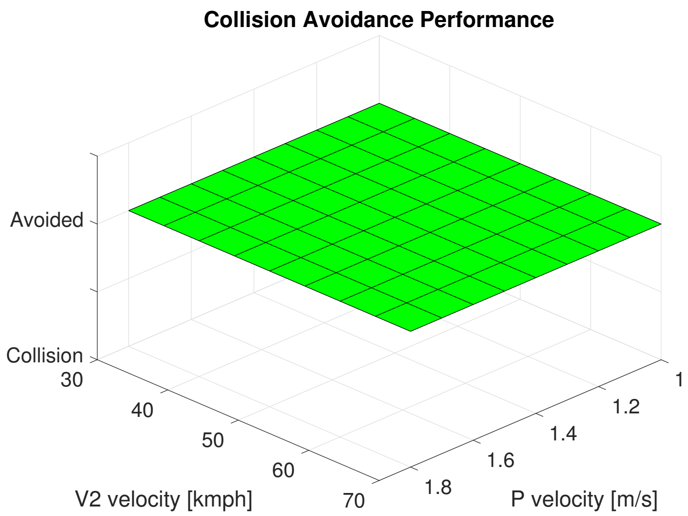
Figure A.1: Performance of concept with driver 1 with a latency of 100 ms.



(a) vcp_1



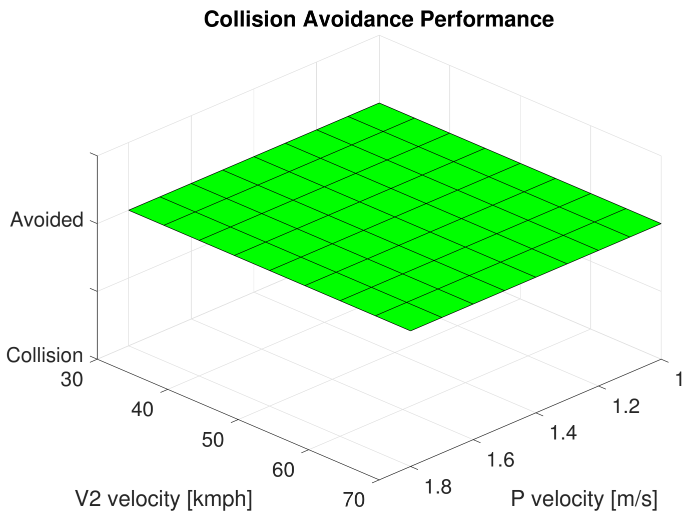
(b) vcp_2



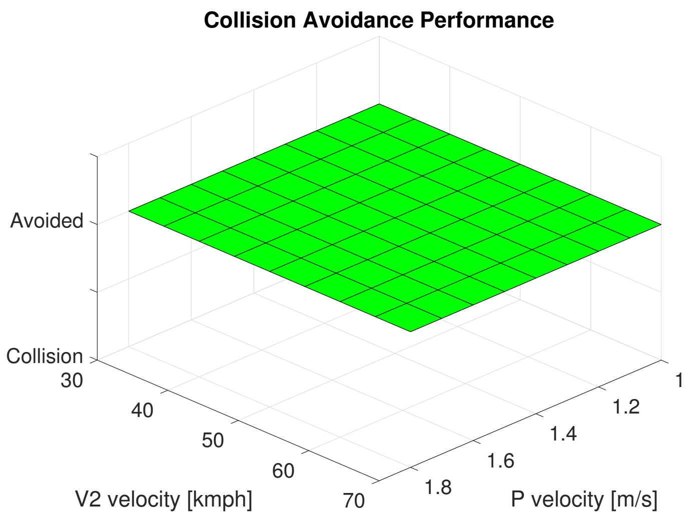
(c) vcp_3

Figure A.2: Performance of concept with driver 2 with a latency of 100 ms.

A.1.3 200 ms Communication Latency



(a) vcp_2



(b) vcp_3

Figure A.3: Performance of concept with driver 1 with a latency of 200 ms.

Table A.13: Driver 1 with 200 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6

30	1.8	Avoided	0.0	2.5	1.3
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.6
35	1.8	Avoided	0.0	2.6	1.3
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7
40	1.5	Avoided	0.0	2.9	1.7
40	1.6	Avoided	0.0	2.9	1.7
40	1.7	Avoided	0.0	2.8	1.6
40	1.8	Avoided	0.0	2.6	1.3
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	2.9	1.8
45	1.7	Avoided	0.0	2.7	1.2
45	1.8	Avoided	0.0	2.6	0.9
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.0	1.8
50	1.7	Avoided	0.0	2.8	1.1
50	1.8	Collision	12.0	2.6	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.1	1.9
55	1.6	Avoided	0.0	3.0	1.3

55	1.7	Avoided	0.0	2.8	0.8
55	1.8	Collision	22.7	2.6	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.2	2.0
60	1.6	Avoided	0.0	2.9	0.9
60	1.7	Collision	16.6	2.7	0.0
60	1.8	Collision	25.9	2.6	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.3	2.0
65	1.5	Avoided	0.0	3.2	1.9
65	1.6	Avoided	0.0	2.9	0.4
65	1.7	Collision	17.1	2.8	0.0
65	1.8	Collision	34.1	2.6	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.2	1.1
70	1.6	Avoided	0.0	3.0	0.2
70	1.7	Collision	27.3	2.8	0.0
70	1.8	Collision	41.1	2.6	0.0

Table A.14: Driver 1 with 200 ms latency for vcp_2.

$\mathbf{V_2}$ **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	$\mathbf{V_I}$ **[kmph]**	$\mathbf{TTC_W}$ **[s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7

35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.7
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.9	1.8
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	3.0	1.9
45	1.8	Avoided	0.0	3.0	1.9
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9
50	1.7	Avoided	0.0	3.1	1.9
50	1.8	Avoided	0.0	3.1	1.9
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.2	1.9
55	1.7	Avoided	0.0	3.2	1.9
55	1.8	Avoided	0.0	3.1	1.9
60	1.0	Avoided	0.0	3.3	2.0

60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.3	2.0
60	1.6	Avoided	0.0	3.3	2.0
60	1.7	Avoided	0.0	3.3	2.0
60	1.8	Avoided	0.0	3.1	1.9
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.4	2.0
65	1.6	Avoided	0.0	3.4	2.0
65	1.7	Avoided	0.0	3.3	2.0
65	1.8	Avoided	0.0	3.1	1.2
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.4	2.2
70	1.7	Avoided	0.0	3.4	2.2
70	1.8	Avoided	0.0	3.2	1.1

Table A.15: Driver 1 with 200 ms latency for vcp_3.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4
30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5

35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6
55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7

60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.16: Driver 2 with 200 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.0	1.4
30	1.7	Avoided	0.0	2.8	1.3
30	1.8	Avoided	0.0	2.7	1.2
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.2	1.4
35	1.6	Avoided	0.0	3.0	1.4
35	1.7	Avoided	0.0	2.8	1.3

35	1.8	Avoided	0.0	2.6	1.6
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.3	1.4
40	1.5	Avoided	0.0	3.2	1.4
40	1.6	Avoided	0.0	3.0	1.3
40	1.7	Avoided	0.0	2.8	1.2
40	1.8	Avoided	0.0	2.6	0.8
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.5	1.3
45	1.3	Avoided	0.0	3.5	1.3
45	1.4	Avoided	0.0	3.4	1.4
45	1.5	Avoided	0.0	3.2	1.4
45	1.6	Avoided	0.0	2.9	1.1
45	1.7	Avoided	0.0	2.7	1.2
45	1.8	Avoided	0.0	2.6	0.2
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.6	1.4
50	1.4	Avoided	0.0	3.4	1.4
50	1.5	Avoided	0.0	3.2	1.3
50	1.6	Avoided	0.0	3.0	1.2
50	1.7	Avoided	0.0	2.8	0.9
50	1.8	Collision	17.5	2.6	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.7	1.9
55	1.4	Avoided	0.0	3.5	1.4
55	1.5	Avoided	0.0	3.2	1.1
55	1.6	Avoided	0.0	3.0	2.1
55	1.7	Collision	9.6	2.8	0.0
55	1.8	Collision	26.6	2.6	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.9
60	1.3	Avoided	0.0	3.7	1.9
60	1.4	Avoided	0.0	3.4	1.3
60	1.5	Avoided	0.0	3.2	1.2
60	1.6	Avoided	0.0	2.9	0.2

60	1.7	Collision	24.0	2.7	0.0
60	1.8	Collision	30.3	2.6	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	3.9	2.1
65	1.3	Avoided	0.0	3.7	2.0
65	1.4	Avoided	0.0	3.4	1.2
65	1.5	Avoided	0.0	3.2	1.1
65	1.6	Collision	17.2	2.9	0.0
65	1.7	Collision	25.8	2.8	0.0
65	1.8	Collision	37.3	2.6	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	2.2
70	1.2	Avoided	0.0	4.0	2.2
70	1.3	Avoided	0.0	3.7	2.0
70	1.4	Avoided	0.0	3.4	1.3
70	1.5	Avoided	0.0	3.2	1.5
70	1.6	Collision	19.6	3.0	0.0
70	1.7	Collision	34.1	2.8	0.0
70	1.8	Collision	44.7	2.6	0.0

Table A.17: Driver 2 with 200 ms latency for vcp_2.

V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.1	1.8
30	1.7	Avoided	0.0	3.1	1.8
30	1.8	Avoided	0.0	3.1	1.8
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	3.3	1.6
35	1.7	Avoided	0.0	3.3	1.6
35	1.8	Avoided	0.0	3.2	1.4
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4

40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.4	1.4
40	1.6	Avoided	0.0	3.4	1.4
40	1.7	Avoided	0.0	3.3	1.4
40	1.8	Avoided	0.0	3.2	1.4
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.5	1.4
45	1.6	Avoided	0.0	3.5	1.4
45	1.7	Avoided	0.0	3.3	1.4
45	1.8	Avoided	0.0	3.1	1.4
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.7	1.3
50	1.5	Avoided	0.0	3.7	1.4
50	1.6	Avoided	0.0	3.6	1.4
50	1.7	Avoided	0.0	3.4	1.4
50	1.8	Avoided	0.0	3.2	1.3
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.8	1.4
55	1.5	Avoided	0.0	3.7	1.4
55	1.6	Avoided	0.0	3.6	1.4
55	1.7	Avoided	0.0	3.4	1.3
55	1.8	Avoided	0.0	3.2	1.1
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.9	1.5
60	1.4	Avoided	0.0	3.9	1.5
60	1.5	Avoided	0.0	3.8	1.5
60	1.6	Avoided	0.0	3.6	1.5
60	1.7	Avoided	0.0	3.3	1.2
60	1.8	Avoided	0.0	3.1	1.2
65	1.0	Avoided	0.0	4.0	1.7

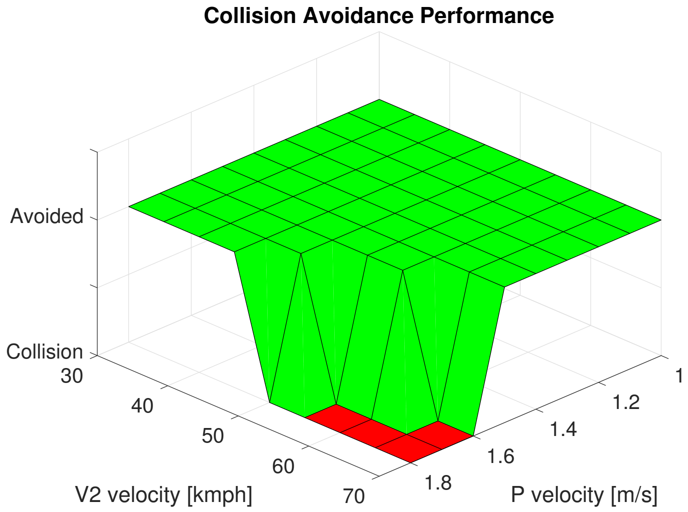
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	4.0	1.7
65	1.4	Avoided	0.0	4.0	1.7
65	1.5	Avoided	0.0	3.8	1.7
65	1.6	Avoided	0.0	3.6	1.5
65	1.7	Avoided	0.0	3.3	1.1
65	1.8	Avoided	0.0	3.1	3.2
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	4.0	1.8
70	1.5	Avoided	0.0	3.8	1.7
70	1.6	Avoided	0.0	3.6	1.5
70	1.7	Avoided	0.0	3.4	1.3
70	1.8	Avoided	0.0	3.2	3.4

Table A.18: Driver 2 with 200 ms latency for vcp_3.

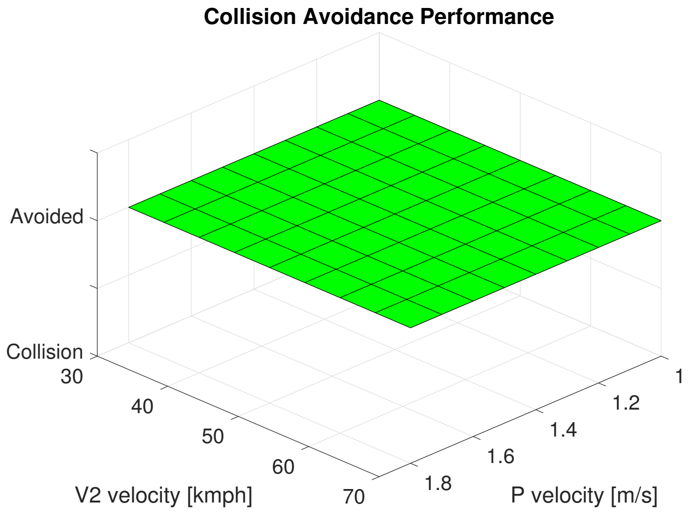
V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.1	1.7
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2
35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.3	1.5
35	1.8	Avoided	0.0	3.3	1.5
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2

40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.4	1.2
40	1.8	Avoided	0.0	3.4	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.5	1.1
45	1.8	Avoided	0.0	3.5	1.1
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.7	1.1
50	1.7	Avoided	0.0	3.7	1.1
50	1.8	Avoided	0.0	3.6	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.8	1.1
55	1.7	Avoided	0.0	3.8	1.1
55	1.8	Avoided	0.0	3.7	1.1
60	1.0	Avoided	0.0	3.8	1.2
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.9	1.2
60	1.6	Avoided	0.0	3.9	1.2
60	1.7	Avoided	0.0	3.8	1.2
60	1.8	Avoided	0.0	3.7	1.2
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4

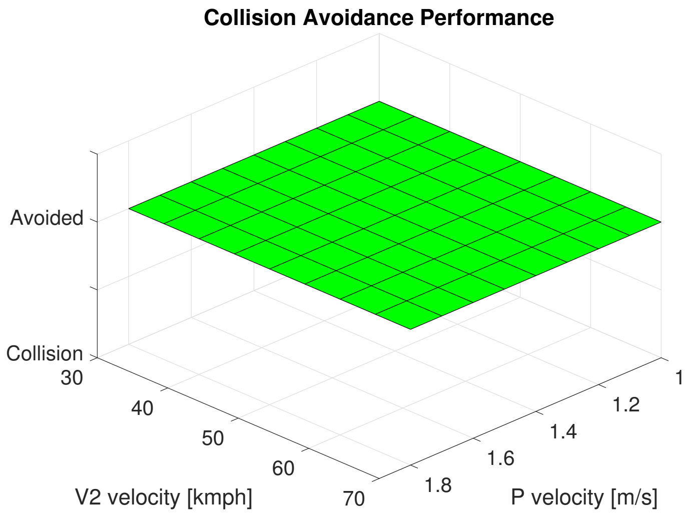
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	4.0	1.4
65	1.6	Avoided	0.0	4.0	1.4
65	1.7	Avoided	0.0	3.9	1.4
65	1.8	Avoided	0.0	3.7	1.3
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	4.0	1.5
70	1.7	Avoided	0.0	3.9	1.5
70	1.8	Avoided	0.0	3.7	1.3



(a) vcp_1



(b) vcp_2



(c) vcp_3

Figure A.4: Performance of concept with driver 2 with a latency of 200 ms.

A.1.4 300 ms Communication Latency

Table A.19: Driver 1 with 300 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.5	1.4
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.6	1.6
35	1.8	Avoided	0.0	2.5	1.1
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7
40	1.5	Avoided	0.0	2.9	1.7
40	1.6	Avoided	0.0	2.8	1.6
40	1.7	Avoided	0.0	2.7	1.3
40	1.8	Avoided	0.0	2.5	0.2
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	2.8	1.7
45	1.7	Avoided	0.0	2.6	0.9
45	1.8	Collision	7.7	2.5	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9

50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.0	1.8
50	1.6	Avoided	0.0	2.9	1.5
50	1.7	Avoided	0.0	2.7	0.7
50	1.8	Collision	21.9	2.5	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.1	1.9
55	1.5	Avoided	0.0	3.1	1.8
55	1.6	Avoided	0.0	2.9	1.1
55	1.7	Collision	12.5	2.7	0.0
55	1.8	Collision	29.7	2.5	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.2	2.0
60	1.5	Avoided	0.0	3.1	1.9
60	1.6	Avoided	0.0	2.8	0.5
60	1.7	Collision	25.9	2.6	0.0
60	1.8	Collision	32.8	2.5	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.3	2.0
65	1.5	Avoided	0.0	3.1	1.2
65	1.6	Collision	17.1	2.8	0.0
65	1.7	Collision	27.0	2.7	0.0
65	1.8	Collision	39.8	2.5	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.3	1.9
70	1.5	Avoided	0.0	3.1	0.7
70	1.6	Collision	17.5	2.9	0.0
70	1.7	Collision	34.8	2.7	0.0
70	1.8	Collision	46.2	2.5	0.0

Table A.20: Driver 1 with 300 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.7
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.9	1.8
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	3.0	1.9
45	1.8	Avoided	0.0	3.0	1.9
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9

50	1.7	Avoided	0.0	3.1	1.9
50	1.8	Avoided	0.0	3.0	1.9
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.2	1.9
55	1.7	Avoided	0.0	3.1	1.9
55	1.8	Avoided	0.0	3.1	1.9
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.3	2.0
60	1.6	Avoided	0.0	3.3	2.0
60	1.7	Avoided	0.0	3.2	2.0
60	1.8	Avoided	0.0	3.0	1.2
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.4	2.0
65	1.6	Avoided	0.0	3.4	2.0
65	1.7	Avoided	0.0	3.2	1.9
65	1.8	Avoided	0.0	3.0	0.9
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.4	2.2
70	1.7	Avoided	0.0	3.3	1.9
70	1.8	Avoided	0.0	3.1	0.7

Table A.21: Driver 1 with 300 ms latency for vcp_3.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.22: Driver 2 with 300 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8

30	1.5	Avoided	0.0	3.0	1.4
30	1.6	Avoided	0.0	2.9	1.4
30	1.7	Avoided	0.0	2.7	1.2
30	1.8	Avoided	0.0	2.6	1.8
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.2	1.4
35	1.5	Avoided	0.0	3.1	1.4
35	1.6	Avoided	0.0	2.9	1.4
35	1.7	Avoided	0.0	2.7	1.1
35	1.8	Avoided	0.0	2.5	0.8
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.3	1.4
40	1.5	Avoided	0.0	3.1	1.4
40	1.6	Avoided	0.0	2.9	1.2
40	1.7	Avoided	0.0	2.7	1.7
40	1.8	Collision	6.9	2.5	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.5	1.3
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.3	1.4
45	1.5	Avoided	0.0	3.1	1.3
45	1.6	Avoided	0.0	2.8	2.3
45	1.7	Avoided	0.0	2.6	0.3
45	1.8	Collision	14.1	2.5	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.6	1.4
50	1.4	Avoided	0.0	3.3	1.3
50	1.5	Avoided	0.0	3.1	1.1
50	1.6	Avoided	0.0	2.9	2.1
50	1.7	Collision	4.3	2.7	0.0
50	1.8	Collision	25.5	2.5	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.7	1.4
55	1.3	Avoided	0.0	3.6	1.4

55	1.4	Avoided	0.0	3.4	1.3
55	1.5	Avoided	0.0	3.1	1.2
55	1.6	Avoided	0.0	2.9	0.9
55	1.7	Collision	19.4	2.7	0.0
55	1.8	Collision	33.1	2.5	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.8	1.9
60	1.3	Avoided	0.0	3.6	1.4
60	1.4	Avoided	0.0	3.3	1.2
60	1.5	Avoided	0.0	3.1	1.1
60	1.6	Collision	15.9	2.8	0.0
60	1.7	Collision	30.3	2.6	0.0
60	1.8	Collision	36.7	2.5	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	3.9	2.1
65	1.3	Avoided	0.0	3.6	1.5
65	1.4	Avoided	0.0	3.3	1.0
65	1.5	Avoided	0.0	3.1	1.4
65	1.6	Collision	25.3	2.8	0.0
65	1.7	Collision	31.3	2.7	0.0
65	1.8	Collision	42.9	2.5	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	2.2
70	1.2	Avoided	0.0	4.0	2.2
70	1.3	Avoided	0.0	3.6	1.4
70	1.4	Avoided	0.0	3.3	1.0
70	1.5	Collision	0.1	3.1	0.0
70	1.6	Collision	27.4	2.9	0.0
70	1.7	Collision	38.8	2.7	0.0
70	1.8	Collision	49.5	2.5	0.0

Table A.23: Driver 2 with 300 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.1	1.8
30	1.7	Avoided	0.0	3.1	1.8

30	1.8	Avoided	0.0	3.0	1.4
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	3.3	1.6
35	1.7	Avoided	0.0	3.2	1.4
35	1.8	Avoided	0.0	3.1	1.4
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.4	1.4
40	1.6	Avoided	0.0	3.4	1.4
40	1.7	Avoided	0.0	3.3	1.4
40	1.8	Avoided	0.0	3.1	1.4
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.5	1.4
45	1.6	Avoided	0.0	3.5	1.4
45	1.7	Avoided	0.0	3.2	1.4
45	1.8	Avoided	0.0	3.0	1.2
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.7	1.3
50	1.5	Avoided	0.0	3.7	1.4
50	1.6	Avoided	0.0	3.5	1.4
50	1.7	Avoided	0.0	3.3	1.4
50	1.8	Avoided	0.0	3.1	1.2
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.8	1.4
55	1.5	Avoided	0.0	3.7	1.4
55	1.6	Avoided	0.0	3.5	1.4

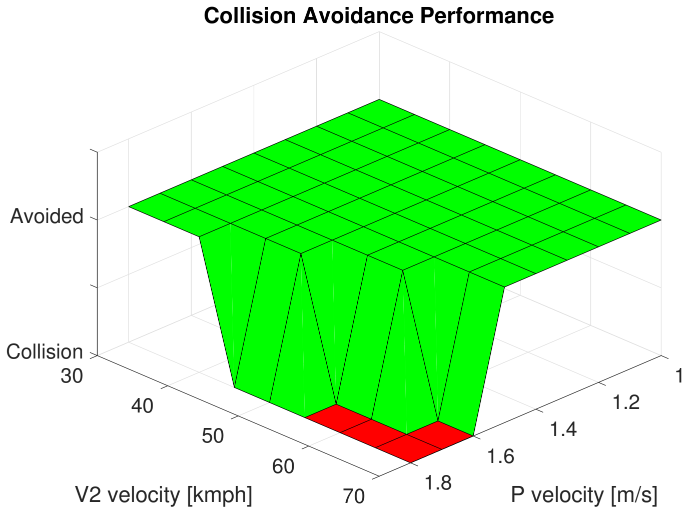
55	1.7	Avoided	0.0	3.3	1.3
55	1.8	Avoided	0.0	3.1	1.2
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.9	1.5
60	1.4	Avoided	0.0	3.9	1.5
60	1.5	Avoided	0.0	3.7	1.5
60	1.6	Avoided	0.0	3.5	1.4
60	1.7	Avoided	0.0	3.2	1.3
60	1.8	Avoided	0.0	3.0	2.7
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	4.0	1.7
65	1.4	Avoided	0.0	3.9	1.7
65	1.5	Avoided	0.0	3.7	1.6
65	1.6	Avoided	0.0	3.5	1.4
65	1.7	Avoided	0.0	3.2	1.1
65	1.8	Avoided	0.0	3.0	1.4
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	4.0	1.8
70	1.5	Avoided	0.0	3.7	1.6
70	1.6	Avoided	0.0	3.5	1.3
70	1.7	Avoided	0.0	3.3	1.0
70	1.8	Avoided	0.0	3.1	1.4

Table A.24: Driver 2 with 300 ms latency for vcp_3.

