



Software Engineering, Department of Computer Engineering

Boğaziçi University

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By Taner Eşme

TRAFFIC LIGHTS FOR SAFETY AND EFFICIENCY

REQUIREMENT SPECIFICATION DOCUMENT

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1. INTRODUCTION

This document specifies the requirements for making traffic flow safe and efficient in a conjunction by using Axel's goal-oriented requirement engineering model. In this section, system-as-is and system-to-be will be depicted.

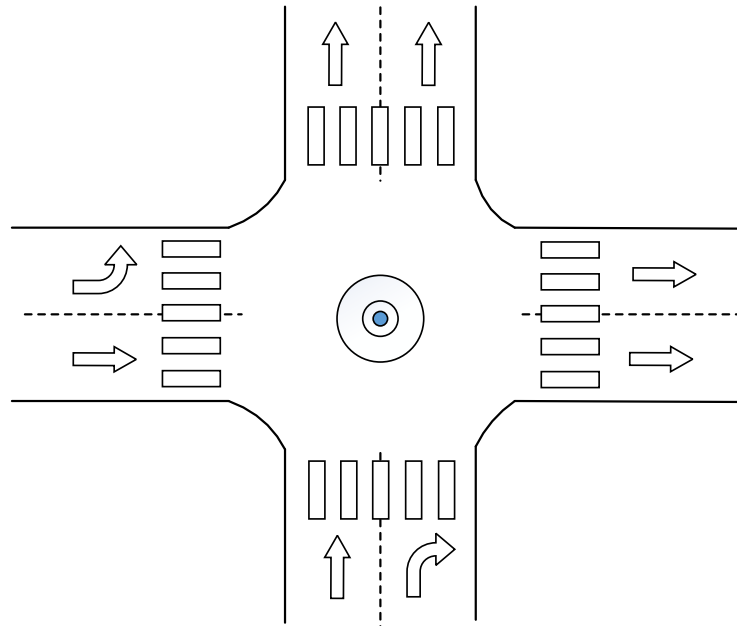


Figure 1 System-as-is

You can see a visual depiction of system-as-is above. It is quite obvious that the activities of drivers and pedestrians at this intersection will be ruled by disharmony. Trying to improve the experience at this intersection leads us to come up with a new system and we call this new system being talked of as system-to-be.

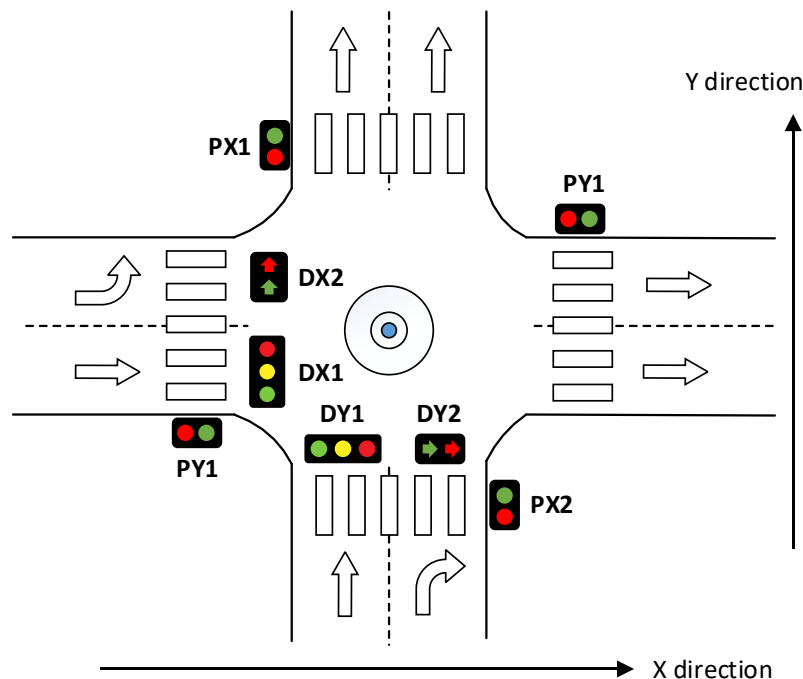


Figure 2 System-to-be

In system-to-be, traffic lights will be used to make the system-as-is safe and efficient. Traffic flow will be able to be controlled easily, correctly and fairly thanks to traffic lights. We will have 8 traffic light in the

system as actuators, and sensors to measure the count of pedestrians waiting for and congestions on the roads. Only green and red lights will be used as actuators, yellow lights will not be used in the system-to-be.