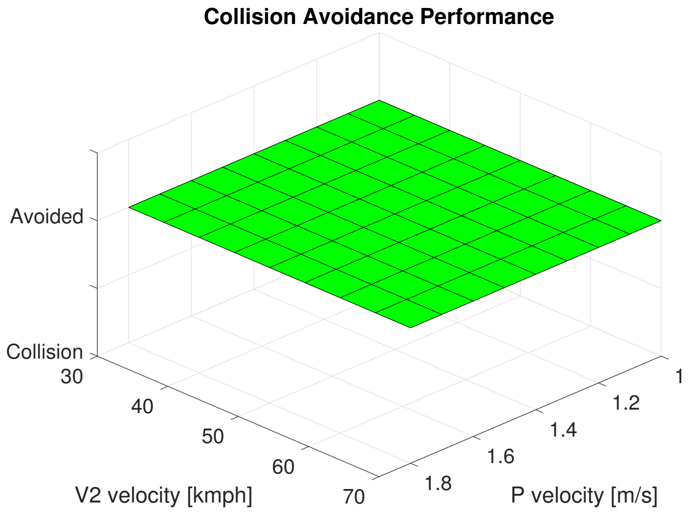
V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.1	1.7
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.3	1.5
35	1.8	Avoided	0.0	3.3	1.5
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.4	1.2
40	1.8	Avoided	0.0	3.4	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.5	1.1
45	1.8	Avoided	0.0	3.5	1.1
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.7	1.1
50	1.7	Avoided	0.0	3.7	1.1
50	1.8	Avoided	0.0	3.6	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.8	1.1
55	1.7	Avoided	0.0	3.8	1.1
55	1.8	Avoided	0.0	3.6	1.1
60	1.0	Avoided	0.0	3.8	1.2

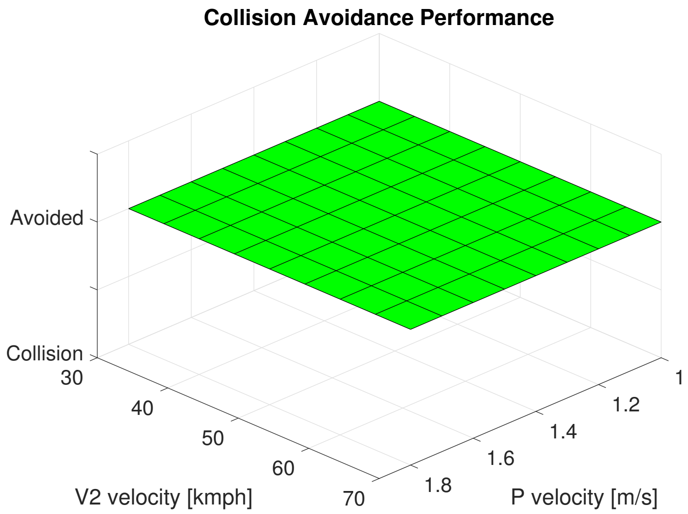
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.9	1.2
60	1.6	Avoided	0.0	3.9	1.2
60	1.7	Avoided	0.0	3.8	1.2
60	1.8	Avoided	0.0	3.6	1.1
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	4.0	1.4
65	1.6	Avoided	0.0	4.0	1.4
65	1.7	Avoided	0.0	3.8	1.4
65	1.8	Avoided	0.0	3.6	1.2
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	4.0	1.5
70	1.7	Avoided	0.0	3.8	1.4
70	1.8	Avoided	0.0	3.6	1.2



(a) vcp_1

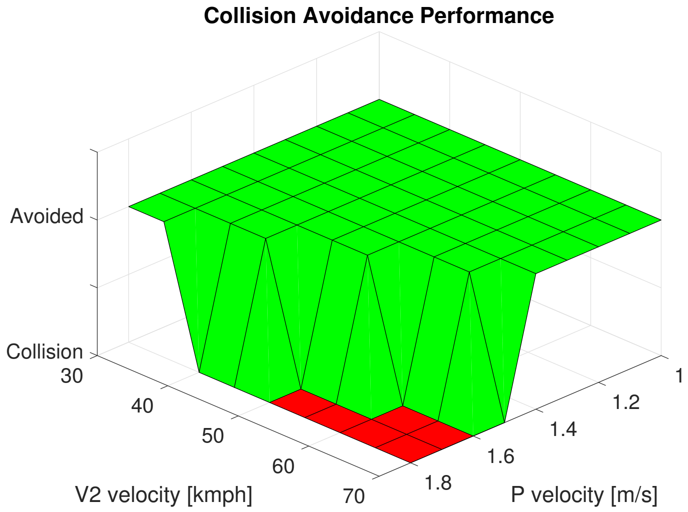


(b) vcp_2

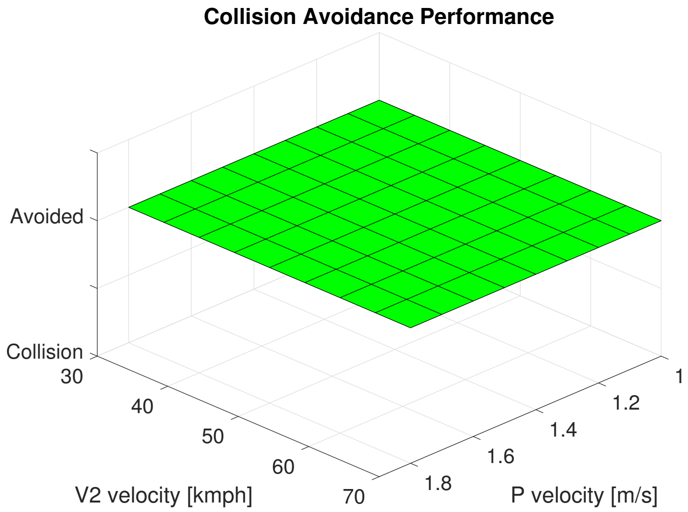


(c) vcp_3

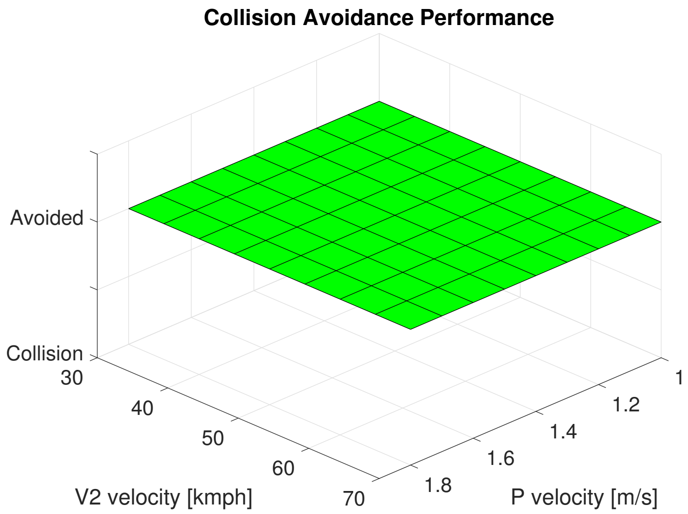
Figure A.5: Performance of concept with driver 1 with a latency of 300 ms.



(a) vcp_1



(b) vcp_2



(c) vcp_3

Figure A.6: Performance of concept with driver 2 with a latency of 300 ms.

A.1.5 400 ms Communication Latency

Table A.25: Driver 1 with 400 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.5	1.3
30	1.8	Avoided	0.0	2.5	1.4
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.6
35	1.7	Avoided	0.0	2.6	1.3
35	1.8	Avoided	0.0	2.4	0.2
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7
40	1.5	Avoided	0.0	2.9	1.7
40	1.6	Avoided	0.0	2.8	1.6
40	1.7	Avoided	0.0	2.6	1.3
40	1.8	Collision	14.4	2.4	0.0
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	2.9	1.8
45	1.6	Avoided	0.0	2.7	1.2
45	1.7	Collision	7.7	2.5	0.0
45	1.8	Collision	19.0	2.4	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9

50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.0	1.8
50	1.6	Avoided	0.0	2.8	1.1
50	1.7	Collision	12.0	2.6	0.0
50	1.8	Collision	28.3	2.4	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.1	1.8
55	1.5	Avoided	0.0	3.0	1.3
55	1.6	Avoided	0.0	2.8	0.8
55	1.7	Collision	22.7	2.6	0.0
55	1.8	Collision	35.5	2.4	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.2	2.0
60	1.5	Avoided	0.0	3.0	1.2
60	1.6	Collision	16.6	2.7	0.0
60	1.7	Collision	32.8	2.5	0.0
60	1.8	Collision	38.3	2.4	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.2	1.9
65	1.5	Avoided	0.0	3.0	0.8
65	1.6	Collision	27.0	2.7	0.0
65	1.7	Collision	34.1	2.6	0.0
65	1.8	Collision	45.1	2.4	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.1
70	1.4	Avoided	0.0	3.2	1.1
70	1.5	Avoided	0.0	3.0	0.3
70	1.6	Collision	27.3	2.8	0.0
70	1.7	Collision	41.1	2.6	0.0
70	1.8	Collision	51.3	2.4	0.0

Table A.26: Driver 1 with 400 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.7
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.9	1.8
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	3.0	1.9
45	1.8	Avoided	0.0	2.9	1.8
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9

50	1.7	Avoided	0.0	3.1	1.9
50	1.8	Avoided	0.0	3.0	1.9
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.2	1.9
55	1.7	Avoided	0.0	3.1	1.9
55	1.8	Avoided	0.0	3.0	1.3
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.3	2.0
60	1.6	Avoided	0.0	3.3	2.0
60	1.7	Avoided	0.0	3.1	1.9
60	1.8	Avoided	0.0	2.9	0.9
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.4	2.0
65	1.6	Avoided	0.0	3.3	2.0
65	1.7	Avoided	0.0	3.1	1.2
65	1.8	Avoided	0.0	2.9	0.5
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.4	2.2
70	1.7	Avoided	0.0	3.2	1.1
70	1.8	Avoided	0.0	3.0	0.7

Table A.27: Driver 1 with 400 ms latency for vcp_3.

V_2 **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	V_I **[kmph]**	TTC_W **[s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.28: Driver 2 with 400 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8

30	1.5	Avoided	0.0	3.0	1.4
30	1.6	Avoided	0.0	2.8	1.3
30	1.7	Avoided	0.0	2.6	1.8
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.2	1.4
35	1.5	Avoided	0.0	3.0	1.4
35	1.6	Avoided	0.0	2.8	1.3
35	1.7	Avoided	0.0	2.6	1.7
35	1.8	Collision	6.0	2.4	0.0
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.3	1.4
40	1.5	Avoided	0.0	3.0	1.3
40	1.6	Avoided	0.0	2.8	1.2
40	1.7	Avoided	0.0	2.6	0.9
40	1.8	Collision	17.8	2.4	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.5	1.3
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.2	1.4
45	1.5	Avoided	0.0	3.0	1.2
45	1.6	Avoided	0.0	2.7	1.3
45	1.7	Collision	14.1	2.5	0.0
45	1.8	Collision	22.6	2.4	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.5	1.4
50	1.4	Avoided	0.0	3.2	1.3
50	1.5	Avoided	0.0	3.0	1.2
50	1.6	Avoided	0.0	2.8	1.0
50	1.7	Collision	17.5	2.6	0.0
50	1.8	Collision	31.2	2.4	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.7	1.4
55	1.3	Avoided	0.0	3.5	1.4

55	1.4	Avoided	0.0	3.3	1.2
55	1.5	Avoided	0.0	3.0	2.2
55	1.6	Collision	7.2	2.8	0.0
55	1.7	Collision	26.6	2.6	0.0
55	1.8	Collision	37.9	2.4	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.8	1.9
60	1.3	Avoided	0.0	3.5	1.4
60	1.4	Avoided	0.0	3.2	1.2
60	1.5	Avoided	0.0	3.0	1.7
60	1.6	Collision	23.6	2.7	0.0
60	1.7	Collision	36.7	2.5	0.0
60	1.8	Collision	41.4	2.4	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	3.8	2.1
65	1.3	Avoided	0.0	3.5	1.4
65	1.4	Avoided	0.0	3.2	1.1
65	1.5	Avoided	0.0	3.0	0.3
65	1.6	Collision	31.0	2.7	0.0
65	1.7	Collision	37.3	2.6	0.0
65	1.8	Collision	47.4	2.4	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	2.2
70	1.2	Avoided	0.0	3.9	2.2
70	1.3	Avoided	0.0	3.5	1.3
70	1.4	Avoided	0.0	3.2	1.2
70	1.5	Collision	19.0	3.0	0.0
70	1.6	Collision	33.2	2.8	0.0
70	1.7	Collision	44.7	2.6	0.0
70	1.8	Collision	54.1	2.4	0.0

Table A.29: Driver 2 with 400 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.1	1.8
30	1.7	Avoided	0.0	3.1	1.8

30	1.8	Avoided	0.0	3.0	1.4
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	3.3	1.6
35	1.7	Avoided	0.0	3.2	1.4
35	1.8	Avoided	0.0	3.0	1.4
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.4	1.4
40	1.6	Avoided	0.0	3.3	1.4
40	1.7	Avoided	0.0	3.2	1.4
40	1.8	Avoided	0.0	3.0	1.3
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.5	1.4
45	1.6	Avoided	0.0	3.4	1.4
45	1.7	Avoided	0.0	3.1	1.3
45	1.8	Avoided	0.0	2.9	1.1
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.7	1.3
50	1.5	Avoided	0.0	3.6	1.4
50	1.6	Avoided	0.0	3.4	1.4
50	1.7	Avoided	0.0	3.2	1.3
50	1.8	Avoided	0.0	3.0	1.3
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.8	1.4
55	1.5	Avoided	0.0	3.7	1.4
55	1.6	Avoided	0.0	3.4	1.3

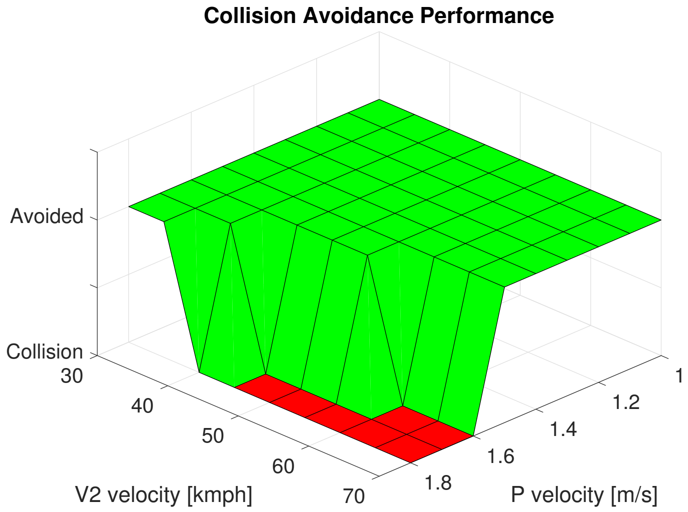
55	1.7	Avoided	0.0	3.2	1.1
55	1.8	Avoided	0.0	3.0	3.1
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.9	1.5
60	1.4	Avoided	0.0	3.8	1.5
60	1.5	Avoided	0.0	3.6	1.4
60	1.6	Avoided	0.0	3.4	1.3
60	1.7	Avoided	0.0	3.1	1.2
60	1.8	Avoided	0.0	2.9	1.1
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	4.0	1.7
65	1.4	Avoided	0.0	3.9	1.7
65	1.5	Avoided	0.0	3.6	1.5
65	1.6	Avoided	0.0	3.4	1.3
65	1.7	Avoided	0.0	3.1	3.2
65	1.8	Collision	9.7	2.9	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	3.9	1.8
70	1.5	Avoided	0.0	3.6	1.5
70	1.6	Avoided	0.0	3.4	1.3
70	1.7	Avoided	0.0	3.2	3.4
70	1.8	Collision	10.8	3.0	0.0

Table A.30: Driver 2 with 400 ms latency for vcp_3.

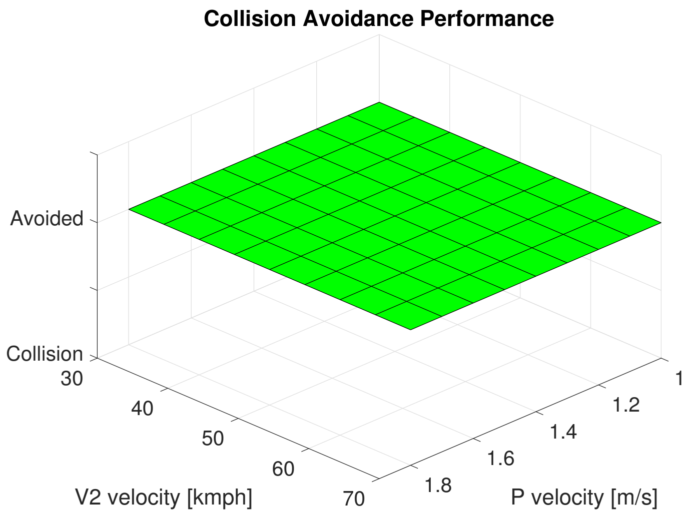
V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.1	1.7
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.3	1.5
35	1.8	Avoided	0.0	3.3	1.5
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.4	1.2
40	1.8	Avoided	0.0	3.4	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.5	1.1
45	1.8	Avoided	0.0	3.5	1.2
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.7	1.1
50	1.7	Avoided	0.0	3.6	1.1
50	1.8	Avoided	0.0	3.5	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.8	1.1
55	1.7	Avoided	0.0	3.7	1.1
55	1.8	Avoided	0.0	3.5	1.1
60	1.0	Avoided	0.0	3.8	1.2

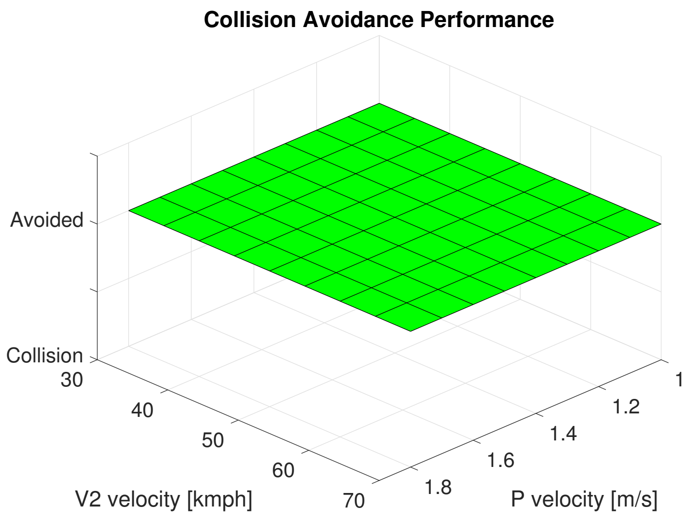
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.9	1.2
60	1.6	Avoided	0.0	3.9	1.2
60	1.7	Avoided	0.0	3.7	1.2
60	1.8	Avoided	0.0	3.5	1.1
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	4.0	1.4
65	1.6	Avoided	0.0	3.9	1.4
65	1.7	Avoided	0.0	3.7	1.3
65	1.8	Avoided	0.0	3.5	1.1
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	4.0	1.5
70	1.7	Avoided	0.0	3.7	1.3
70	1.8	Avoided	0.0	3.5	1.0



(a) vcp$_2$

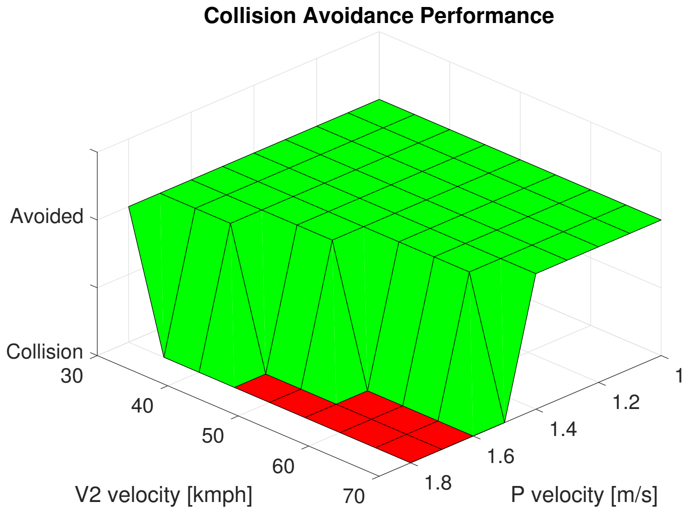


(b) vcp$_2$

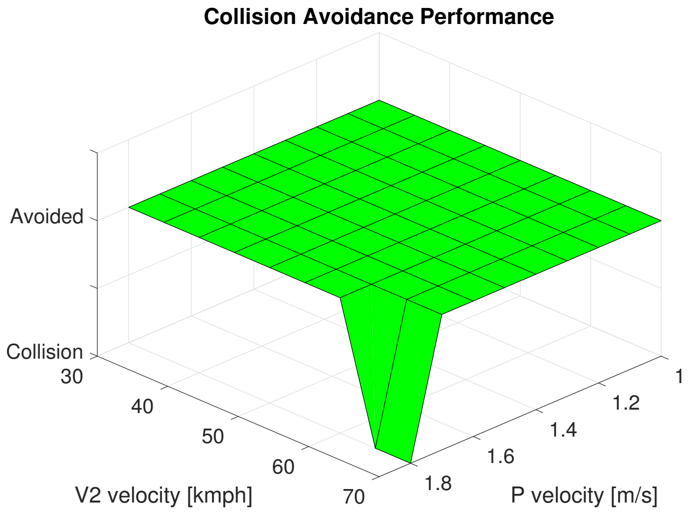


(c) vcp$_3$

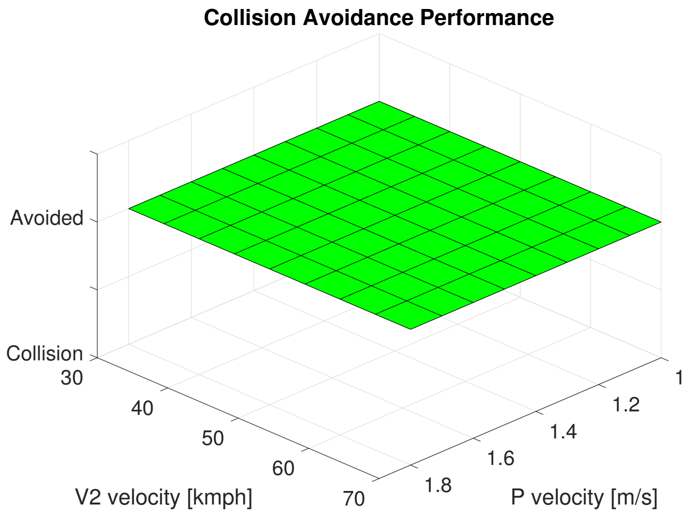
Figure A.7: Performance of concept with driver 1 with a latency of 400 ms.



(a) vcp$_1$



(b) vcp$_2$



(c) vcp$_3$

Figure A.8: Performance of concept with driver 2 with a latency of 400 ms.

A.1.6 500 ms Communication Latency

Table A.31: Driver 1 with 500 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.5	1.3
30	1.7	Avoided	0.0	2.5	1.4
30	1.8	Avoided	0.0	2.4	0.6
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.6	1.6
35	1.7	Avoided	0.0	2.5	1.1
35	1.8	Collision	13.3	2.3	0.0
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7
40	1.5	Avoided	0.0	2.8	1.6
40	1.6	Avoided	0.0	2.7	1.3
40	1.7	Avoided	0.0	2.5	0.2
40	1.8	Collision	21.8	2.3	0.0
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	2.9	1.8
45	1.6	Avoided	0.0	2.6	0.9
45	1.7	Collision	19.0	2.4	0.0
45	1.8	Collision	25.6	2.3	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9

50	1.4	Avoided	0.0	3.0	1.8
50	1.5	Avoided	0.0	2.9	1.5
50	1.6	Avoided	0.0	2.7	0.7
50	1.7	Collision	21.9	2.5	0.0
50	1.8	Collision	34.1	2.3	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.1	1.8
55	1.5	Avoided	0.0	2.9	1.1
55	1.6	Collision	12.5	2.7	0.0
55	1.7	Collision	29.7	2.5	0.0
55	1.8	Collision	33.0	2.3	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.1	1.9
60	1.5	Avoided	0.0	2.9	0.9
60	1.6	Collision	25.9	2.6	0.0
60	1.7	Collision	38.3	2.4	0.0
60	1.8	Collision	43.6	2.3	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.3	2.0
65	1.4	Avoided	0.0	3.1	1.2
65	1.5	Avoided	0.0	2.9	0.5
65	1.6	Collision	34.1	2.6	0.0
65	1.7	Collision	39.8	2.5	0.0
65	1.8	Collision	43.3	2.3	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.1
70	1.4	Avoided	0.0	3.1	0.7
70	1.5	Collision	16.8	2.9	0.0
70	1.6	Collision	34.8	2.7	0.0
70	1.7	Collision	46.2	2.5	0.0
70	1.8	Collision	49.1	2.3	0.0

Table A.32: Driver 1 with 500 ms latency for vcp_2.

V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.7
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.8	1.7
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	3.0	1.9
45	1.8	Avoided	0.0	2.8	1.7
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9

50	1.7	Avoided	0.0	3.0	1.9
50	1.8	Avoided	0.0	2.9	1.5
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.1	1.9
55	1.7	Avoided	0.0	3.1	1.9
55	1.8	Avoided	0.0	2.9	1.1
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.3	2.0
60	1.6	Avoided	0.0	3.2	2.0
60	1.7	Avoided	0.0	3.0	1.2
60	1.8	Avoided	0.0	2.8	0.5
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.4	2.0
65	1.6	Avoided	0.0	3.3	2.0
65	1.7	Avoided	0.0	3.0	0.9
65	1.8	Collision	17.1	2.8	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.3	1.9
70	1.7	Avoided	0.0	3.1	0.7
70	1.8	Collision	16.8	2.9	0.0

Table A.33: Driver 1 with 500 ms latency for vcp_3.

V_2 **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	V_I **[kmph]**	TTC_W **[s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.34: Driver 2 with 500 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.0	1.4

30	1.5	Avoided	0.0	3.0	1.4
30	1.6	Avoided	0.0	2.7	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.4	0.1
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.2	1.4
35	1.5	Avoided	0.0	2.9	1.4
35	1.6	Avoided	0.0	2.7	1.1
35	1.7	Avoided	0.0	2.5	0.8
35	1.8	Collision	16.5	2.3	0.0
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.3	1.4
40	1.4	Avoided	0.0	3.2	1.4
40	1.5	Avoided	0.0	2.9	1.2
40	1.6	Avoided	0.0	2.7	1.8
40	1.7	Collision	6.9	2.5	0.0
40	1.8	Collision	23.9	2.3	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.5	1.3
45	1.3	Avoided	0.0	3.4	1.4
45	1.4	Avoided	0.0	3.1	1.3
45	1.5	Avoided	0.0	2.9	1.1
45	1.6	Avoided	0.0	2.6	0.3
45	1.7	Collision	22.6	2.4	0.0
45	1.8	Collision	28.2	2.3	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.6	1.4
50	1.3	Avoided	0.0	3.4	1.4
50	1.4	Avoided	0.0	3.1	1.1
50	1.5	Avoided	0.0	2.9	2.2
50	1.6	Collision	1.5	2.7	0.0
50	1.7	Collision	25.5	2.5	0.0
50	1.8	Collision	36.4	2.3	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.7	1.4
55	1.3	Avoided	0.0	3.4	1.3

55	1.4	Avoided	0.0	3.2	1.1
55	1.5	Avoided	0.0	2.9	1.0
55	1.6	Collision	18.8	2.7	0.0
55	1.7	Collision	33.1	2.5	0.0
55	1.8	Collision	36.5	2.3	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.7	1.4
60	1.3	Avoided	0.0	3.4	1.3
60	1.4	Avoided	0.0	3.1	1.1
60	1.5	Avoided	0.0	2.9	0.4
60	1.6	Collision	30.3	2.6	0.0
60	1.7	Collision	41.4	2.4	0.0
60	1.8	Collision	46.5	2.3	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	3.7	1.6
65	1.3	Avoided	0.0	3.4	1.2
65	1.4	Avoided	0.0	3.1	1.8
65	1.5	Collision	15.9	2.9	0.0
65	1.6	Collision	37.3	2.6	0.0
65	1.7	Collision	42.9	2.5	0.0
65	1.8	Collision	46.8	2.3	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	3.8	1.7
70	1.3	Avoided	0.0	3.4	1.3
70	1.4	Avoided	0.0	3.1	0.2
70	1.5	Collision	26.9	2.9	0.0
70	1.6	Collision	38.8	2.7	0.0
70	1.7	Collision	49.5	2.5	0.0
70	1.8	Collision	52.3	2.3	0.0

Table A.35: Driver 2 with 500 ms latency for vcp_2.

$\mathbf{V_2}$ **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	$\mathbf{V_I}$ **[kmph]**	$\mathbf{TTC_W}$ **[s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.1	1.8
30	1.7	Avoided	0.0	3.0	1.4

30	1.8	Avoided	0.0	2.9	1.4
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	3.2	1.4
35	1.7	Avoided	0.0	3.1	1.4
35	1.8	Avoided	0.0	2.9	1.4
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.4	1.4
40	1.6	Avoided	0.0	3.3	1.4
40	1.7	Avoided	0.0	3.1	1.4
40	1.8	Avoided	0.0	2.9	1.2
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.5	1.4
45	1.6	Avoided	0.0	3.3	1.4
45	1.7	Avoided	0.0	3.0	1.2
45	1.8	Avoided	0.0	2.8	2.7
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.7	1.3
50	1.5	Avoided	0.0	3.6	1.4
50	1.6	Avoided	0.0	3.3	1.4
50	1.7	Avoided	0.0	3.1	1.2
50	1.8	Avoided	0.0	2.9	2.8
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.7	1.4
55	1.5	Avoided	0.0	3.6	1.4
55	1.6	Avoided	0.0	3.3	1.3

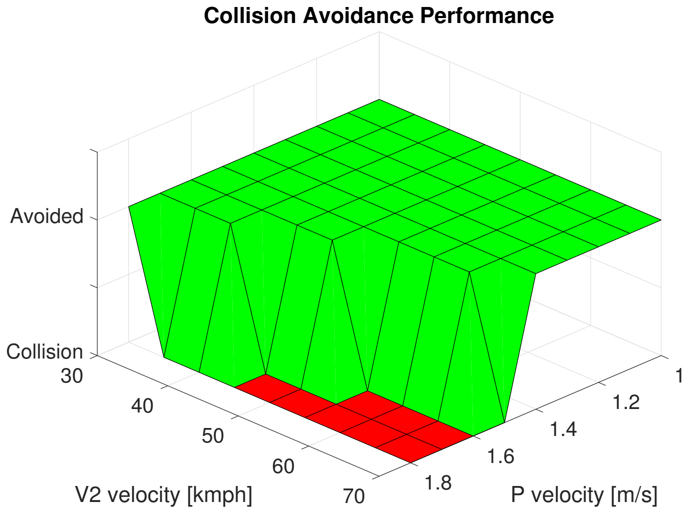
55	1.7	Avoided	0.0	3.1	1.2
55	1.8	Avoided	0.0	2.9	1.6
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.9	1.5
60	1.4	Avoided	0.0	3.8	1.5
60	1.5	Avoided	0.0	3.5	1.4
60	1.6	Avoided	0.0	3.3	1.2
60	1.7	Avoided	0.0	3.0	2.7
60	1.8	Collision	11.4	2.8	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	4.0	1.7
65	1.4	Avoided	0.0	3.8	1.7
65	1.5	Avoided	0.0	3.5	1.4
65	1.6	Avoided	0.0	3.3	1.1
65	1.7	Avoided	0.0	3.0	1.4
65	1.8	Collision	23.0	2.8	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	3.8	1.7
70	1.5	Avoided	0.0	3.5	1.3
70	1.6	Avoided	0.0	3.3	1.0
70	1.7	Avoided	0.0	3.1	1.4
70	1.8	Collision	24.1	2.9	0.0

Table A.36: Driver 2 with 500 ms latency for vcp_3.

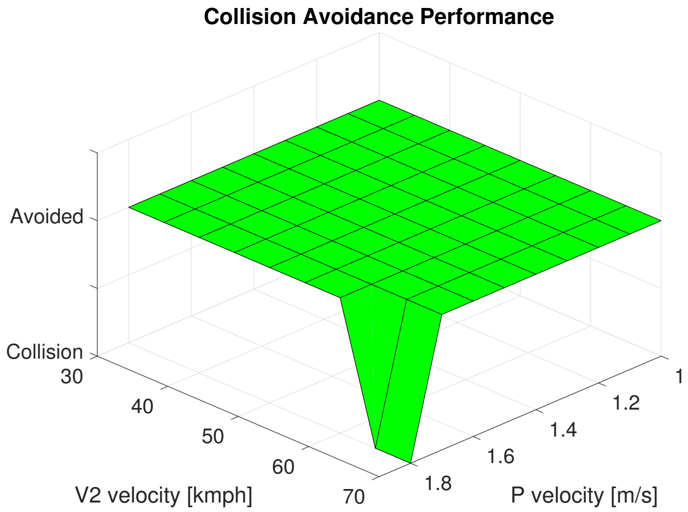
V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.1	1.7
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.3	1.5
35	1.8	Avoided	0.0	3.3	1.5
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.4	1.2
40	1.8	Avoided	0.0	3.4	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.5	1.1
45	1.8	Avoided	0.0	3.4	1.2
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.7	1.1
50	1.7	Avoided	0.0	3.6	1.1
50	1.8	Avoided	0.0	3.4	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.8	1.1
55	1.7	Avoided	0.0	3.7	1.1
55	1.8	Avoided	0.0	3.4	1.1
60	1.0	Avoided	0.0	3.8	1.2

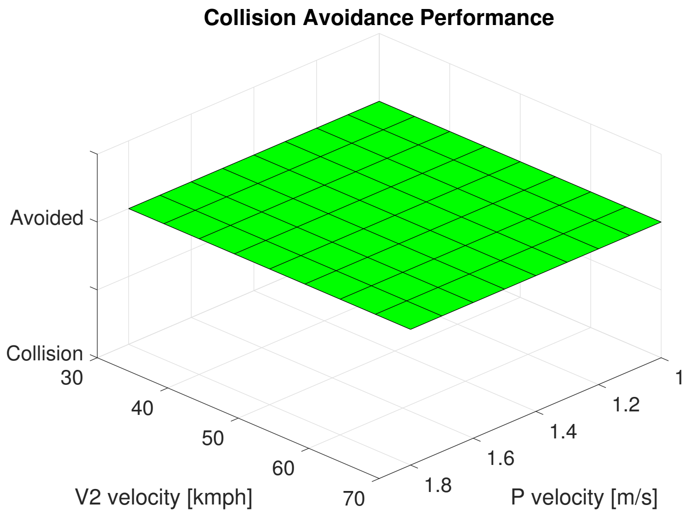
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.9	1.2
60	1.6	Avoided	0.0	3.8	1.2
60	1.7	Avoided	0.0	3.6	1.1
60	1.8	Avoided	0.0	3.4	1.0
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	4.0	1.4
65	1.6	Avoided	0.0	3.9	1.4
65	1.7	Avoided	0.0	3.6	1.2
65	1.8	Avoided	0.0	3.4	1.0
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	3.9	1.5
70	1.7	Avoided	0.0	3.6	1.2
70	1.8	Avoided	0.0	3.4	0.8



(a) vcp_2

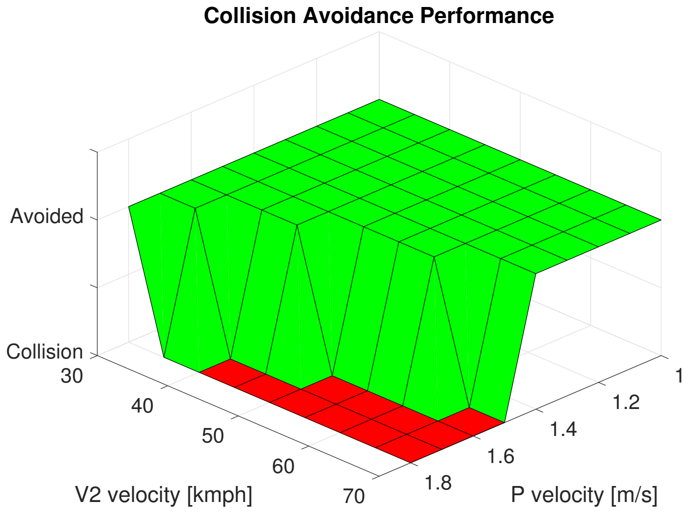


(b) vcp_2

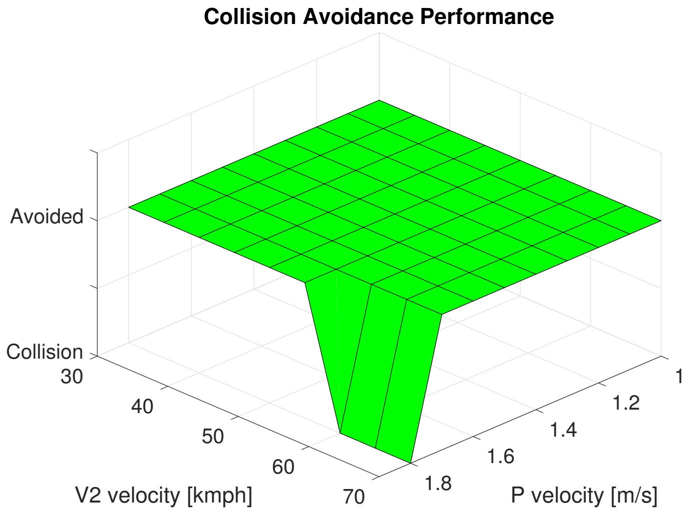


(c) vcp_3

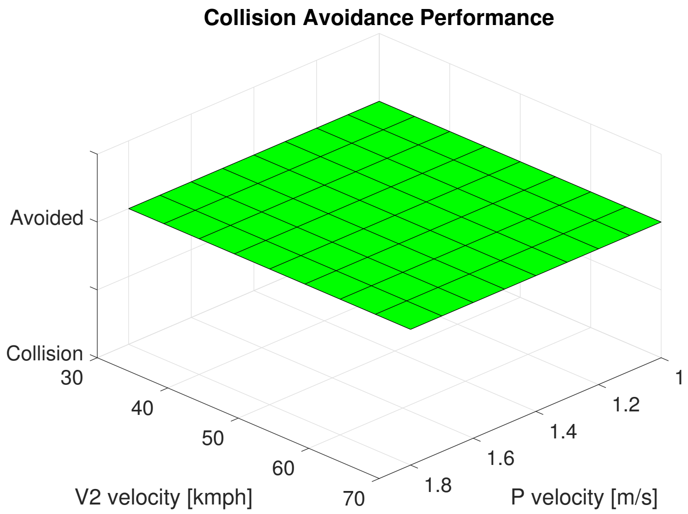
Figure A.9: Performance of concept with driver 1 with a latency of 500 ms.



(a) vcp_1



(b) vcp_2



(c) vcp_3

Figure A.10: Performance of concept with driver 2 with a latency of 500 ms.