Each letter next to lights shows the name of the light (e.g. PX1 indicates the lights for the pedestrians waiting for crossing on X direction). The light-name for drivers starts with letter D and one for the pedestrians starts with the letter P. Arrows on the roads indicates the directions that the drivers can go.

The document will constitute of seven sections with the introduction. After the introduction section, you will find the section Goal Model that will give you details of the system goals from business ones to technical ones. In the third section, the obstacles of the system together with the solutions for some of them will be addressed. In the fourth section, you will find the agents and relationships of them each other. Fifth and sixth sections will identify conceptual and operation models that are necessary to carry out the system requirements. The seventh and last section is the conclusion part of the document that gives you a summary of what you read.

2. GOAL MODEL

We are going to address each sub goal separately because it is not possible to fit all of the goals into a single page. Annotations will be interleaved.

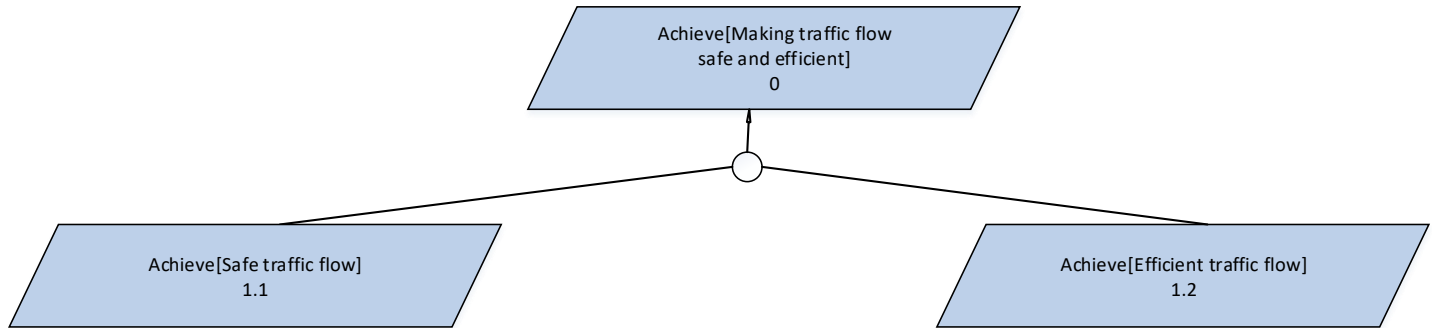


Figure 3 Main Goal - Making traffic flow safe and efficient

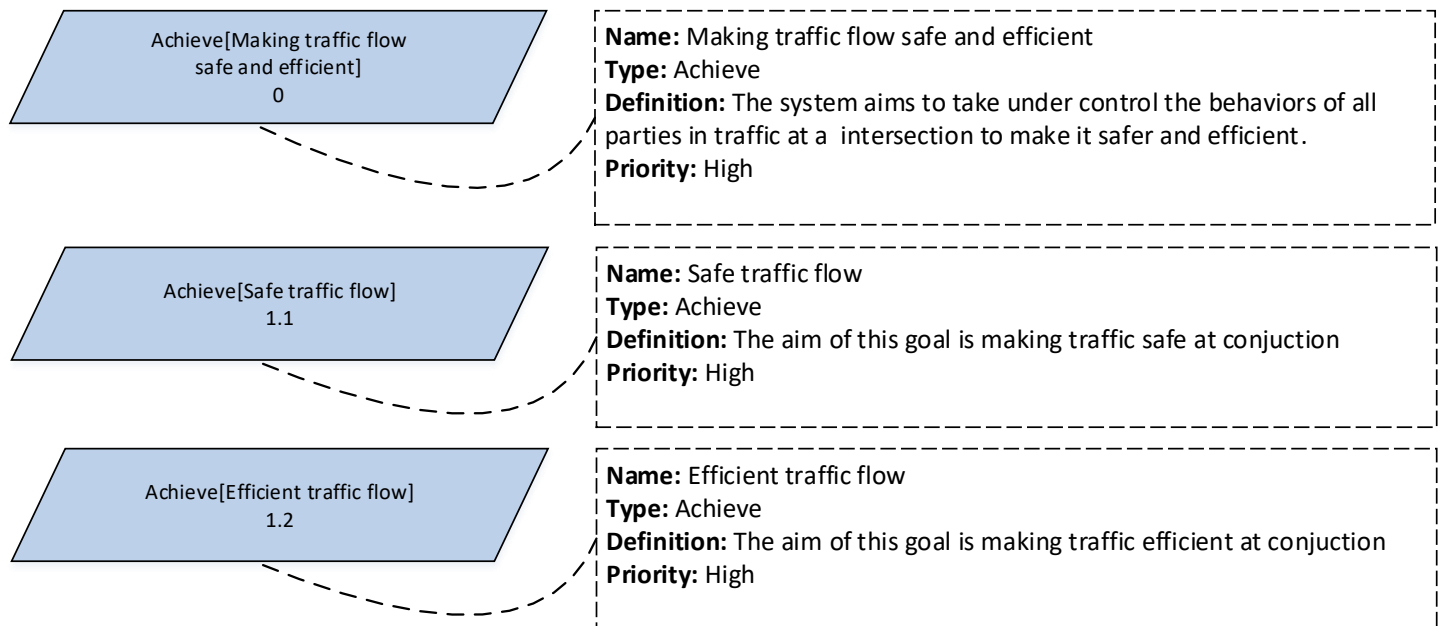


Figure 4 Annotation of Main Goal - Making traffic flow safe and efficient

2.1 Sub goal - Safe traffic flow

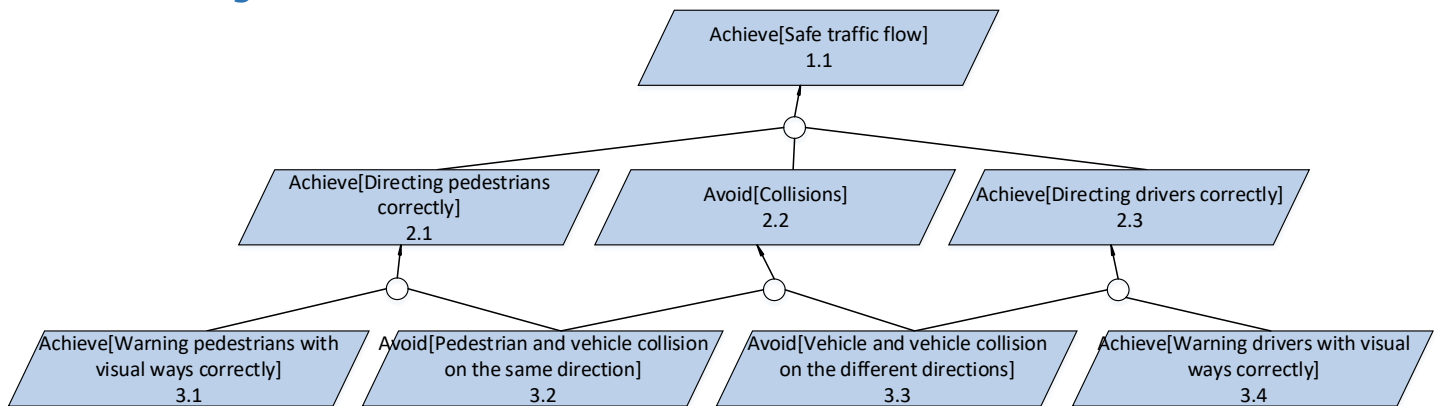
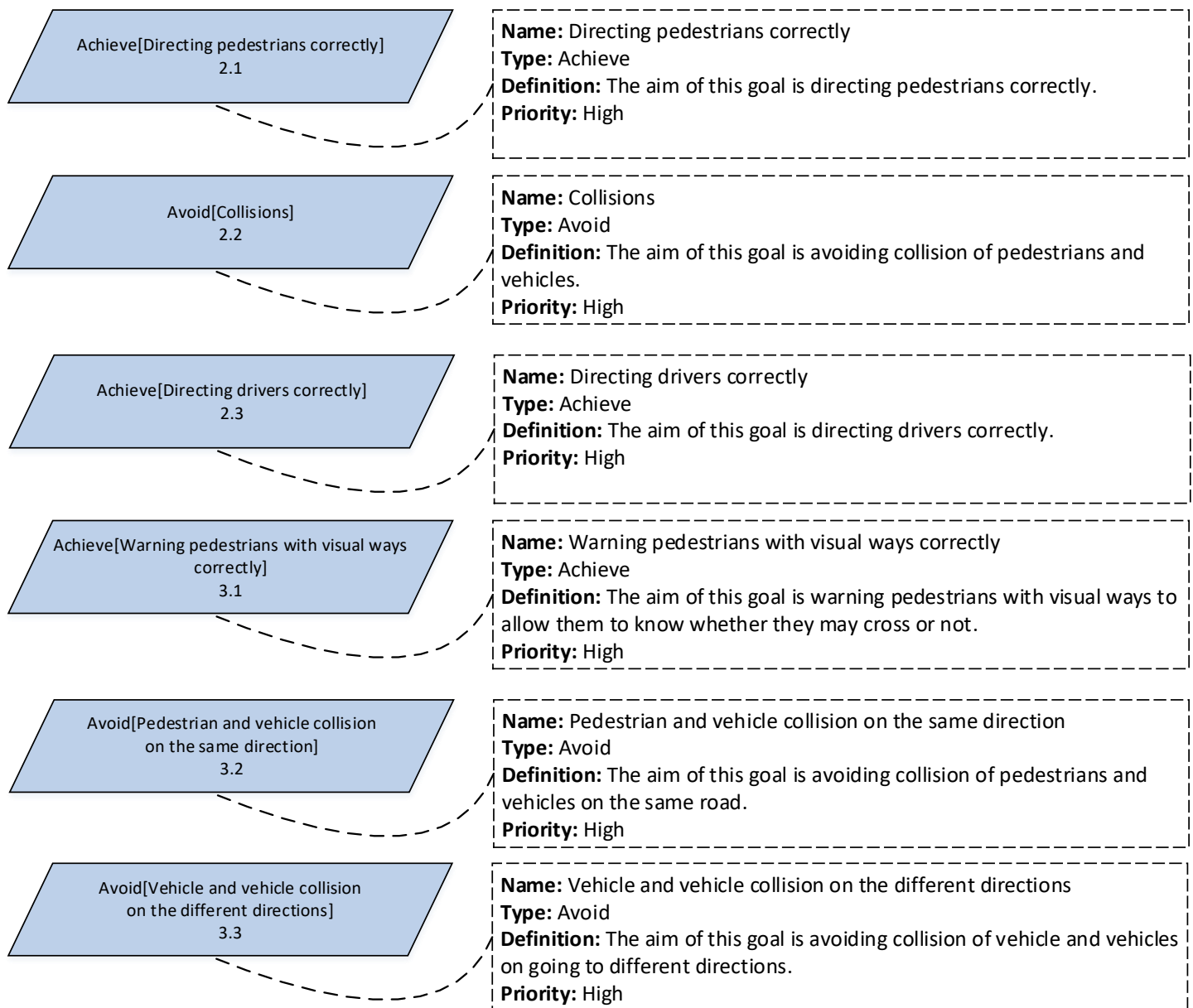