A.1.7 600 ms Communication Latency

Table A.37: Driver 1 with 600 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.5	1.4
30	1.7	Avoided	0.0	2.4	0.6
30	1.8	Collision	7.2	2.3	0.0
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.6
35	1.6	Avoided	0.0	2.6	1.3
35	1.7	Avoided	0.0	2.4	0.2
35	1.8	Collision	20.8	2.2	0.0
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.9	1.7
40	1.5	Avoided	0.0	2.8	1.6
40	1.6	Avoided	0.0	2.6	1.3
40	1.7	Collision	14.4	2.4	0.0
40	1.8	Collision	17.2	2.2	0.0
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	2.9	1.8
45	1.5	Avoided	0.0	2.8	1.7
45	1.6	Collision	7.7	2.5	0.0
45	1.7	Collision	25.6	2.3	0.0
45	1.8	Collision	31.2	2.2	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9

50	1.4	Avoided	0.0	3.0	1.8
50	1.5	Avoided	0.0	2.8	1.1
50	1.6	Collision	12.0	2.6	0.0
50	1.7	Collision	28.3	2.4	0.0
50	1.8	Collision	30.3	2.2	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.1	1.9
55	1.4	Avoided	0.0	3.1	1.8
55	1.5	Avoided	0.0	2.8	0.8
55	1.6	Collision	22.7	2.6	0.0
55	1.7	Collision	35.5	2.4	0.0
55	1.8	Collision	36.0	2.2	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.2	2.0
60	1.4	Avoided	0.0	3.0	1.2
60	1.5	Avoided	0.0	2.8	0.5
60	1.6	Collision	32.8	2.5	0.0
60	1.7	Collision	43.6	2.3	0.0
60	1.8	Collision	40.1	2.2	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.3	2.0
65	1.4	Avoided	0.0	3.0	0.8
65	1.5	Collision	17.1	2.8	0.0
65	1.6	Collision	39.8	2.5	0.0
65	1.7	Collision	45.1	2.4	0.0
65	1.8	Collision	46.2	2.2	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.3	1.9
70	1.4	Avoided	0.0	3.0	0.5
70	1.5	Collision	27.3	2.8	0.0
70	1.6	Collision	41.1	2.6	0.0
70	1.7	Collision	51.3	2.4	0.0
70	1.8	Collision	51.7	2.2	0.0

Table A.38: Driver 1 with 600 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.7	1.6
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.9	1.8
40	1.8	Avoided	0.0	2.8	1.7
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	2.9	1.8
45	1.8	Avoided	0.0	2.7	1.2
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.1	1.9

50	1.7	Avoided	0.0	3.0	1.9
50	1.8	Avoided	0.0	2.8	1.2
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.1	1.9
55	1.7	Avoided	0.0	3.0	1.3
55	1.8	Avoided	0.0	2.8	0.8
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.3	2.0
60	1.6	Avoided	0.0	3.2	2.0
60	1.7	Avoided	0.0	2.9	0.9
60	1.8	Collision	16.6	2.7	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.3	2.0
65	1.6	Avoided	0.0	3.2	1.9
65	1.7	Avoided	0.0	2.9	0.5
65	1.8	Collision	27.0	2.7	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.4	2.2
70	1.6	Avoided	0.0	3.2	1.1
70	1.7	Avoided	0.0	3.0	0.7
70	1.8	Collision	27.3	2.8	0.0

Table A.39: Driver 1 with 600 ms latency for vcp_3.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.40: Driver 2 with 600 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.0	1.4

30	1.5	Avoided	0.0	2.9	1.4
30	1.6	Avoided	0.0	2.6	1.8
30	1.7	Avoided	0.0	2.4	0.1
30	1.8	Collision	12.3	2.3	0.0
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.2	1.4
35	1.4	Avoided	0.0	3.1	1.4
35	1.5	Avoided	0.0	2.8	1.2
35	1.6	Avoided	0.0	2.6	1.7
35	1.7	Collision	6.0	2.4	0.0
35	1.8	Collision	22.6	2.2	0.0
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.3	1.4
40	1.4	Avoided	0.0	3.1	1.4
40	1.5	Avoided	0.0	2.8	1.2
40	1.6	Avoided	0.0	2.6	0.9
40	1.7	Collision	17.8	2.4	0.0
40	1.8	Collision	21.3	2.2	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.3	1.4
45	1.4	Avoided	0.0	3.0	1.2
45	1.5	Avoided	0.0	2.8	2.4
45	1.6	Collision	14.1	2.5	0.0
45	1.7	Collision	28.2	2.3	0.0
45	1.8	Collision	33.6	2.2	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.6	1.4
50	1.3	Avoided	0.0	3.3	1.3
50	1.4	Avoided	0.0	3.0	1.2
50	1.5	Avoided	0.0	2.8	1.2
50	1.6	Collision	17.5	2.6	0.0
50	1.7	Collision	31.2	2.4	0.0
50	1.8	Collision	33.5	2.2	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.7	1.4
55	1.3	Avoided	0.0	3.3	1.2

55	1.4	Avoided	0.0	3.1	1.2
55	1.5	Collision	5.4	2.8	0.0
55	1.6	Collision	26.6	2.6	0.0
55	1.7	Collision	37.9	2.4	0.0
55	1.8	Collision	38.9	2.2	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.6	1.4
60	1.3	Avoided	0.0	3.3	1.2
60	1.4	Avoided	0.0	3.0	1.9
60	1.5	Collision	14.3	2.8	0.0
60	1.6	Collision	36.7	2.5	0.0
60	1.7	Collision	46.5	2.3	0.0
60	1.8	Collision	43.1	2.2	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	3.9	1.7
65	1.2	Avoided	0.0	3.6	1.5
65	1.3	Avoided	0.0	3.3	1.0
65	1.4	Avoided	0.0	3.0	0.5
65	1.5	Collision	24.1	2.8	0.0
65	1.6	Collision	42.9	2.5	0.0
65	1.7	Collision	47.4	2.4	0.0
65	1.8	Collision	49.1	2.2	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	3.7	1.6
70	1.3	Avoided	0.0	3.3	1.0
70	1.4	Collision	17.7	3.0	0.0
70	1.5	Collision	32.8	2.8	0.0
70	1.6	Collision	44.7	2.6	0.0
70	1.7	Collision	54.1	2.4	0.0
70	1.8	Collision	54.5	2.2	0.0

Table A.41: Driver 2 with 600 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.1	1.8
30	1.7	Avoided	0.0	3.0	1.4

30	1.8	Avoided	0.0	2.8	1.3
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	3.2	1.4
35	1.7	Avoided	0.0	3.0	1.4
35	1.8	Avoided	0.0	2.8	1.3
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.4	1.4
40	1.6	Avoided	0.0	3.2	1.4
40	1.7	Avoided	0.0	3.0	1.3
40	1.8	Avoided	0.0	2.8	1.2
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.4	1.4
45	1.6	Avoided	0.0	3.2	1.4
45	1.7	Avoided	0.0	2.9	1.1
45	1.8	Avoided	0.0	2.7	1.6
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.6	1.4
50	1.5	Avoided	0.0	3.5	1.4
50	1.6	Avoided	0.0	3.2	1.3
50	1.7	Avoided	0.0	3.0	1.3
50	1.8	Avoided	0.0	2.8	1.4
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.7	1.4
55	1.5	Avoided	0.0	3.5	1.4
55	1.6	Avoided	0.0	3.2	1.1

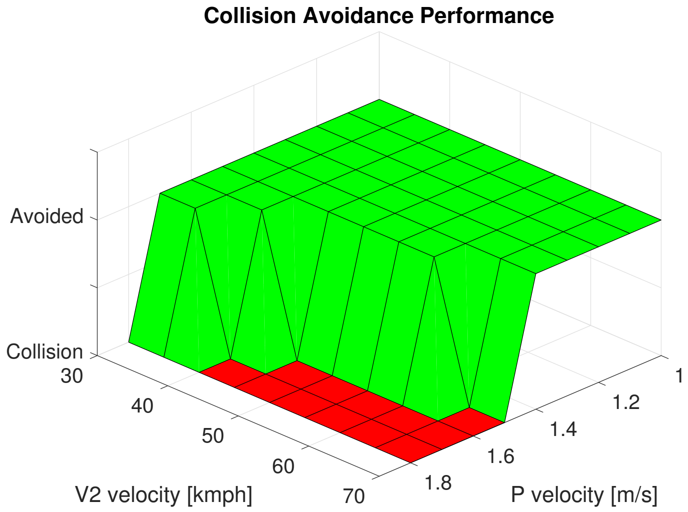
55	1.7	Avoided	0.0	3.0	3.1
55	1.8	Avoided	0.0	2.8	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.9	1.5
60	1.4	Avoided	0.0	3.7	1.5
60	1.5	Avoided	0.0	3.4	1.3
60	1.6	Avoided	0.0	3.2	1.3
60	1.7	Avoided	0.0	2.9	1.1
60	1.8	Collision	23.1	2.7	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	3.9	1.7
65	1.4	Avoided	0.0	3.7	1.6
65	1.5	Avoided	0.0	3.4	1.3
65	1.6	Avoided	0.0	3.2	1.1
65	1.7	Collision	9.7	2.9	0.0
65	1.8	Collision	31.0	2.7	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	3.7	1.6
70	1.5	Avoided	0.0	3.4	1.3
70	1.6	Avoided	0.0	3.2	3.4
70	1.7	Collision	10.8	3.0	0.0
70	1.8	Collision	32.4	2.8	0.0

Table A.42: Driver 2 with 600 ms latency for vcp_3.

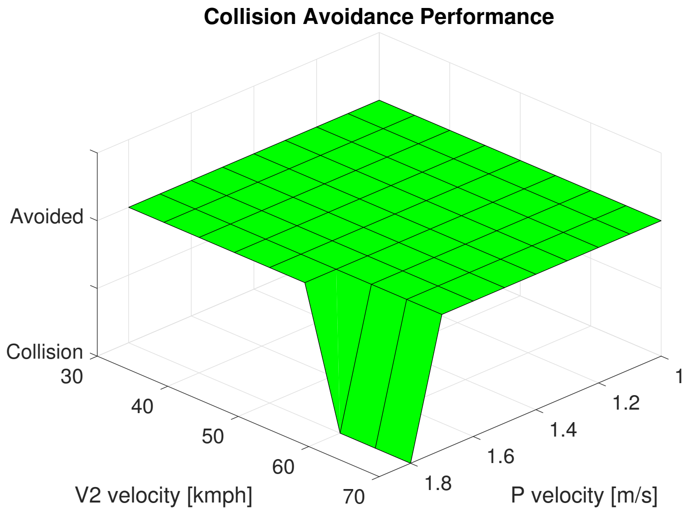
V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.1	1.7
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.3	1.5
35	1.8	Avoided	0.0	3.2	1.2
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.4	1.2
40	1.8	Avoided	0.0	3.3	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.5	1.2
45	1.8	Avoided	0.0	3.3	1.2
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.7	1.1
50	1.7	Avoided	0.0	3.5	1.1
50	1.8	Avoided	0.0	3.3	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.7	1.1
55	1.7	Avoided	0.0	3.6	1.1
55	1.8	Avoided	0.0	3.3	1.0
60	1.0	Avoided	0.0	3.8	1.2

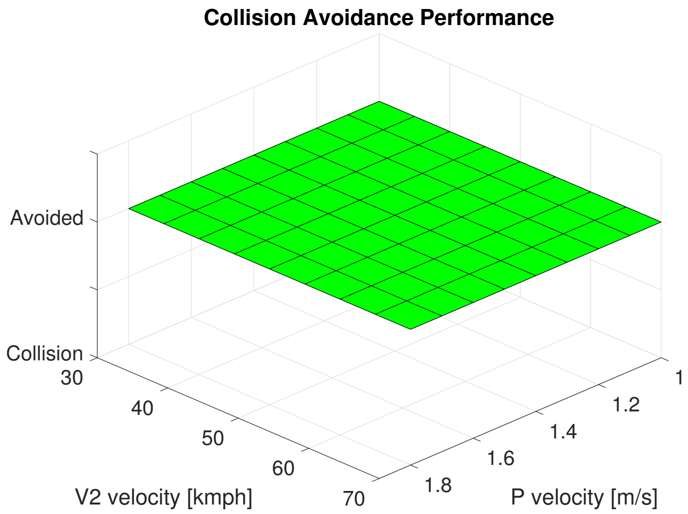
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.9	1.2
60	1.6	Avoided	0.0	3.8	1.2
60	1.7	Avoided	0.0	3.5	1.1
60	1.8	Avoided	0.0	3.3	0.9
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	4.0	1.4
65	1.6	Avoided	0.0	3.8	1.4
65	1.7	Avoided	0.0	3.5	1.1
65	1.8	Avoided	0.0	3.3	0.8
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	3.8	1.4
70	1.7	Avoided	0.0	3.5	1.0
70	1.8	Avoided	0.0	3.3	0.7



(a) vcp_2

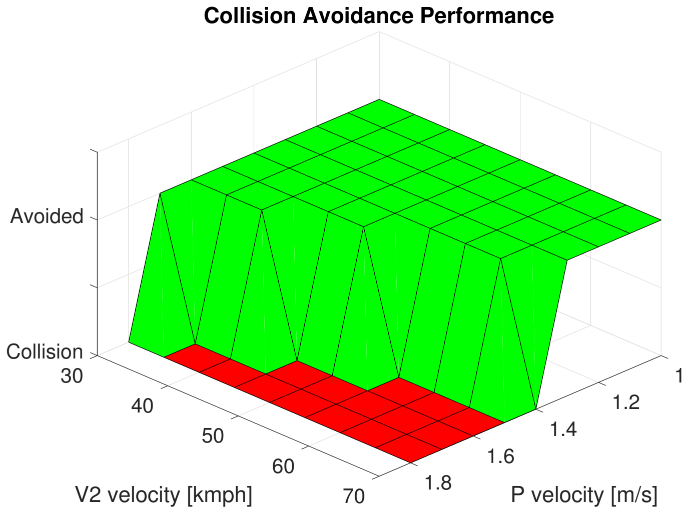


(b) vcp_2

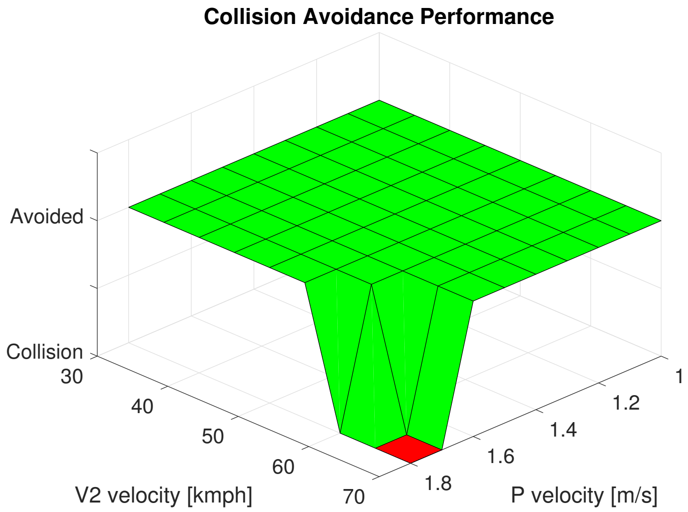


(c) vcp_3

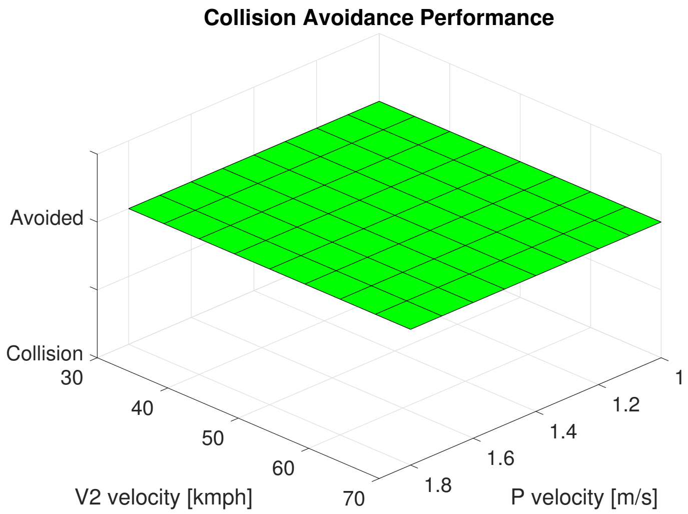
Figure A.11: Performance of concept with driver 1 with a latency of 600 ms.



(a) vcp$_1$



(b) vcp$_2$



(c) vcp$_3$

Figure A.12: Performance of concept with driver 2 with a latency of 600 ms.

A.1.8 700 ms Communication Latency

Table A.43: Driver 1 with 700 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.5	1.4
30	1.7	Collision	7.2	2.3	0.0
30	1.8	Avoided	0.0	2.2	0.3
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.6	1.6
35	1.6	Avoided	0.0	2.5	1.1
35	1.7	Collision	13.3	2.3	0.0
35	1.8	Collision	13.5	2.1	0.0
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.8	1.6
40	1.5	Avoided	0.0	2.7	1.3
40	1.6	Avoided	0.0	2.5	0.2
40	1.7	Collision	21.8	2.3	0.0
40	1.8	Collision	21.0	2.1	0.0
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	2.9	1.8
45	1.5	Avoided	0.0	2.7	1.2
45	1.6	Collision	19.0	2.4	0.0
45	1.7	Collision	31.2	2.2	0.0
45	1.8	Collision	26.2	2.1	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9

50	1.4	Avoided	0.0	2.9	1.5
50	1.5	Avoided	0.0	2.7	0.7
50	1.6	Collision	21.9	2.5	0.0
50	1.7	Collision	34.1	2.3	0.0
50	1.8	Collision	33.1	2.1	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.1	1.8
55	1.4	Avoided	0.0	3.0	1.3
55	1.5	Collision	12.5	2.7	0.0
55	1.6	Collision	29.7	2.5	0.0
55	1.7	Collision	32.4	2.3	0.0
55	1.8	Collision	38.6	2.1	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.2	2.0
60	1.4	Avoided	0.0	2.9	0.9
60	1.5	Collision	16.6	2.7	0.0
60	1.6	Collision	38.3	2.4	0.0
60	1.7	Collision	39.6	2.2	0.0
60	1.8	Collision	42.7	2.1	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.2	1.9
65	1.4	Avoided	0.0	2.9	0.5
65	1.5	Collision	27.0	2.7	0.0
65	1.6	Collision	45.1	2.4	0.0
65	1.7	Collision	42.3	2.3	0.0
65	1.8	Collision	48.7	2.1	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.1
70	1.3	Avoided	0.0	3.2	1.1
70	1.4	Collision	16.8	2.9	0.0
70	1.5	Collision	34.8	2.7	0.0
70	1.6	Collision	46.2	2.5	0.0
70	1.7	Collision	48.6	2.3	0.0
70	1.8	Collision	54.1	2.1	0.0

Table A.44: Driver 1 with 700 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.6	1.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.7
35	1.8	Avoided	0.0	2.6	1.6
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.8	1.7
40	1.8	Avoided	0.0	2.7	1.3
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	3.0	1.9
45	1.7	Avoided	0.0	2.8	1.7
45	1.8	Avoided	0.0	2.6	1.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.0	1.9

50	1.7	Avoided	0.0	2.9	1.5
50	1.8	Avoided	0.0	2.7	0.8
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.2	1.9
55	1.6	Avoided	0.0	3.1	1.8
55	1.7	Avoided	0.0	2.9	1.1
55	1.8	Collision	12.5	2.7	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.2	2.0
60	1.6	Avoided	0.0	3.1	1.9
60	1.7	Avoided	0.0	2.8	0.5
60	1.8	Collision	25.9	2.6	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.3	2.0
65	1.6	Avoided	0.0	3.1	1.2
65	1.7	Collision	17.1	2.8	0.0
65	1.8	Collision	34.1	2.6	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.3	1.9
70	1.6	Avoided	0.0	3.1	0.7
70	1.7	Collision	16.8	2.9	0.0
70	1.8	Collision	34.8	2.7	0.0

Table A.45: Driver 1 with 700 ms latency for vcp_3.

V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.46: Driver 2 with 700 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.0	1.4

30	1.5	Avoided	0.0	2.8	1.3
30	1.6	Avoided	0.0	2.5	1.0
30	1.7	Collision	12.3	2.3	0.0
30	1.8	Collision	5.7	2.2	0.0
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.2	1.4
35	1.4	Avoided	0.0	3.0	1.4
35	1.5	Avoided	0.0	2.7	1.1
35	1.6	Avoided	0.0	2.5	0.8
35	1.7	Collision	16.5	2.3	0.0
35	1.8	Collision	17.3	2.1	0.0
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.2	1.4
40	1.4	Avoided	0.0	3.0	1.3
40	1.5	Avoided	0.0	2.7	1.9
40	1.6	Collision	6.9	2.5	0.0
40	1.7	Collision	23.9	2.3	0.0
40	1.8	Collision	23.9	2.1	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.2	1.4
45	1.4	Avoided	0.0	2.9	1.0
45	1.5	Avoided	0.0	2.7	1.4
45	1.6	Collision	22.6	2.4	0.0
45	1.7	Collision	33.6	2.2	0.0
45	1.8	Collision	29.1	2.1	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.6	1.4
50	1.3	Avoided	0.0	3.2	1.3
50	1.4	Avoided	0.0	2.9	2.4
50	1.5	Avoided	0.0	2.7	0.0
50	1.6	Collision	25.5	2.5	0.0
50	1.7	Collision	36.4	2.3	0.0
50	1.8	Collision	35.7	2.1	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.7	1.4
55	1.2	Avoided	0.0	3.6	1.4
55	1.3	Avoided	0.0	3.2	1.1

55	1.4	Avoided	0.0	3.0	2.3
55	1.5	Collision	18.8	2.7	0.0
55	1.6	Collision	33.1	2.5	0.0
55	1.7	Collision	35.9	2.3	0.0
55	1.8	Collision	40.9	2.1	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.8	1.4
60	1.2	Avoided	0.0	3.5	1.4
60	1.3	Avoided	0.0	3.2	1.2
60	1.4	Avoided	0.0	2.9	0.6
60	1.5	Collision	23.1	2.7	0.0
60	1.6	Collision	41.4	2.4	0.0
60	1.7	Collision	42.5	2.2	0.0
60	1.8	Collision	45.2	2.1	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	3.9	1.7
65	1.2	Avoided	0.0	3.5	1.4
65	1.3	Avoided	0.0	3.2	1.1
65	1.4	Collision	14.2	2.9	0.0
65	1.5	Collision	31.0	2.7	0.0
65	1.6	Collision	47.4	2.4	0.0
65	1.7	Collision	45.6	2.3	0.0
65	1.8	Collision	51.1	2.1	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	3.6	1.4
70	1.3	Avoided	0.0	3.2	1.4
70	1.4	Collision	25.8	2.9	0.0
70	1.5	Collision	38.8	2.7	0.0
70	1.6	Collision	49.5	2.5	0.0
70	1.7	Collision	51.7	2.3	0.0
70	1.8	Collision	56.4	2.1	0.0

Table A.47: Driver 2 with 700 ms latency for vcp_2.

$\mathbf{V_2}$ **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	$\mathbf{V_I}$ **[kmph]**	$\mathbf{TTC_W}$ **[s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.0	1.4
30	1.7	Avoided	0.0	2.9	1.4

30	1.8	Avoided	0.0	2.7	1.2
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.3	1.6
35	1.6	Avoided	0.0	1.9	0.7
35	1.7	Avoided	0.0	2.9	1.4
35	1.8	Avoided	0.0	2.7	1.1
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.3	1.4
40	1.6	Avoided	0.0	3.1	1.4
40	1.7	Avoided	0.0	2.9	1.2
40	1.8	Avoided	0.0	2.7	2.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.3	1.4
45	1.6	Avoided	0.0	3.1	1.3
45	1.7	Avoided	0.0	2.8	2.7
45	1.8	Avoided	0.0	2.6	0.3
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.6	1.4
50	1.5	Avoided	0.0	3.4	1.4
50	1.6	Avoided	0.0	3.1	1.1
50	1.7	Avoided	0.0	2.9	2.8
50	1.8	Avoided	0.0	2.7	0.0
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.8	1.4
55	1.4	Avoided	0.0	3.7	1.4
55	1.5	Avoided	0.0	3.4	1.3
55	1.6	Avoided	0.0	3.1	1.2

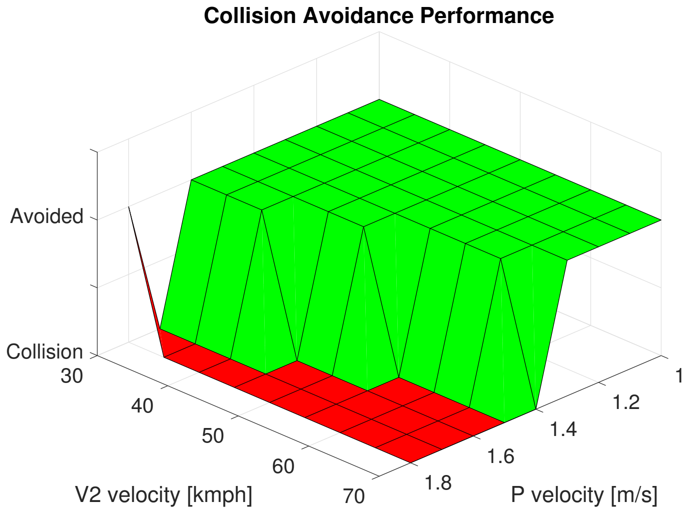
55	1.7	Avoided	0.0	2.9	1.6
55	1.8	Collision	18.8	2.7	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.8	1.5
60	1.4	Avoided	0.0	3.6	1.4
60	1.5	Avoided	0.0	3.3	1.2
60	1.6	Avoided	0.0	3.1	1.2
60	1.7	Collision	11.4	2.8	0.0
60	1.8	Collision	30.3	2.6	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	3.9	1.7
65	1.4	Avoided	0.0	3.6	1.5
65	1.5	Avoided	0.0	3.3	1.0
65	1.6	Avoided	0.0	3.1	3.2
65	1.7	Collision	23.0	2.8	0.0
65	1.8	Collision	37.3	2.6	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	4.0	1.8
70	1.4	Avoided	0.0	3.6	1.4
70	1.5	Avoided	0.0	3.3	1.0
70	1.6	Avoided	0.0	3.1	1.4
70	1.7	Collision	24.1	2.9	0.0
70	1.8	Collision	38.8	2.7	0.0

Table A.48: Driver 2 with 700 ms latency for vcp_3.

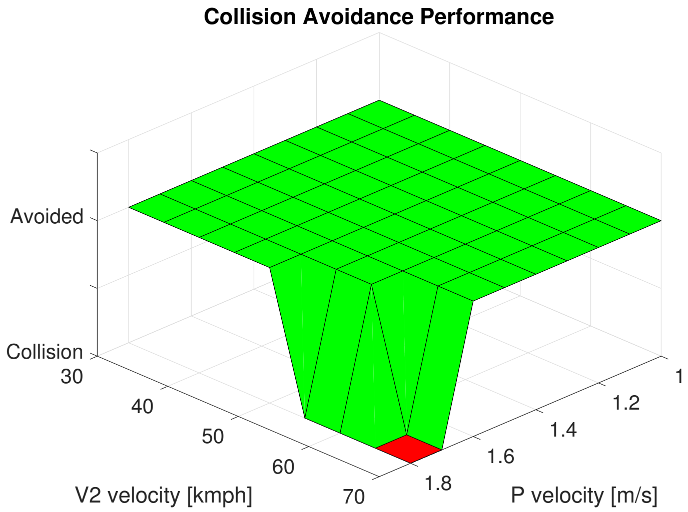
V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.0	1.3
30	1.5	Avoided	0.0	3.0	1.3
30	1.6	Avoided	0.0	3.0	1.3
30	1.7	Avoided	0.0	3.0	1.3
30	1.8	Avoided	0.0	3.0	1.3
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.2	1.2
35	1.4	Avoided	0.0	3.2	1.2
35	1.5	Avoided	0.0	3.2	1.2
35	1.6	Avoided	0.0	3.2	1.2
35	1.7	Avoided	0.0	3.2	1.2
35	1.8	Avoided	0.0	3.2	1.2
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.3	1.2
40	1.4	Avoided	0.0	3.3	1.2
40	1.5	Avoided	0.0	3.3	1.2
40	1.6	Avoided	0.0	3.3	1.2
40	1.7	Avoided	0.0	3.3	1.2
40	1.8	Avoided	0.0	3.3	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.2
45	1.3	Avoided	0.0	3.5	1.2
45	1.4	Avoided	0.0	3.5	1.2
45	1.5	Avoided	0.0	3.5	1.2
45	1.6	Avoided	0.0	3.5	1.2
45	1.7	Avoided	0.0	3.5	1.2
45	1.8	Avoided	0.0	3.5	1.2
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.6	1.1
50	1.2	Avoided	0.0	3.6	1.1
50	1.3	Avoided	0.0	3.6	1.1
50	1.4	Avoided	0.0	3.6	1.1
50	1.5	Avoided	0.0	3.6	1.1
50	1.6	Avoided	0.0	3.6	1.1
50	1.7	Avoided	0.0	3.6	1.1
50	1.8	Avoided	0.0	3.5	1.1
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.7	1.1
55	1.2	Avoided	0.0	3.7	1.1
55	1.3	Avoided	0.0	3.7	1.1
55	1.4	Avoided	0.0	3.7	1.1
55	1.5	Avoided	0.0	3.7	1.1
55	1.6	Avoided	0.0	3.7	1.1
55	1.7	Avoided	0.0	3.7	1.1
55	1.8	Avoided	0.0	3.5	1.1
60	1.0	Avoided	0.0	3.8	1.2

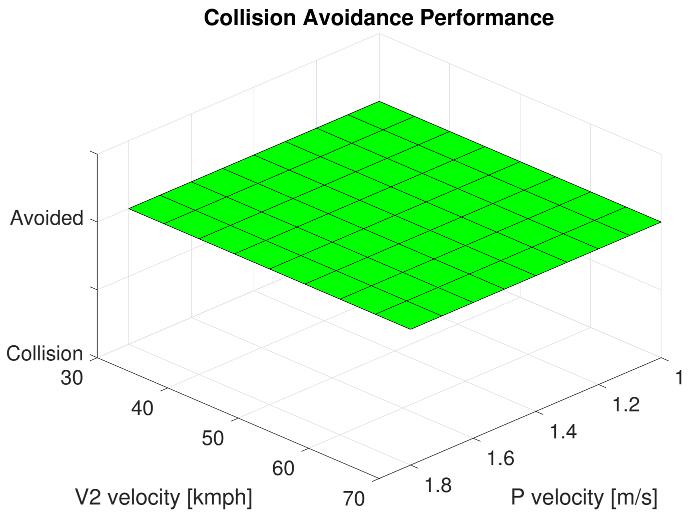
60	1.1	Avoided	0.0	3.8	1.2
60	1.2	Avoided	0.0	3.8	1.2
60	1.3	Avoided	0.0	3.8	1.2
60	1.4	Avoided	0.0	3.8	1.2
60	1.5	Avoided	0.0	3.8	1.2
60	1.6	Avoided	0.0	3.8	1.2
60	1.7	Avoided	0.0	3.7	1.2
60	1.8	Avoided	0.0	3.5	1.1
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	3.9	1.4
65	1.2	Avoided	0.0	3.9	1.4
65	1.3	Avoided	0.0	3.9	1.4
65	1.4	Avoided	0.0	3.9	1.4
65	1.5	Avoided	0.0	3.9	1.4
65	1.6	Avoided	0.0	3.9	1.4
65	1.7	Avoided	0.0	3.7	1.3
65	1.8	Avoided	0.0	3.5	1.1
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	4.0	1.5
70	1.6	Avoided	0.0	4.0	1.5
70	1.7	Avoided	0.0	3.7	1.3
70	1.8	Avoided	0.0	3.5	1.0



(a) vcp_2

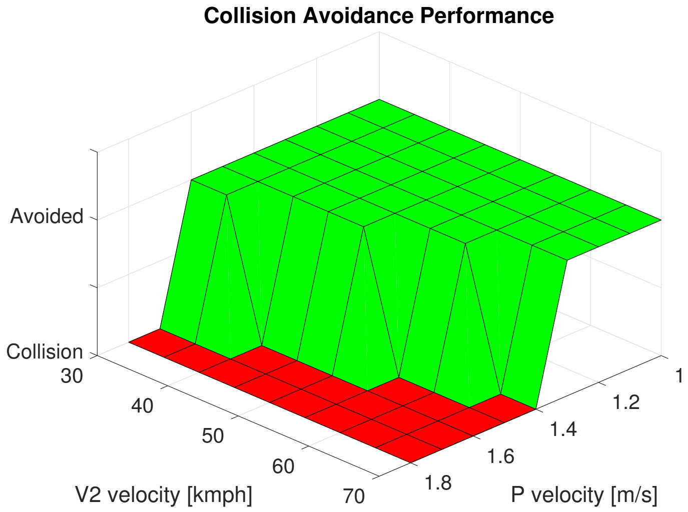


(b) vcp_2

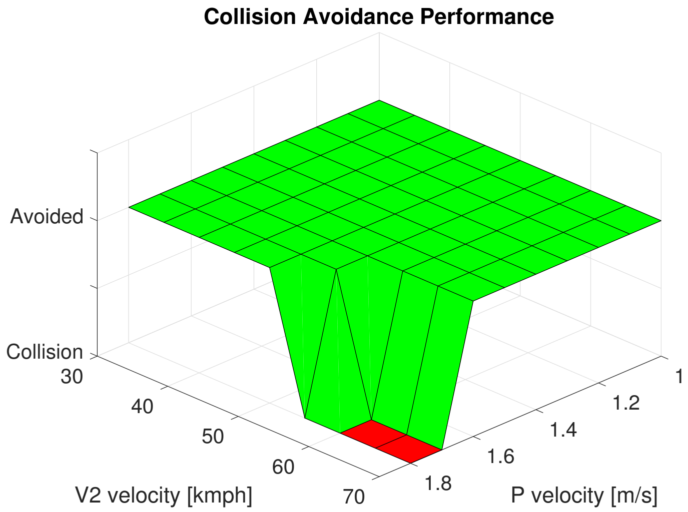


(c) vcp_3

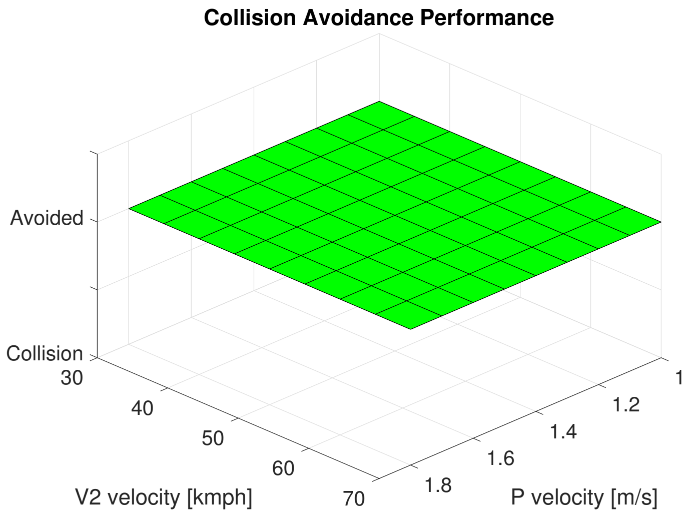
Figure A.13: Performance of concept with driver 1 with a latency of 700 ms.



(a) vcp_1



(b) vcp_2



(c) vcp_3

Figure A.14: Performance of concept with driver 2 with a latency of 700 ms.

A.1.9 800 ms Communication Latency

Table A.49: Driver 1 with 800 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.5	1.3
30	1.6	Avoided	0.0	2.4	0.5
30	1.7	Avoided	0.0	2.2	0.3
30	1.8	Collision	5.5	2.1	0.0
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.6
35	1.5	Avoided	0.0	2.6	1.3
35	1.6	Avoided	0.0	2.4	0.2
35	1.7	Collision	20.8	2.2	0.0
35	1.8	Collision	17.3	2.0	0.0
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.8	1.6
40	1.5	Avoided	0.0	2.6	1.3
40	1.6	Collision	14.4	2.4	0.0
40	1.7	Collision	16.3	2.2	0.0
40	1.8	Collision	23.9	2.0	0.0
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	2.8	1.7
45	1.5	Avoided	0.0	2.6	0.9
45	1.6	Collision	25.6	2.3	0.0
45	1.7	Collision	25.5	2.1	0.0
45	1.8	Collision	28.9	2.0	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.0	1.8

50	1.4	Avoided	0.0	2.8	1.1
50	1.5	Collision	12.0	2.6	0.0
50	1.6	Collision	28.3	2.4	0.0
50	1.7	Collision	29.0	2.2	0.0
50	1.8	Collision	35.5	2.0	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.1	1.8
55	1.4	Avoided	0.0	2.9	1.1
55	1.5	Collision	22.7	2.6	0.0
55	1.6	Collision	35.5	2.4	0.0
55	1.7	Collision	35.5	2.2	0.0
55	1.8	Collision	40.9	2.0	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.1	1.9
60	1.4	Avoided	0.0	2.8	0.5
60	1.5	Collision	25.9	2.6	0.0
60	1.6	Collision	43.6	2.3	0.0
60	1.7	Collision	42.2	2.1	0.0
60	1.8	Collision	45.0	2.0	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.3	2.0
65	1.3	Avoided	0.0	3.1	1.2
65	1.4	Collision	17.1	2.8	0.0
65	1.5	Collision	34.1	2.6	0.0
65	1.6	Collision	41.8	2.3	0.0
65	1.7	Collision	45.2	2.2	0.0
65	1.8	Collision	50.9	2.0	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.1
70	1.3	Avoided	0.0	3.1	0.7
70	1.4	Collision	27.3	2.8	0.0
70	1.5	Collision	41.1	2.6	0.0
70	1.6	Collision	51.3	2.4	0.0
70	1.7	Collision	51.2	2.2	0.0
70	1.8	Collision	56.2	2.0	0.0

Table A.50: Driver 1 with 800 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.5	1.3
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.7	1.6
35	1.8	Avoided	0.0	2.6	1.3
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.9	1.8
40	1.7	Avoided	0.0	2.8	1.7
40	1.8	Avoided	0.0	2.6	1.3
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	2.9	1.8
45	1.7	Avoided	0.0	2.7	1.2
45	1.8	Collision	7.7	2.5	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	3.0	1.9

50	1.7	Avoided	0.0	2.8	1.2
50	1.8	Collision	12.0	2.6	0.0
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.1	1.9
55	1.6	Avoided	0.0	3.0	1.3
55	1.7	Avoided	0.0	2.8	0.8
55	1.8	Collision	22.7	2.6	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.2	2.0
60	1.6	Avoided	0.0	3.0	1.2
60	1.7	Collision	16.6	2.7	0.0
60	1.8	Collision	32.8	2.5	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.4	2.0
65	1.5	Avoided	0.0	3.2	1.9
65	1.6	Avoided	0.0	3.0	0.8
65	1.7	Collision	27.0	2.7	0.0
65	1.8	Collision	39.8	2.5	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.2	1.1
70	1.6	Avoided	0.0	3.0	0.7
70	1.7	Collision	27.3	2.8	0.0
70	1.8	Collision	41.1	2.6	0.0

Table A.51: Driver 1 with 800 ms latency for vcp_3.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.4	1.9

Table A.52: Driver 2 with 800 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.0	1.4
30	1.4	Avoided	0.0	2.9	1.4

30	1.5	Avoided	0.0	2.7	1.2
30	1.6	Avoided	0.0	2.4	0.1
30	1.7	Collision	2.7	2.2	0.0
30	1.8	Collision	11.0	2.1	0.0
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.3	1.5
35	1.3	Avoided	0.0	3.1	1.4
35	1.4	Avoided	0.0	2.9	1.4
35	1.5	Avoided	0.0	2.6	1.7
35	1.6	Collision	6.0	2.4	0.0
35	1.7	Collision	22.6	2.2	0.0
35	1.8	Collision	19.8	2.0	0.0
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.3	1.4
40	1.3	Avoided	0.0	3.1	1.4
40	1.4	Avoided	0.0	2.9	1.2
40	1.5	Avoided	0.0	2.6	0.9
40	1.6	Collision	17.8	2.4	0.0
40	1.7	Collision	20.4	2.2	0.0
40	1.8	Collision	26.1	2.0	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.4	1.4
45	1.3	Avoided	0.0	3.1	1.3
45	1.4	Avoided	0.0	2.8	2.5
45	1.5	Avoided	0.0	2.6	0.3
45	1.6	Collision	28.2	2.3	0.0
45	1.7	Collision	28.3	2.1	0.0
45	1.8	Collision	31.2	2.0	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.5	1.4
50	1.3	Avoided	0.0	3.1	1.1
50	1.4	Avoided	0.0	2.8	1.3
50	1.5	Collision	17.5	2.6	0.0
50	1.6	Collision	31.2	2.4	0.0
50	1.7	Collision	32.0	2.2	0.0
50	1.8	Collision	37.6	2.0	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.7	1.4
55	1.2	Avoided	0.0	3.5	1.4
55	1.3	Avoided	0.0	3.1	1.2

55	1.4	Avoided	0.0	2.9	1.2
55	1.5	Collision	26.6	2.6	0.0
55	1.6	Collision	37.9	2.4	0.0
55	1.7	Collision	38.3	2.2	0.0
55	1.8	Collision	42.8	2.0	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.8	1.4
60	1.2	Avoided	0.0	3.4	1.3
60	1.3	Avoided	0.0	3.1	1.1
60	1.4	Collision	12.5	2.8	0.0
60	1.5	Collision	30.3	2.6	0.0
60	1.6	Collision	46.5	2.3	0.0
60	1.7	Collision	44.5	2.1	0.0
60	1.8	Collision	47.1	2.0	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	3.8	1.6
65	1.2	Avoided	0.0	3.4	1.2
65	1.3	Avoided	0.0	3.1	2.1
65	1.4	Collision	23.0	2.8	0.0
65	1.5	Collision	37.3	2.6	0.0
65	1.6	Collision	45.1	2.3	0.0
65	1.7	Collision	47.8	2.2	0.0
65	1.8	Collision	52.9	2.0	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	3.9	1.7
70	1.2	Avoided	0.0	3.5	1.2
70	1.3	Avoided	0.0	3.1	0.4
70	1.4	Collision	32.4	2.8	0.0
70	1.5	Collision	44.7	2.6	0.0
70	1.6	Collision	54.1	2.4	0.0
70	1.7	Collision	53.8	2.2	0.0
70	1.8	Collision	58.1	2.0	0.0

Table A.53: Driver 2 with 800 ms latency for vcp_2.

V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.1	1.8
30	1.6	Avoided	0.0	3.0	1.4
30	1.7	Avoided	0.0	2.8	1.3

30	1.8	Avoided	0.0	2.6	1.8
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.2	1.4
35	1.6	Avoided	0.0	3.0	1.4
35	1.7	Avoided	0.0	2.8	1.3
35	1.8	Avoided	0.0	2.6	1.7
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.3	1.4
40	1.6	Avoided	0.0	3.0	1.3
40	1.7	Avoided	0.0	2.8	1.2
40	1.8	Avoided	0.0	2.6	0.9
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.5	1.4
45	1.5	Avoided	0.0	3.2	1.4
45	1.6	Avoided	0.0	3.0	1.2
45	1.7	Avoided	0.0	2.7	1.6
45	1.8	Collision	14.1	2.5	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.6	1.4
50	1.5	Avoided	0.0	3.3	1.4
50	1.6	Avoided	0.0	3.0	1.3
50	1.7	Avoided	0.0	2.8	1.4
50	1.8	Collision	17.5	2.6	0.0
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.7	1.4
55	1.4	Avoided	0.0	3.6	1.4
55	1.5	Avoided	0.0	3.3	1.2
55	1.6	Avoided	0.0	3.0	3.1

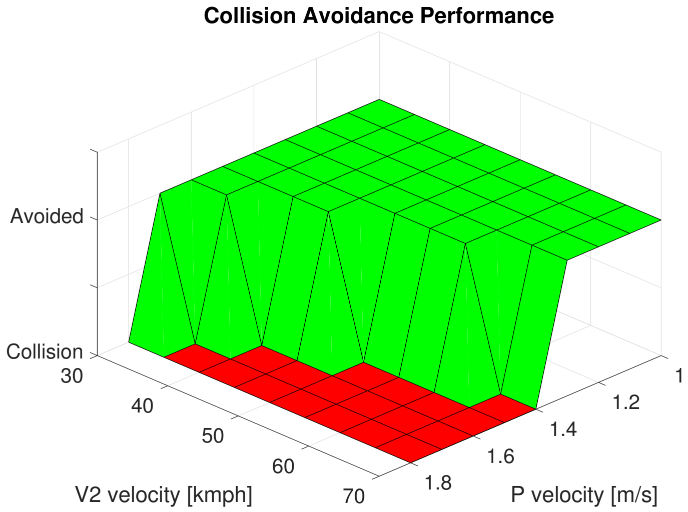
55	1.7	Avoided	0.0	2.8	0.0
55	1.8	Collision	26.6	2.6	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.8	1.5
60	1.4	Avoided	0.0	3.5	1.4
60	1.5	Avoided	0.0	3.2	1.3
60	1.6	Avoided	0.0	3.0	2.7
60	1.7	Collision	23.1	2.7	0.0
60	1.8	Collision	36.7	2.5	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	3.9	1.7
65	1.4	Avoided	0.0	3.5	1.4
65	1.5	Avoided	0.0	3.2	1.1
65	1.6	Avoided	0.0	3.0	1.4
65	1.7	Collision	31.0	2.7	0.0
65	1.8	Collision	42.9	2.5	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	3.9	1.8
70	1.4	Avoided	0.0	3.5	1.3
70	1.5	Avoided	0.0	3.2	3.4
70	1.6	Collision	10.8	3.0	0.0
70	1.7	Collision	32.4	2.8	0.0
70	1.8	Collision	44.7	2.6	0.0

Table A.54: Driver 2 with 800 ms latency for vcp_3.