Figure 5 Sub goals of safe traffic flow



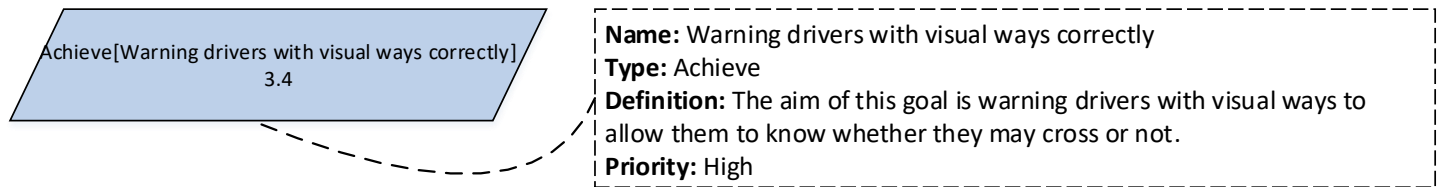


Figure 6 Annotations of sub goals of safe traffic flow

2.1.1 Sub goal - Warning pedestrians with visual ways correctly

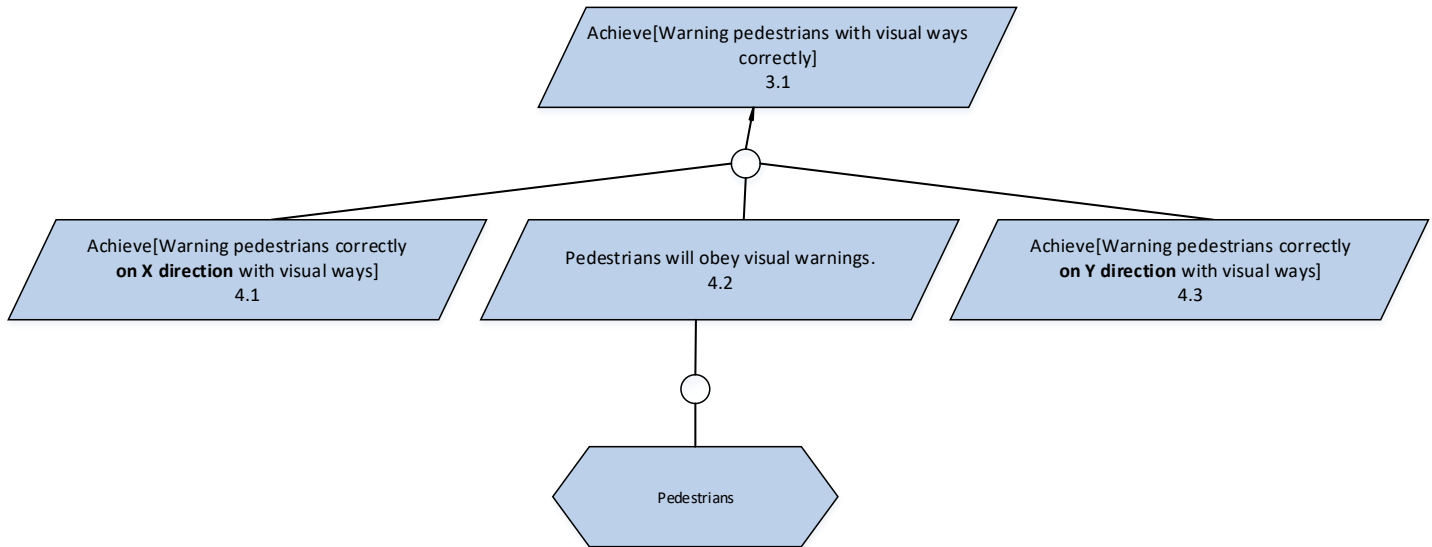


Figure 7 Sub goals of warning pedestrians with visual ways correctly