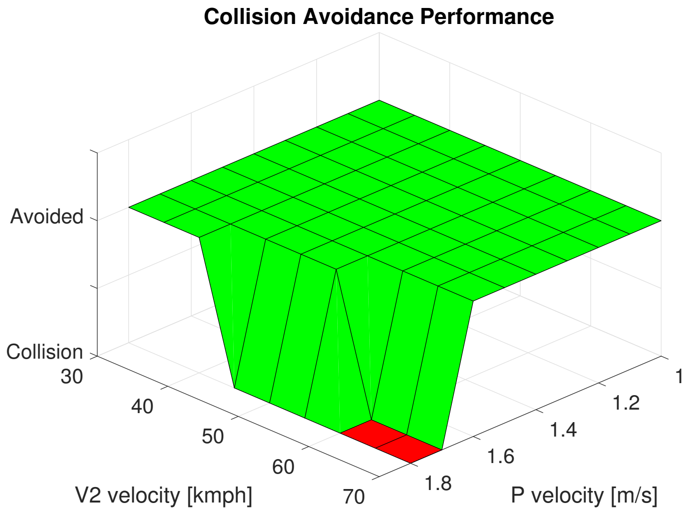
V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.0	1.3
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.2	1.2
35	1.8	Avoided	0.0	3.2	1.2
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.3	1.2
40	1.8	Avoided	0.0	3.1	1.2
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.1
45	1.7	Avoided	0.0	3.3	1.2
45	1.8	Avoided	0.0	3.1	1.1
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.6	1.1
50	1.7	Avoided	0.0	3.3	1.1
50	1.8	Avoided	0.0	3.1	0.9
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.8	1.1
55	1.6	Avoided	0.0	3.6	1.1
55	1.7	Avoided	0.0	3.4	1.1
55	1.8	Avoided	0.0	3.1	1.0
60	1.0	Avoided	0.0	3.8	1.2

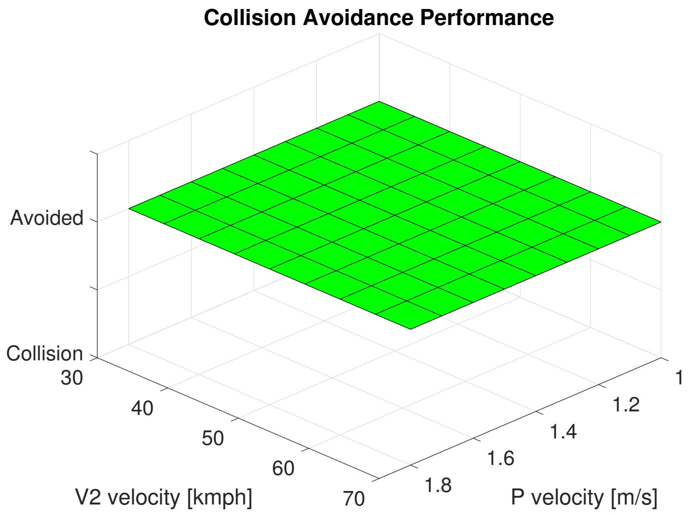
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.8	1.2
60	1.6	Avoided	0.0	3.6	1.1
60	1.7	Avoided	0.0	3.3	0.9
60	1.8	Avoided	0.0	3.1	0.8
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	3.9	1.4
65	1.6	Avoided	0.0	3.6	1.2
65	1.7	Avoided	0.0	3.3	0.8
65	1.8	Avoided	0.0	3.1	3.0
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	3.9	1.5
70	1.6	Avoided	0.0	3.6	1.2
70	1.7	Avoided	0.0	3.3	0.7
70	1.8	Avoided	0.0	3.1	1.6



(a) vcp_2

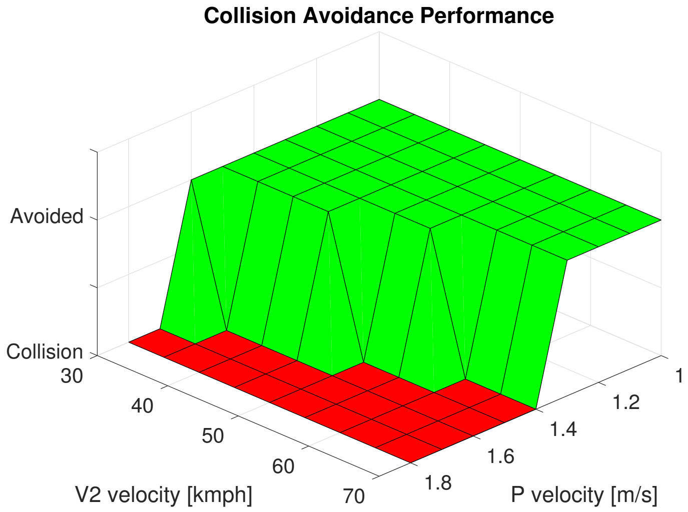


(b) vcp_2

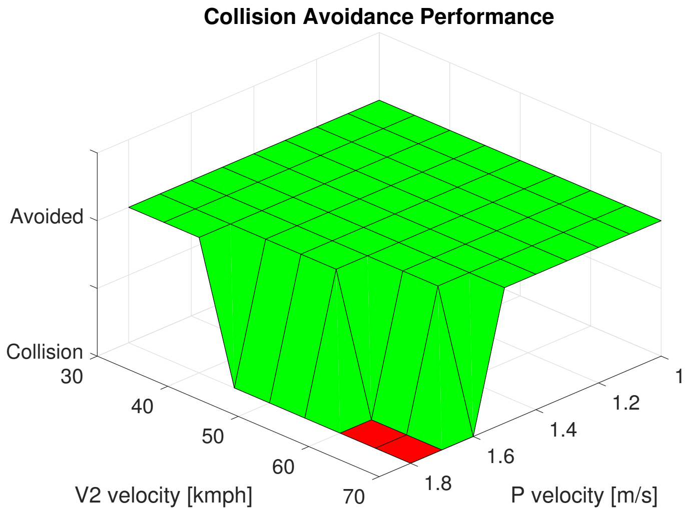


(c) vcp_3

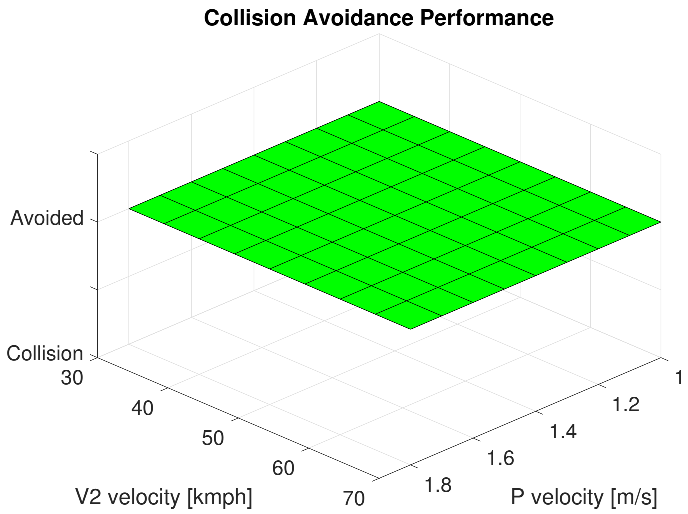
Figure A.15: Performance of concept with driver 1 with a latency of 800 ms.



(a) vcp$_1$



(b) vcp$_2$



(c) vcp$_3$

Figure A.16: Performance of concept with driver 2 with a latency of 800 ms.

A.1.10 900 ms Communication Latency

Table A.55: Driver 1 with 900 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.5	1.4
30	1.6	Collision	7.2	2.3	0.0
30	1.7	Collision	2.6	2.1	0.0
30	1.8	Collision	22.4	1.1	0.0
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.6	1.5
35	1.5	Avoided	0.0	2.5	1.1
35	1.6	Collision	13.3	2.3	0.0
35	1.7	Collision	12.4	2.1	0.0
35	1.8	Collision	20.0	1.9	0.0
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.7
40	1.4	Avoided	0.0	2.8	1.6
40	1.5	Avoided	0.0	2.5	0.2
40	1.6	Collision	21.8	2.3	0.0
40	1.7	Collision	20.2	2.1	0.0
40	1.8	Collision	26.3	1.9	0.0
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	2.9	1.8
45	1.4	Avoided	0.0	2.7	1.2
45	1.5	Collision	7.7	2.5	0.0
45	1.6	Collision	31.2	2.2	0.0
45	1.7	Collision	28.3	2.0	0.0
45	1.8	Collision	31.3	1.9	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.0	1.8

50	1.4	Avoided	0.0	2.7	0.7
50	1.5	Collision	21.9	2.5	0.0
50	1.6	Collision	34.1	2.3	0.0
50	1.7	Collision	31.9	2.1	0.0
50	1.8	Collision	37.6	1.9	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.1	1.9
55	1.3	Avoided	0.0	3.0	1.3
55	1.4	Avoided	0.0	2.8	0.8
55	1.5	Collision	29.7	2.5	0.0
55	1.6	Collision	31.1	2.3	0.0
55	1.7	Collision	38.0	2.1	0.0
55	1.8	Collision	42.9	1.9	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.2	2.0
60	1.3	Avoided	0.0	3.0	1.2
60	1.4	Collision	16.6	2.7	0.0
60	1.5	Collision	32.8	2.5	0.0
60	1.6	Collision	39.0	2.2	0.0
60	1.7	Collision	44.5	2.0	0.0
60	1.8	Collision	47.1	1.9	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.3	2.0
65	1.3	Avoided	0.0	3.0	0.8
65	1.4	Collision	27.0	2.7	0.0
65	1.5	Collision	39.8	2.5	0.0
65	1.6	Collision	44.6	2.2	0.0
65	1.7	Collision	47.6	2.1	0.0
65	1.8	Collision	52.9	1.9	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.1
70	1.3	Avoided	0.0	3.0	0.7
70	1.4	Collision	34.8	2.7	0.0
70	1.5	Collision	46.2	2.5	0.0
70	1.6	Collision	47.5	2.3	0.0
70	1.7	Collision	53.6	2.1	0.0
70	1.8	Collision	58.1	1.9	0.0

Table A.56: Driver 1 with 900 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.6	1.6
30	1.8	Avoided	0.0	2.5	1.4
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.7
35	1.7	Avoided	0.0	2.6	1.6
35	1.8	Avoided	0.0	2.5	1.1
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.8	1.7
40	1.7	Avoided	0.0	2.7	1.3
40	1.8	Avoided	0.0	2.5	0.2
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	3.0	1.9
45	1.6	Avoided	0.0	2.9	1.8
45	1.7	Avoided	0.0	2.6	1.0
45	1.8	Collision	19.0	2.4	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.1	1.9
50	1.6	Avoided	0.0	2.9	1.5

50	1.7	Avoided	0.0	2.7	0.8
50	1.8	Collision	21.9	2.5	0.0
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.1	1.9
55	1.6	Avoided	0.0	2.9	1.1
55	1.7	Collision	12.5	2.7	0.0
55	1.8	Collision	29.7	2.5	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.3	2.0
60	1.5	Avoided	0.0	3.1	1.9
60	1.6	Avoided	0.0	2.9	0.9
60	1.7	Collision	25.9	2.6	0.0
60	1.8	Collision	38.3	2.4	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.3	2.0
65	1.5	Avoided	0.0	3.1	1.2
65	1.6	Avoided	0.0	2.9	0.5
65	1.7	Collision	34.1	2.6	0.0
65	1.8	Collision	45.1	2.4	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.4	2.2
70	1.5	Avoided	0.0	3.1	0.7
70	1.6	Collision	16.8	2.9	0.0
70	1.7	Collision	34.8	2.7	0.0
70	1.8	Collision	46.2	2.5	0.0

Table A.57: Driver 1 with 900 ms latency for vcp_3.

V_2 **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	V_I **[kmph]**	TTC_W **[s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.3	1.7
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.3	1.8

Table A.58: Driver 2 with 900 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.7
30	1.1	Avoided	0.0	3.1	1.7
30	1.2	Avoided	0.0	3.1	1.7
30	1.3	Avoided	0.0	3.0	1.4
30	1.4	Avoided	0.0	2.8	1.3

30	1.5	Avoided	0.0	2.6	1.8
30	1.6	Collision	12.3	2.3	0.0
30	1.7	Collision	9.5	2.1	0.0
30	1.8	Collision	22.4	1.1	0.0
35	1.0	Avoided	0.0	3.3	1.5
35	1.1	Avoided	0.0	3.3	1.5
35	1.2	Avoided	0.0	3.2	1.4
35	1.3	Avoided	0.0	3.0	1.4
35	1.4	Avoided	0.0	2.8	1.2
35	1.5	Avoided	0.0	2.5	0.7
35	1.6	Collision	16.5	2.3	0.0
35	1.7	Collision	16.3	2.1	0.0
35	1.8	Collision	21.9	1.9	0.0
40	1.0	Avoided	0.0	3.4	1.3
40	1.1	Avoided	0.0	3.4	1.3
40	1.2	Avoided	0.0	3.3	1.4
40	1.3	Avoided	0.0	3.0	1.3
40	1.4	Avoided	0.0	2.8	1.2
40	1.5	Collision	6.9	2.5	0.0
40	1.6	Collision	23.9	2.3	0.0
40	1.7	Collision	23.1	2.1	0.0
40	1.8	Collision	28.0	1.9	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.3
45	1.2	Avoided	0.0	3.3	1.4
45	1.3	Avoided	0.0	3.0	1.2
45	1.4	Avoided	0.0	2.7	1.6
45	1.5	Collision	14.1	2.5	0.0
45	1.6	Collision	33.6	2.2	0.0
45	1.7	Collision	30.4	2.0	0.0
45	1.8	Collision	33.1	1.9	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.6	1.4
50	1.2	Avoided	0.0	3.4	1.4
50	1.3	Avoided	0.0	3.0	1.2
50	1.4	Avoided	0.0	2.7	0.0
50	1.5	Collision	25.5	2.5	0.0
50	1.6	Collision	36.4	2.3	0.0
50	1.7	Collision	34.2	2.1	0.0
50	1.8	Collision	39.3	1.9	0.0
55	1.0	Avoided	0.0	3.8	1.3
55	1.1	Avoided	0.0	3.7	1.4
55	1.2	Avoided	0.0	3.4	1.3
55	1.3	Avoided	0.0	3.0	2.5

55	1.4	Avoided	0.0	2.8	0.0
55	1.5	Collision	33.1	2.5	0.0
55	1.6	Collision	34.6	2.3	0.0
55	1.7	Collision	40.2	2.1	0.0
55	1.8	Collision	44.3	1.9	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.7	1.4
60	1.2	Avoided	0.0	3.3	1.2
60	1.3	Avoided	0.0	3.0	2.0
60	1.4	Collision	23.1	2.7	0.0
60	1.5	Collision	36.7	2.5	0.0
60	1.6	Collision	41.9	2.2	0.0
60	1.7	Collision	46.4	2.0	0.0
60	1.8	Collision	48.7	1.9	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	3.7	1.6
65	1.2	Avoided	0.0	3.3	1.0
65	1.3	Avoided	0.0	3.0	0.7
65	1.4	Collision	31.0	2.7	0.0
65	1.5	Collision	42.9	2.5	0.0
65	1.6	Collision	47.2	2.2	0.0
65	1.7	Collision	49.8	2.1	0.0
65	1.8	Collision	54.5	1.9	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	3.8	1.7
70	1.2	Avoided	0.0	3.4	1.2
70	1.3	Collision	16.1	3.0	0.0
70	1.4	Collision	38.8	2.7	0.0
70	1.5	Collision	49.5	2.5	0.0
70	1.6	Collision	50.5	2.3	0.0
70	1.7	Collision	55.7	2.1	0.0
70	1.8	Collision	59.6	1.9	0.0

Table A.59: Driver 2 with 900 ms latency for vcp_2.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.8
30	1.1	Avoided	0.0	3.1	1.8
30	1.2	Avoided	0.0	3.1	1.8
30	1.3	Avoided	0.0	3.1	1.8
30	1.4	Avoided	0.0	3.1	1.8
30	1.5	Avoided	0.0	3.0	1.4
30	1.6	Avoided	0.0	3.0	1.4
30	1.7	Avoided	0.0	2.7	1.2

30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	3.3	1.6
35	1.1	Avoided	0.0	3.3	1.6
35	1.2	Avoided	0.0	3.3	1.6
35	1.3	Avoided	0.0	3.3	1.6
35	1.4	Avoided	0.0	3.3	1.6
35	1.5	Avoided	0.0	3.2	1.4
35	1.6	Avoided	0.0	2.9	1.4
35	1.7	Avoided	0.0	2.7	1.1
35	1.8	Avoided	0.0	2.5	0.8
40	1.0	Avoided	0.0	3.4	1.4
40	1.1	Avoided	0.0	3.4	1.4
40	1.2	Avoided	0.0	3.4	1.4
40	1.3	Avoided	0.0	3.4	1.4
40	1.4	Avoided	0.0	3.4	1.4
40	1.5	Avoided	0.0	3.2	1.4
40	1.6	Avoided	0.0	2.9	1.2
40	1.7	Avoided	0.0	2.7	2.0
40	1.8	Collision	6.9	2.5	0.0
45	1.0	Avoided	0.0	3.5	1.3
45	1.1	Avoided	0.0	3.5	1.4
45	1.2	Avoided	0.0	3.5	1.4
45	1.3	Avoided	0.0	3.5	1.4
45	1.4	Avoided	0.0	3.4	1.4
45	1.5	Avoided	0.0	3.1	1.3
45	1.6	Avoided	0.0	2.9	1.1
45	1.7	Avoided	0.0	2.6	0.3
45	1.8	Collision	22.6	2.4	0.0
50	1.0	Avoided	0.0	3.7	1.3
50	1.1	Avoided	0.0	3.7	1.3
50	1.2	Avoided	0.0	3.7	1.3
50	1.3	Avoided	0.0	3.7	1.3
50	1.4	Avoided	0.0	3.5	1.4
50	1.5	Avoided	0.0	3.2	1.3
50	1.6	Avoided	0.0	2.9	2.8
50	1.7	Avoided	0.0	2.7	0.0
50	1.8	Collision	25.5	2.5	0.0
55	1.0	Avoided	0.0	3.8	1.4
55	1.1	Avoided	0.0	3.8	1.4
55	1.2	Avoided	0.0	3.8	1.4
55	1.3	Avoided	0.0	3.7	1.4
55	1.4	Avoided	0.0	3.5	1.4
55	1.5	Avoided	0.0	3.2	1.1
55	1.6	Avoided	0.0	2.9	1.5

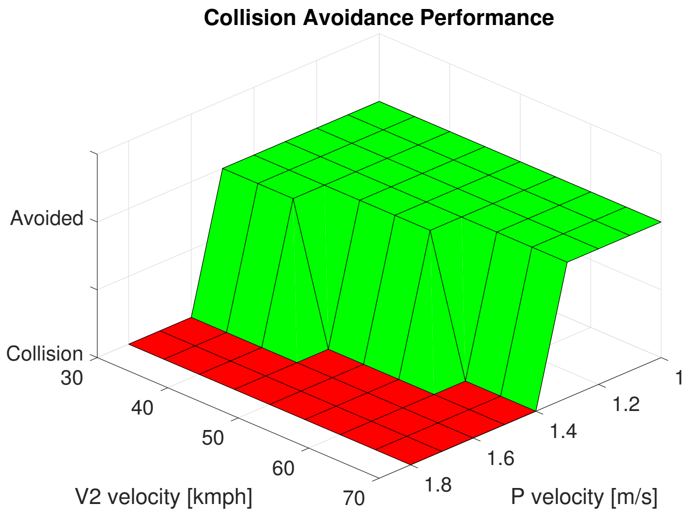
55	1.7	Collision	18.8	2.7	0.0
55	1.8	Collision	33.1	2.5	0.0
60	1.0	Avoided	0.0	3.9	1.4
60	1.1	Avoided	0.0	3.9	1.4
60	1.2	Avoided	0.0	3.9	1.4
60	1.3	Avoided	0.0	3.8	1.5
60	1.4	Avoided	0.0	3.4	1.3
60	1.5	Avoided	0.0	3.1	1.2
60	1.6	Avoided	0.0	2.9	1.1
60	1.7	Collision	30.3	2.6	0.0
60	1.8	Collision	41.4	2.4	0.0
65	1.0	Avoided	0.0	4.0	1.7
65	1.1	Avoided	0.0	4.0	1.7
65	1.2	Avoided	0.0	4.0	1.7
65	1.3	Avoided	0.0	3.8	1.7
65	1.4	Avoided	0.0	3.4	1.3
65	1.5	Avoided	0.0	3.1	3.2
65	1.6	Collision	9.7	2.9	0.0
65	1.7	Collision	37.3	2.6	0.0
65	1.8	Collision	47.4	2.4	0.0
70	1.0	Avoided	0.0	4.0	1.8
70	1.1	Avoided	0.0	4.0	1.8
70	1.2	Avoided	0.0	4.0	1.8
70	1.3	Avoided	0.0	3.8	1.7
70	1.4	Avoided	0.0	3.4	1.3
70	1.5	Avoided	0.0	3.1	1.4
70	1.6	Collision	24.1	2.9	0.0
70	1.7	Collision	38.8	2.7	0.0
70	1.8	Collision	49.5	2.5	0.0

Table A.60: Driver 2 with 900 ms latency for vcp_3.

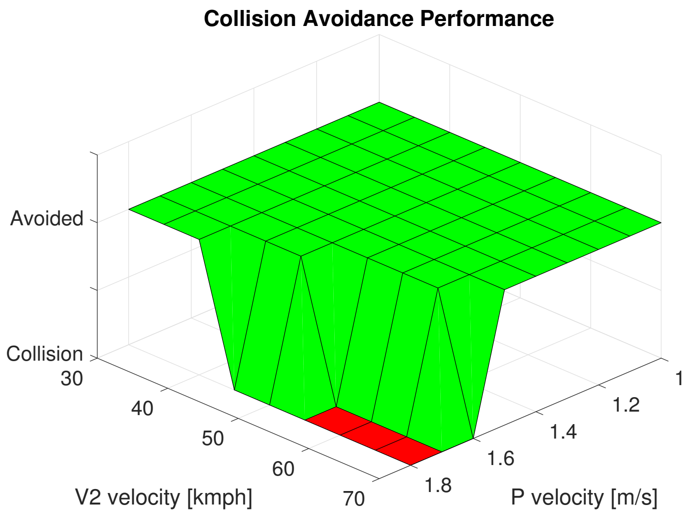
V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	3.1	1.2
30	1.1	Avoided	0.0	3.1	1.2
30	1.2	Avoided	0.0	3.1	1.2
30	1.3	Avoided	0.0	3.1	1.2
30	1.4	Avoided	0.0	3.1	1.7
30	1.5	Avoided	0.0	3.1	1.7
30	1.6	Avoided	0.0	3.1	1.7
30	1.7	Avoided	0.0	3.1	1.7
30	1.8	Avoided	0.0	3.0	1.3
35	1.0	Avoided	0.0	3.2	1.2
35	1.1	Avoided	0.0	3.2	1.2

35	1.2	Avoided	0.0	3.2	1.2
35	1.3	Avoided	0.0	3.3	1.5
35	1.4	Avoided	0.0	3.3	1.5
35	1.5	Avoided	0.0	3.3	1.5
35	1.6	Avoided	0.0	3.3	1.5
35	1.7	Avoided	0.0	3.2	1.2
35	1.8	Avoided	0.0	3.1	1.3
40	1.0	Avoided	0.0	3.4	1.2
40	1.1	Avoided	0.0	3.4	1.2
40	1.2	Avoided	0.0	3.4	1.2
40	1.3	Avoided	0.0	3.4	1.2
40	1.4	Avoided	0.0	3.4	1.2
40	1.5	Avoided	0.0	3.4	1.2
40	1.6	Avoided	0.0	3.4	1.2
40	1.7	Avoided	0.0	3.3	1.2
40	1.8	Avoided	0.0	3.0	1.1
45	1.0	Avoided	0.0	3.5	1.1
45	1.1	Avoided	0.0	3.5	1.1
45	1.2	Avoided	0.0	3.5	1.1
45	1.3	Avoided	0.0	3.5	1.1
45	1.4	Avoided	0.0	3.5	1.1
45	1.5	Avoided	0.0	3.5	1.1
45	1.6	Avoided	0.0	3.5	1.2
45	1.7	Avoided	0.0	3.2	1.2
45	1.8	Avoided	0.0	3.0	1.0
50	1.0	Avoided	0.0	3.6	1.1
50	1.1	Avoided	0.0	3.7	1.1
50	1.2	Avoided	0.0	3.7	1.1
50	1.3	Avoided	0.0	3.7	1.1
50	1.4	Avoided	0.0	3.7	1.1
50	1.5	Avoided	0.0	3.7	1.1
50	1.6	Avoided	0.0	3.5	1.1
50	1.7	Avoided	0.0	3.2	1.1
50	1.8	Avoided	0.0	3.0	0.8
55	1.0	Avoided	0.0	3.8	1.1
55	1.1	Avoided	0.0	3.8	1.1
55	1.2	Avoided	0.0	3.8	1.1
55	1.3	Avoided	0.0	3.8	1.1
55	1.4	Avoided	0.0	3.8	1.1
55	1.5	Avoided	0.0	3.7	1.1
55	1.6	Avoided	0.0	3.5	1.1
55	1.7	Avoided	0.0	3.3	1.0
55	1.8	Avoided	0.0	3.0	2.8
60	1.0	Avoided	0.0	3.8	1.2

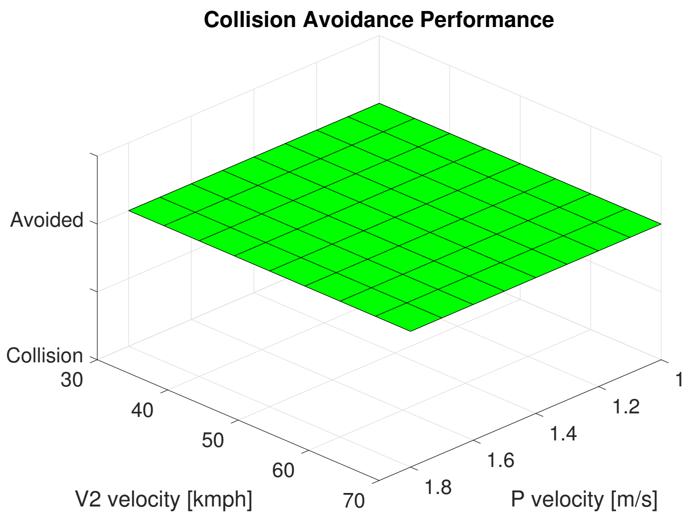
60	1.1	Avoided	0.0	3.9	1.2
60	1.2	Avoided	0.0	3.9	1.2
60	1.3	Avoided	0.0	3.9	1.2
60	1.4	Avoided	0.0	3.9	1.2
60	1.5	Avoided	0.0	3.8	1.2
60	1.6	Avoided	0.0	3.5	1.1
60	1.7	Avoided	0.0	3.2	0.7
60	1.8	Avoided	0.0	3.0	2.4
65	1.0	Avoided	0.0	3.9	1.4
65	1.1	Avoided	0.0	4.0	1.4
65	1.2	Avoided	0.0	4.0	1.4
65	1.3	Avoided	0.0	4.0	1.4
65	1.4	Avoided	0.0	4.0	1.4
65	1.5	Avoided	0.0	3.8	1.4
65	1.6	Avoided	0.0	3.5	1.1
65	1.7	Avoided	0.0	3.2	0.8
65	1.8	Avoided	0.0	3.0	1.2
70	1.0	Avoided	0.0	4.0	1.5
70	1.1	Avoided	0.0	4.0	1.5
70	1.2	Avoided	0.0	4.0	1.5
70	1.3	Avoided	0.0	4.0	1.5
70	1.4	Avoided	0.0	4.0	1.5
70	1.5	Avoided	0.0	3.8	1.4
70	1.6	Avoided	0.0	3.5	1.0
70	1.7	Avoided	0.0	3.2	3.6
70	1.8	Collision	0.1	3.0	0.0



(a) vcp$_2$

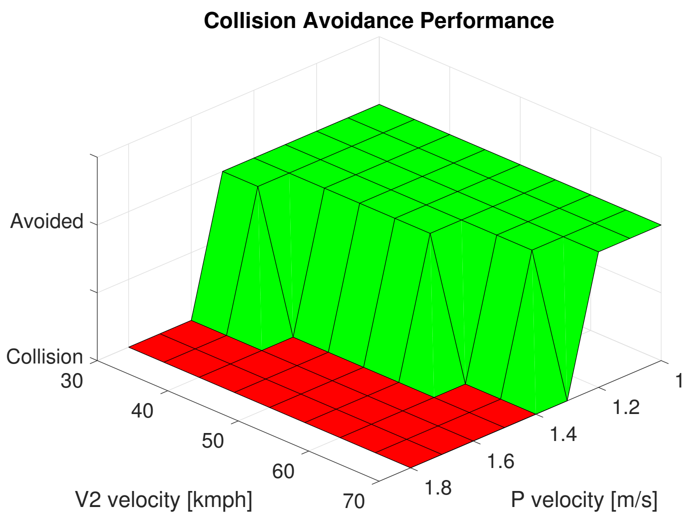


(b) vcp$_2$

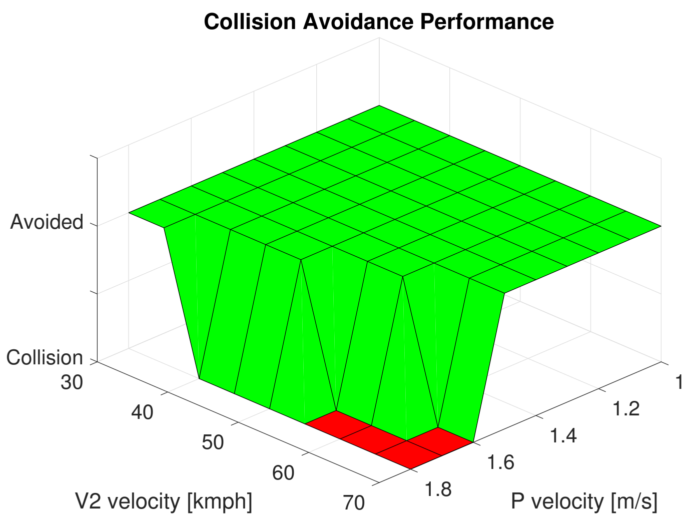


(c) vcp$_3$

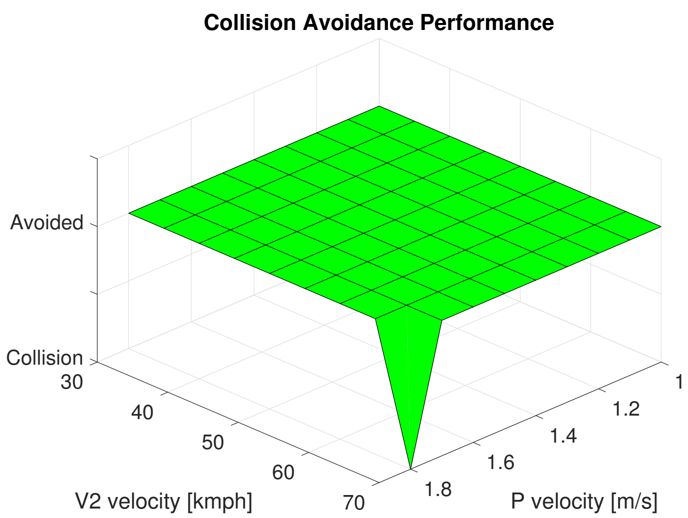
Figure A.17: Performance of concept with driver 1 with a latency of 900 ms.



(a) vcp_1



(b) vcp_2



(c) vcp_3

Figure A.18: Performance of concept with driver 2 with a latency of 900 ms.

A.1.11 1000 ms Communication Latency

Table A.61: Driver 1 with 1000 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.6
30	1.1	Avoided	0.0	2.6	1.6
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.5	1.3
30	1.5	Avoided	0.0	2.5	1.4
30	1.6	Avoided	0.0	2.2	0.4
30	1.7	Collision	21.4	1.2	0.0
30	1.8	Collision	22.4	1.1	0.0
35	1.0	Avoided	0.0	2.7	1.7
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.6	1.5
35	1.5	Avoided	0.0	2.4	0.1
35	1.6	Collision	20.8	2.2	0.0
35	1.7	Collision	16.4	2.0	0.0
35	1.8	Collision	22.3	1.8	0.0
40	1.0	Avoided	0.0	2.9	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.8	1.6
40	1.4	Avoided	0.0	2.7	1.3
40	1.5	Collision	14.4	2.4	0.0
40	1.6	Collision	15.3	2.2	0.0
40	1.7	Collision	23.1	2.0	0.0
40	1.8	Collision	28.3	1.8	0.0
45	1.0	Avoided	0.0	3.0	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	2.9	1.8
45	1.4	Avoided	0.0	2.6	0.9
45	1.5	Collision	19.0	2.4	0.0
45	1.6	Collision	24.8	2.1	0.0
45	1.7	Collision	30.5	1.9	0.0
45	1.8	Collision	33.3	1.8	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	2.9	1.5

50	1.4	Collision	12.0	2.6	0.0
50	1.5	Collision	28.3	2.4	0.0
50	1.6	Collision	28.3	2.2	0.0
50	1.7	Collision	34.2	2.0	0.0
50	1.8	Collision	39.5	1.8	0.0
55	1.0	Avoided	0.0	3.2	1.8
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.1	1.8
55	1.3	Avoided	0.0	2.9	1.1
55	1.4	Collision	12.5	2.7	0.0
55	1.5	Collision	35.5	2.4	0.0
55	1.6	Collision	34.2	2.2	0.0
55	1.7	Collision	40.2	2.0	0.0
55	1.8	Collision	44.6	1.8	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.2	2.0
60	1.3	Avoided	0.0	2.9	0.9
60	1.4	Collision	25.9	2.6	0.0
60	1.5	Collision	38.3	2.4	0.0
60	1.6	Collision	41.6	2.1	0.0
60	1.7	Collision	46.4	1.9	0.0
60	1.8	Collision	48.9	1.8	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.2	1.9
65	1.3	Avoided	0.0	2.9	0.5
65	1.4	Collision	34.1	2.6	0.0
65	1.5	Collision	45.1	2.4	0.0
65	1.6	Collision	47.0	2.1	0.0
65	1.7	Collision	49.7	2.0	0.0
65	1.8	Collision	54.6	1.8	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.3	1.9
70	1.3	Collision	16.8	2.9	0.0
70	1.4	Collision	41.1	2.6	0.0
70	1.5	Collision	51.3	2.4	0.0
70	1.6	Collision	50.2	2.2	0.0
70	1.7	Collision	55.7	2.0	0.0
70	1.8	Collision	59.8	1.8	0.0

Table A.62: Driver 1 with 1000 ms latency for vcp_2.

V_2 **Vel. [kmph]**	**P Vel. [m/s]**	**Outcome**	V_I **[kmph]**	TTC_W **[s]**	r_s [m]
30	1.0	Avoided	0.0	2.6	1.5
30	1.1	Avoided	0.0	2.6	1.5
30	1.2	Avoided	0.0	2.6	1.6
30	1.3	Avoided	0.0	2.6	1.6
30	1.4	Avoided	0.0	2.6	1.6
30	1.5	Avoided	0.0	2.6	1.6
30	1.6	Avoided	0.0	2.6	1.6
30	1.7	Avoided	0.0	2.5	1.3
30	1.8	Avoided	0.0	2.4	0.6
35	1.0	Avoided	0.0	2.7	1.6
35	1.1	Avoided	0.0	2.7	1.7
35	1.2	Avoided	0.0	2.7	1.7
35	1.3	Avoided	0.0	2.7	1.7
35	1.4	Avoided	0.0	2.7	1.7
35	1.5	Avoided	0.0	2.7	1.7
35	1.6	Avoided	0.0	2.7	1.6
35	1.7	Avoided	0.0	2.6	1.3
35	1.8	Avoided	0.0	2.4	0.2
40	1.0	Avoided	0.0	2.8	1.7
40	1.1	Avoided	0.0	2.9	1.7
40	1.2	Avoided	0.0	2.9	1.7
40	1.3	Avoided	0.0	2.9	1.8
40	1.4	Avoided	0.0	2.9	1.8
40	1.5	Avoided	0.0	2.9	1.8
40	1.6	Avoided	0.0	2.8	1.7
40	1.7	Avoided	0.0	2.6	1.3
40	1.8	Collision	14.4	2.4	0.0
45	1.0	Avoided	0.0	2.9	1.8
45	1.1	Avoided	0.0	3.0	1.9
45	1.2	Avoided	0.0	3.0	1.9
45	1.3	Avoided	0.0	3.0	1.9
45	1.4	Avoided	0.0	3.0	1.9
45	1.5	Avoided	0.0	2.9	1.8
45	1.6	Avoided	0.0	2.8	1.7
45	1.7	Collision	7.7	2.5	0.0
45	1.8	Collision	25.6	2.3	0.0
50	1.0	Avoided	0.0	3.1	1.9
50	1.1	Avoided	0.0	3.1	1.9
50	1.2	Avoided	0.0	3.1	1.9
50	1.3	Avoided	0.0	3.1	1.9
50	1.4	Avoided	0.0	3.1	1.9
50	1.5	Avoided	0.0	3.0	1.9
50	1.6	Avoided	0.0	2.8	1.2

50	1.7	Collision	12.0	2.6	0.0
50	1.8	Collision	28.3	2.4	0.0
55	1.0	Avoided	0.0	3.2	1.9
55	1.1	Avoided	0.0	3.2	1.9
55	1.2	Avoided	0.0	3.2	1.9
55	1.3	Avoided	0.0	3.2	1.9
55	1.4	Avoided	0.0	3.2	1.9
55	1.5	Avoided	0.0	3.1	1.8
55	1.6	Avoided	0.0	2.8	0.8
55	1.7	Collision	22.7	2.6	0.0
55	1.8	Collision	35.5	2.4	0.0
60	1.0	Avoided	0.0	3.3	2.0
60	1.1	Avoided	0.0	3.3	2.0
60	1.2	Avoided	0.0	3.3	2.0
60	1.3	Avoided	0.0	3.3	2.0
60	1.4	Avoided	0.0	3.2	2.0
60	1.5	Avoided	0.0	3.0	1.2
60	1.6	Avoided	0.0	2.8	0.5
60	1.7	Collision	32.8	2.5	0.0
60	1.8	Collision	43.6	2.3	0.0
65	1.0	Avoided	0.0	3.4	2.0
65	1.1	Avoided	0.0	3.4	2.0
65	1.2	Avoided	0.0	3.4	2.0
65	1.3	Avoided	0.0	3.4	2.0
65	1.4	Avoided	0.0	3.3	2.0
65	1.5	Avoided	0.0	3.0	0.8
65	1.6	Collision	17.1	2.8	0.0
65	1.7	Collision	39.8	2.5	0.0
65	1.8	Collision	24.4	2.3	0.0
70	1.0	Avoided	0.0	3.4	2.2
70	1.1	Avoided	0.0	3.4	2.2
70	1.2	Avoided	0.0	3.4	2.2
70	1.3	Avoided	0.0	3.4	2.2
70	1.4	Avoided	0.0	3.3	1.9
70	1.5	Avoided	0.0	3.0	0.7
70	1.6	Collision	27.3	2.8	0.0
70	1.7	Collision	41.1	2.6	0.0
70	1.8	Collision	51.3	2.4	0.0

Table A.63: Driver 1 with 1000 ms latency for vcp_3.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.6	1.4
30	1.1	Avoided	0.0	2.6	1.4

30	1.2	Avoided	0.0	2.6	1.4
30	1.3	Avoided	0.0	2.6	1.4
30	1.4	Avoided	0.0	2.6	1.4
30	1.5	Avoided	0.0	2.6	1.4
30	1.6	Avoided	0.0	2.5	1.2
30	1.7	Avoided	0.0	2.5	1.0
30	1.8	Avoided	0.0	2.5	1.0
35	1.0	Avoided	0.0	2.7	1.5
35	1.1	Avoided	0.0	2.7	1.5
35	1.2	Avoided	0.0	2.7	1.5
35	1.3	Avoided	0.0	2.7	1.5
35	1.4	Avoided	0.0	2.7	1.5
35	1.5	Avoided	0.0	2.7	1.5
35	1.6	Avoided	0.0	2.6	1.4
35	1.7	Avoided	0.0	2.6	1.4
35	1.8	Avoided	0.0	2.6	1.4
40	1.0	Avoided	0.0	2.8	1.5
40	1.1	Avoided	0.0	2.8	1.5
40	1.2	Avoided	0.0	2.8	1.5
40	1.3	Avoided	0.0	2.8	1.5
40	1.4	Avoided	0.0	2.8	1.5
40	1.5	Avoided	0.0	2.8	1.5
40	1.6	Avoided	0.0	2.8	1.5
40	1.7	Avoided	0.0	2.8	1.5
40	1.8	Avoided	0.0	2.8	1.5
45	1.0	Avoided	0.0	2.9	1.6
45	1.1	Avoided	0.0	2.9	1.6
45	1.2	Avoided	0.0	2.9	1.6
45	1.3	Avoided	0.0	2.9	1.6
45	1.4	Avoided	0.0	2.9	1.6
45	1.5	Avoided	0.0	2.9	1.6
45	1.6	Avoided	0.0	2.9	1.6
45	1.7	Avoided	0.0	2.9	1.6
45	1.8	Avoided	0.0	2.9	1.6
50	1.0	Avoided	0.0	3.0	1.6
50	1.1	Avoided	0.0	3.0	1.6
50	1.2	Avoided	0.0	3.0	1.6
50	1.3	Avoided	0.0	3.0	1.6
50	1.4	Avoided	0.0	3.0	1.6
50	1.5	Avoided	0.0	3.0	1.6
50	1.6	Avoided	0.0	3.0	1.6
50	1.7	Avoided	0.0	3.0	1.6
50	1.8	Avoided	0.0	3.0	1.6
55	1.0	Avoided	0.0	3.2	1.6

55	1.1	Avoided	0.0	3.2	1.6
55	1.2	Avoided	0.0	3.2	1.6
55	1.3	Avoided	0.0	3.1	1.6
55	1.4	Avoided	0.0	3.1	1.6
55	1.5	Avoided	0.0	3.1	1.6
55	1.6	Avoided	0.0	3.1	1.6
55	1.7	Avoided	0.0	3.1	1.6
55	1.8	Avoided	0.0	3.1	1.6
60	1.0	Avoided	0.0	3.2	1.7
60	1.1	Avoided	0.0	3.2	1.7
60	1.2	Avoided	0.0	3.2	1.7
60	1.3	Avoided	0.0	3.2	1.7
60	1.4	Avoided	0.0	3.2	1.7
60	1.5	Avoided	0.0	3.2	1.7
60	1.6	Avoided	0.0	3.2	1.7
60	1.7	Avoided	0.0	3.2	1.7
60	1.8	Avoided	0.0	3.2	1.7
65	1.0	Avoided	0.0	3.3	1.7
65	1.1	Avoided	0.0	3.3	1.7
65	1.2	Avoided	0.0	3.3	1.7
65	1.3	Avoided	0.0	3.3	1.7
65	1.4	Avoided	0.0	3.3	1.7
65	1.5	Avoided	0.0	3.3	1.7
65	1.6	Avoided	0.0	3.3	1.7
65	1.7	Avoided	0.0	3.3	1.7
65	1.8	Avoided	0.0	3.2	1.6
70	1.0	Avoided	0.0	3.4	1.9
70	1.1	Avoided	0.0	3.4	1.9
70	1.2	Avoided	0.0	3.4	1.9
70	1.3	Avoided	0.0	3.4	1.9
70	1.4	Avoided	0.0	3.4	1.9
70	1.5	Avoided	0.0	3.4	1.9
70	1.6	Avoided	0.0	3.4	1.9
70	1.7	Avoided	0.0	3.4	1.9
70	1.8	Avoided	0.0	3.2	0.8

Table A.64: Driver 2 with 1000 ms latency for vcp_1.