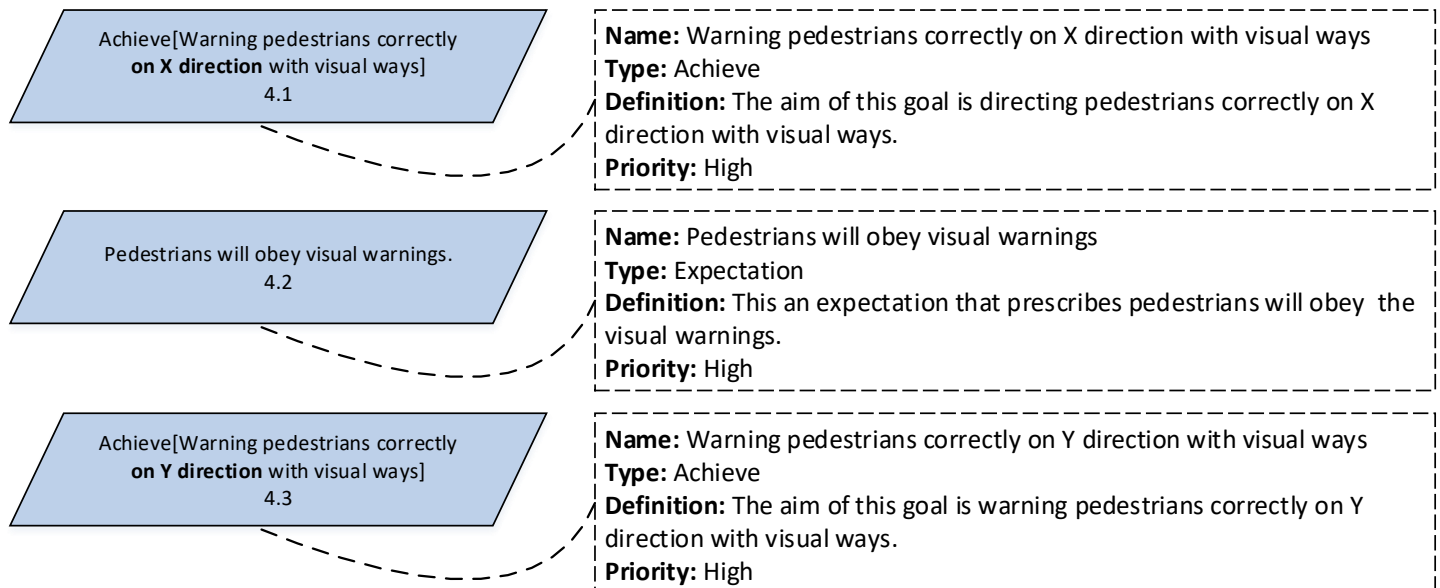


Figure 8 Annotations of sub goals of warning pedestrians with visual ways correctly

2.1.1.1 Sub goal - Warning pedestrians correctly on X direction with visual ways

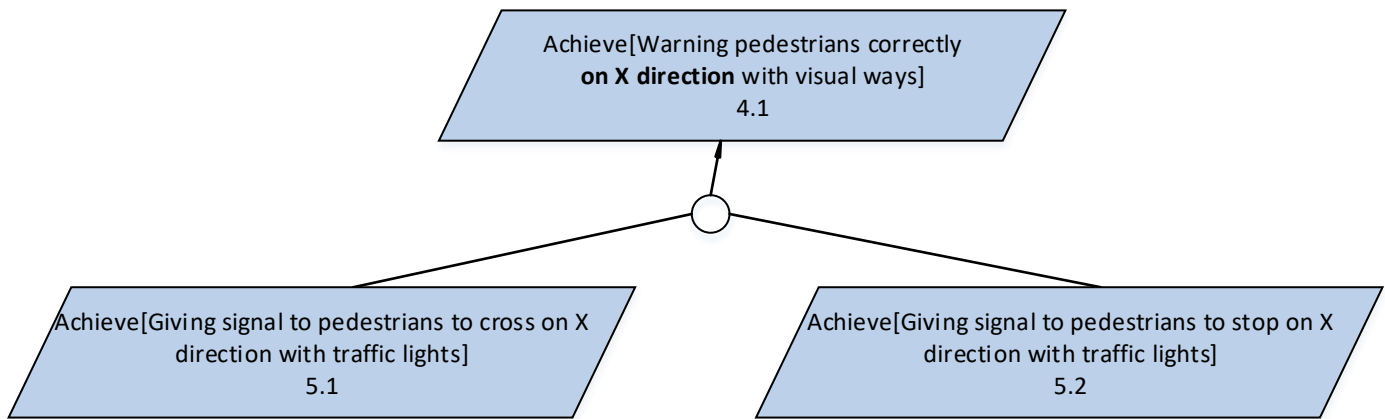


Figure 9 Sub goals of warning pedestrians correctly on X direction with visual ways