V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Avoided	0.0	2.1	1.4
30	1.1	Avoided	0.0	1.8	0.6
30	1.2	Collision	6.4	1.7	0.0
30	1.3	Collision	13.1	1.6	0.0
30	1.4	Collision	16.5	1.5	0.0

30	1.5	Collision	19.6	1.4	0.0
30	1.6	Collision	21.9	1.3	0.0
30	1.7	Collision	22.7	1.2	0.0
30	1.8	Collision	23.5	1.1	0.0
35	1.0	Avoided	0.0	2.0	1.0
35	1.1	Collision	4.8	1.8	0.0
35	1.2	Collision	14.1	1.7	0.0
35	1.3	Collision	18.1	1.5	0.0
35	1.4	Collision	22.7	1.4	0.0
35	1.5	Collision	25.4	1.3	0.0
35	1.6	Collision	26.4	1.3	0.0
35	1.7	Collision	28.1	1.2	0.0
35	1.8	Collision	28.9	1.1	0.0
40	1.0	Avoided	0.0	2.0	0.4
40	1.1	Collision	14.7	1.8	0.0
40	1.2	Collision	21.0	1.7	0.0
40	1.3	Collision	25.7	1.5	0.0
40	1.4	Collision	28.5	1.4	0.0
40	1.5	Collision	30.9	1.3	0.0
40	1.6	Collision	32.7	1.2	0.0
40	1.7	Collision	33.4	1.2	0.0
40	1.8	Collision	34.1	1.1	0.0
45	1.0	Collision	14.8	2.0	0.0
45	1.1	Collision	22.3	1.8	0.0
45	1.2	Collision	27.4	1.6	0.0
45	1.3	Collision	31.6	1.5	0.0
45	1.4	Collision	34.3	1.4	0.0
45	1.5	Collision	36.4	1.3	0.0
45	1.6	Collision	38.1	1.2	0.0
45	1.7	Collision	38.8	1.2	0.0
45	1.8	Collision	39.4	1.1	0.0
50	1.0	Collision	20.6	2.0	0.0
50	1.1	Collision	28.7	1.8	0.0
50	1.2	Collision	33.3	1.7	0.0
50	1.3	Collision	36.2	1.5	0.0
50	1.4	Collision	38.9	1.4	0.0
50	1.5	Collision	41.1	1.3	0.0
50	1.6	Collision	42.7	1.2	0.0
50	1.7	Collision	43.4	1.2	0.0
50	1.8	Collision	44.7	1.1	0.0
55	1.0	Collision	24.8	2.1	0.0
55	1.1	Collision	33.0	1.9	0.0
55	1.2	Collision	38.2	1.6	0.0
55	1.3	Collision	42.1	1.5	0.0

55	1.4	Collision	44.6	1.4	0.0
55	1.5	Collision	46.5	1.3	0.0
55	1.6	Collision	47.4	1.2	0.0
55	1.7	Collision	48.8	1.2	0.0
55	1.8	Collision	49.4	1.1	0.0
60	1.0	Collision	34.4	2.0	0.0
60	1.1	Collision	39.4	1.8	0.0
60	1.2	Collision	43.5	1.6	0.0
60	1.3	Collision	47.2	1.5	0.0
60	1.4	Collision	49.6	1.4	0.0
60	1.5	Collision	51.6	1.3	0.0
60	1.6	Collision	53.1	1.2	0.0
60	1.7	Collision	53.8	1.2	0.0
60	1.8	Collision	54.4	1.1	0.0
65	1.0	Collision	39.4	2.0	0.0
65	1.1	Collision	45.2	1.8	0.0
65	1.2	Collision	49.2	1.6	0.0
65	1.3	Collision	51.9	1.5	0.0
65	1.4	Collision	54.4	1.4	0.0
65	1.5	Collision	56.3	1.3	0.0
65	1.6	Collision	57.8	1.2	0.0
65	1.7	Collision	58.5	1.1	0.0
65	1.8	Collision	59.7	1.1	0.0
70	1.0	Collision	44.5	2.0	0.0
70	1.1	Collision	50.3	1.8	0.0
70	1.2	Collision	54.1	1.6	0.0
70	1.3	Collision	57.7	1.5	0.0
70	1.4	Collision	59.9	1.4	0.0
70	1.5	Collision	61.8	1.3	0.0
70	1.6	Collision	62.6	1.2	0.0
70	1.7	Collision	63.9	1.2	0.0
70	1.8	Collision	64.5	1.1	0.0

Table A.65: Driver 2 with 1000 ms latency for vcp_2.

V_2 Vel. [kmph]	**P Vel. [m/s]**	**Outcome**	**V_I [kmph]**	**TTC_W [s]**	r_s [m]
30	1.0	Avoided	0.0	3.0	1.4
30	1.1	Avoided	0.0	2.9	1.4
30	1.2	Avoided	0.0	2.5	1.2
30	1.3	Collision	11.2	2.3	0.0
30	1.4	Avoided	0.0	2.2	1.6
30	1.5	Avoided	0.0	2.0	1.2
30	1.6	Avoided	0.0	1.9	0.9
30	1.7	Avoided	0.0	1.8	0.7

30	1.8	Avoided	0.0	1.7	0.5
35	1.0	Avoided	0.0	3.0	1.4
35	1.1	Avoided	0.0	2.7	1.1
35	1.2	Avoided	0.0	2.5	0.8
35	1.3	Collision	18.4	2.3	0.0
35	1.4	Avoided	0.0	2.1	1.4
35	1.5	Avoided	0.0	2.0	1.0
35	1.6	Avoided	0.0	1.9	0.7
35	1.7	Avoided	0.0	1.8	0.4
35	1.8	Collision	4.4	1.7	0.0
40	1.0	Avoided	0.0	3.1	1.4
40	1.1	Avoided	0.0	2.7	2.2
40	1.2	Collision	13.4	2.5	0.0
40	1.3	Collision	25.4	2.3	0.0
40	1.4	Avoided	0.0	2.1	0.9
40	1.5	Avoided	0.0	2.0	0.5
40	1.6	Collision	3.9	1.9	0.0
40	1.7	Collision	8.6	1.8	0.0
40	1.8	Collision	11.3	1.7	0.0
45	1.0	Avoided	0.0	3.0	1.1
45	1.1	Avoided	0.0	2.7	1.3
45	1.2	Collision	22.6	2.5	0.0
45	1.3	Collision	32.3	2.3	0.0
45	1.4	Collision	2.3	2.1	0.0
45	1.5	Collision	10.1	2.0	0.0
45	1.6	Collision	13.2	1.8	0.0
45	1.7	Collision	15.1	1.7	0.0
45	1.8	Collision	16.7	1.6	0.0
50	1.0	Avoided	0.0	3.1	1.2
50	1.1	Collision	6.9	2.7	0.0
50	1.2	Collision	28.4	2.5	0.0
50	1.3	Collision	3.4	2.3	0.0
50	1.4	Collision	11.8	2.1	0.0
50	1.5	Collision	15.5	2.0	0.0
50	1.6	Collision	17.5	1.9	0.0
50	1.7	Collision	19.0	1.8	0.0
50	1.8	Collision	20.2	1.7	0.0
55	1.0	Avoided	0.0	3.0	3.1
55	1.1	Collision	18.3	2.7	0.0
55	1.2	Collision	34.1	2.5	0.0
55	1.3	Collision	15.6	2.3	0.0
55	1.4	Collision	20.2	2.1	0.0
55	1.5	Collision	22.3	2.0	0.0
55	1.6	Collision	23.7	1.9	0.0

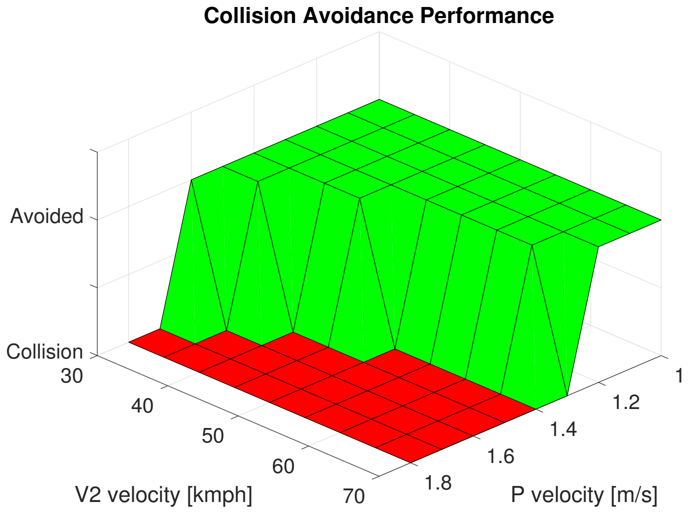
55	1.7	Collision	24.8	1.7	0.0
55	1.8	Collision	25.5	1.6	0.0
60	1.0	Avoided	0.0	3.0	1.5
60	1.1	Collision	26.4	2.7	0.0
60	1.2	Collision	41.1	2.5	0.0
60	1.3	Collision	22.1	2.3	0.0
60	1.4	Collision	25.7	2.1	0.0
60	1.5	Collision	27.7	2.0	0.0
60	1.6	Collision	28.9	1.8	0.0
60	1.7	Collision	29.5	1.7	0.0
60	1.8	Collision	30.0	1.6	0.0
65	1.0	Avoided	0.0	3.0	0.4
65	1.1	Collision	33.6	2.7	0.0
65	1.2	Collision	45.9	2.5	0.0
65	1.3	Collision	28.9	2.3	0.0
65	1.4	Collision	31.5	2.1	0.0
65	1.5	Collision	33.3	2.0	0.0
65	1.6	Collision	34.4	1.9	0.0
65	1.7	Collision	34.9	1.8	0.0
65	1.8	Collision	35.4	1.6	0.0
70	1.0	Collision	17.5	3.0	0.0
70	1.1	Collision	39.7	2.7	0.0
70	1.2	Collision	51.2	2.5	0.0
70	1.3	Collision	33.5	2.3	0.0
70	1.4	Collision	36.1	2.1	0.0
70	1.5	Collision	37.4	2.0	0.0
70	1.6	Collision	38.4	1.9	0.0
70	1.7	Collision	39.1	1.7	0.0
70	1.8	Collision	42.1	1.6	0.0

Table A.66: Driver 2 with 1000 ms latency for vcp_3.

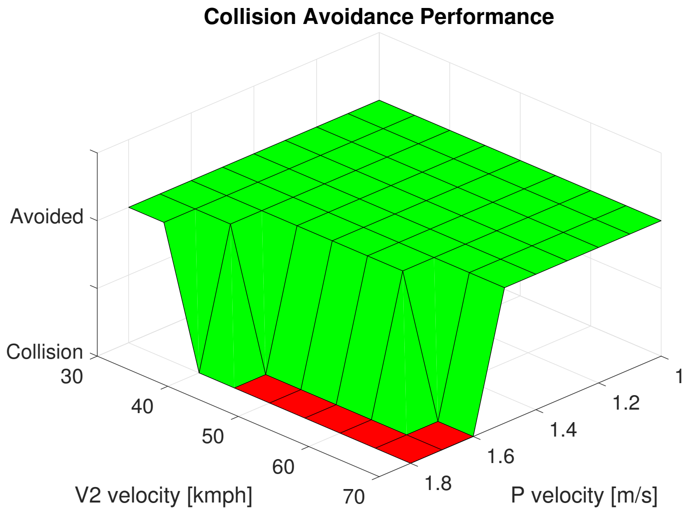
V_2 Vel. [kmph]	P Vel. [m/s]	Outcome	V_I [kmph]	TTC_W [s]	r_s [m]
30	1.0	Collision	30.0	3.1	0.0
30	1.1	Collision	30.0	3.1	0.0
30	1.2	Collision	30.0	3.1	0.0
30	1.3	Collision	30.0	3.1	0.0
30	1.4	Collision	30.0	2.9	0.0
30	1.5	Collision	30.0	2.7	0.0
30	1.6	Collision	30.0	2.5	0.0
30	1.7	Collision	30.0	2.4	0.0
30	1.8	Collision	30.0	2.2	0.0
35	1.0	Collision	35.0	3.2	0.0
35	1.1	Collision	35.0	3.2	0.0

35	1.2	Collision	35.0	3.3	0.0
35	1.3	Collision	35.0	3.1	0.0
35	1.4	Collision	35.0	2.9	0.0
35	1.5	Collision	35.0	2.7	0.0
35	1.6	Collision	35.0	2.5	0.0
35	1.7	Collision	35.0	2.4	0.0
35	1.8	Collision	35.0	2.2	0.0
40	1.0	Collision	40.0	3.4	0.0
40	1.1	Collision	40.0	3.4	0.0
40	1.2	Collision	40.0	3.3	0.0
40	1.3	Collision	40.0	3.1	0.0
40	1.4	Collision	40.0	2.9	0.0
40	1.5	Collision	40.0	2.7	0.0
40	1.6	Collision	40.0	2.5	0.0
40	1.7	Collision	40.0	2.4	0.0
40	1.8	Collision	40.0	2.2	0.0
45	1.0	Collision	45.0	3.5	0.0
45	1.1	Collision	45.0	3.5	0.0
45	1.2	Collision	45.0	3.3	0.0
45	1.3	Collision	45.0	3.1	0.0
45	1.4	Collision	45.0	2.8	0.0
45	1.5	Collision	45.0	2.6	0.0
45	1.6	Collision	45.0	2.5	0.0
45	1.7	Collision	45.0	2.3	0.0
45	1.8	Collision	45.0	2.2	0.0
50	1.0	Collision	50.0	3.6	0.0
50	1.1	Collision	50.0	3.6	0.0
50	1.2	Collision	50.0	3.3	0.0
50	1.3	Collision	50.0	3.1	0.0
50	1.4	Collision	50.0	2.8	0.0
50	1.5	Collision	50.0	2.6	0.0
50	1.6	Collision	50.0	2.5	0.0
50	1.7	Collision	50.0	2.3	0.0
50	1.8	Collision	50.0	2.2	0.0
55	1.0	Collision	55.0	3.8	0.0
55	1.1	Collision	55.0	3.6	0.0
55	1.2	Collision	55.0	3.3	0.0
55	1.3	Collision	55.0	3.1	0.0
55	1.4	Collision	55.0	2.9	0.0
55	1.5	Collision	55.0	2.7	0.0
55	1.6	Collision	55.0	2.5	0.0
55	1.7	Collision	55.0	2.3	0.0
55	1.8	Collision	55.0	2.2	0.0
60	1.0	Collision	60.0	3.8	0.0

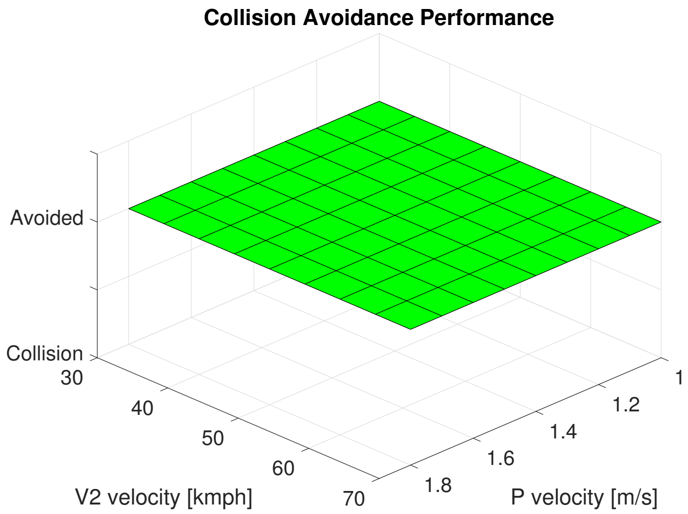
60	1.1	Collision	60.0	3.6	0.0
60	1.2	Collision	60.0	3.3	0.0
60	1.3	Collision	60.0	3.1	0.0
60	1.4	Collision	60.0	2.8	0.0
60	1.5	Collision	60.0	2.6	0.0
60	1.6	Collision	60.0	2.5	0.0
60	1.7	Collision	60.0	2.3	0.0
60	1.8	Collision	60.0	2.2	0.0
65	1.0	Collision	65.0	3.9	0.0
65	1.1	Collision	65.0	3.6	0.0
65	1.2	Collision	65.0	3.3	0.0
65	1.3	Collision	65.0	3.1	0.0
65	1.4	Collision	65.0	2.8	0.0
65	1.5	Collision	65.0	2.6	0.0
65	1.6	Collision	65.0	2.5	0.0
65	1.7	Collision	65.0	2.3	0.0
65	1.8	Collision	65.0	2.2	0.0
70	1.0	Collision	70.0	4.0	0.0
70	1.1	Collision	70.0	3.6	0.0
70	1.2	Collision	70.0	3.3	0.0
70	1.3	Collision	70.0	3.1	0.0
70	1.4	Collision	70.0	2.8	0.0
70	1.5	Collision	70.0	2.6	0.0
70	1.6	Collision	70.0	2.5	0.0
70	1.7	Collision	70.0	2.3	0.0
70	1.8	Collision	70.0	2.2	0.0



(a) vcp_2

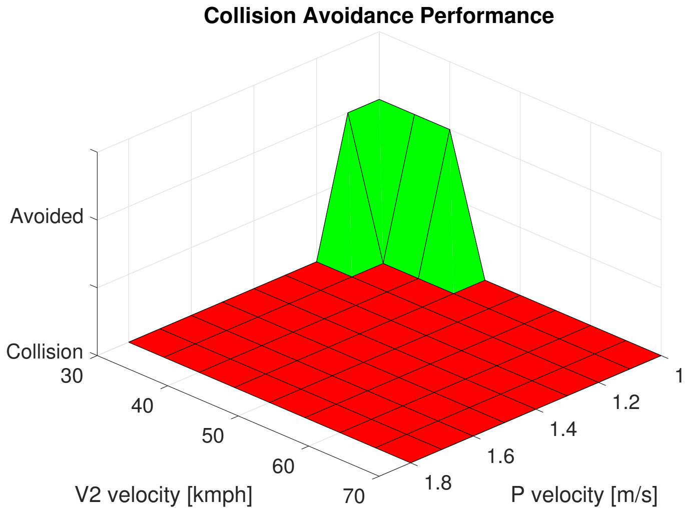


(b) vcp_2

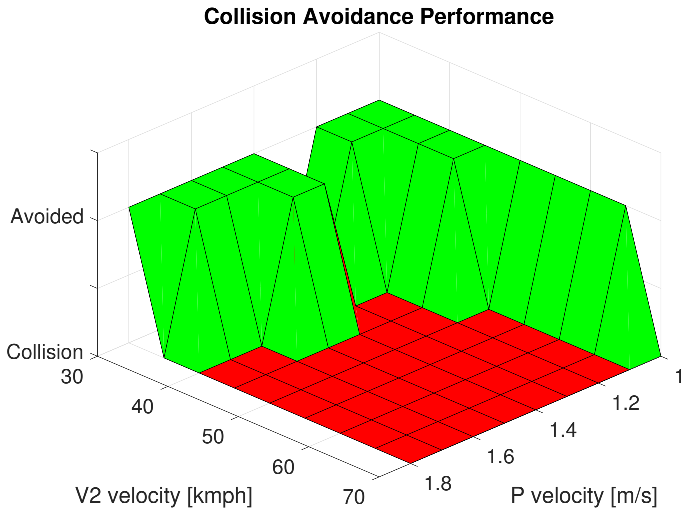


(c) vcp_3

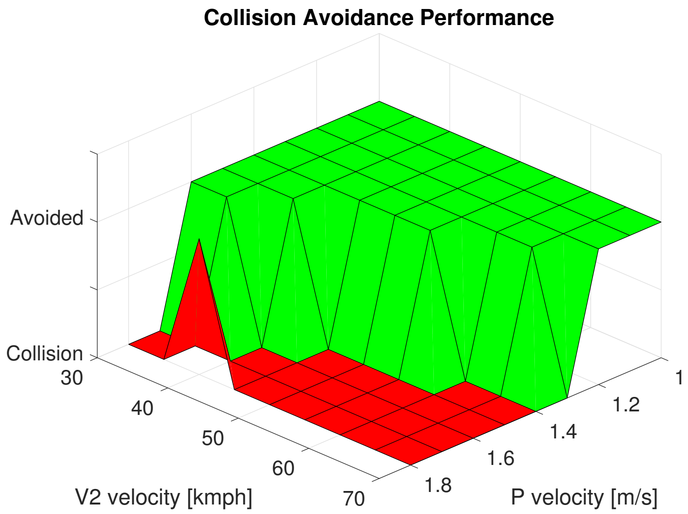
Figure A.19: Performance of concept with driver 1 with a latency of 1000 ms.



(a) vcp$_1$



(b) vcp$_2$



(c) vcp$_3$

Figure A.20: Performance of concept with driver 2 with a latency of 1000 ms.