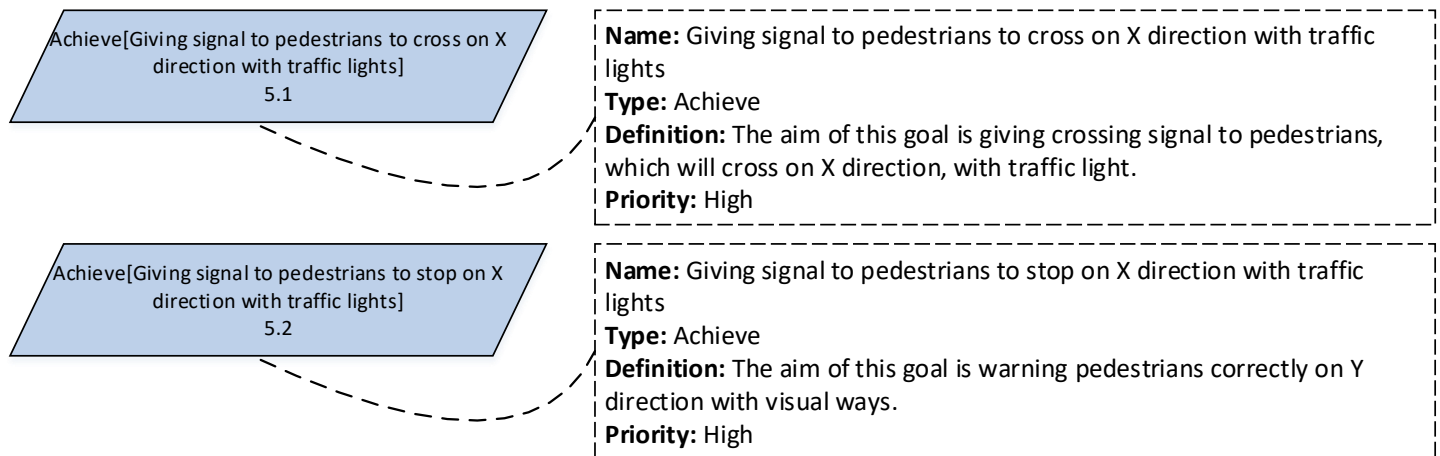


Figure 10 Annotations of sub goals of warning pedestrians correctly on X direction with visual ways

2.1.1.1.1 Sub goal - Giving signal to pedestrians to cross on X direction with traffic lights

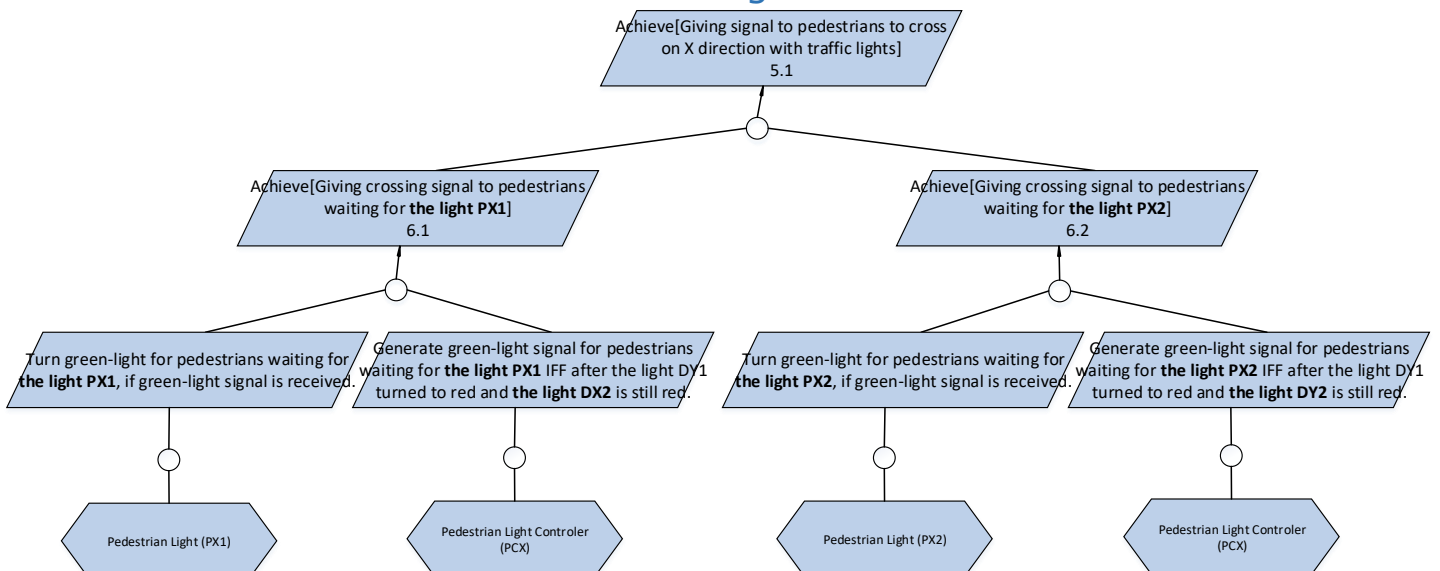


Figure 11 Sub goals of giving signal to pedestrians to cross on X direction with traffic lights

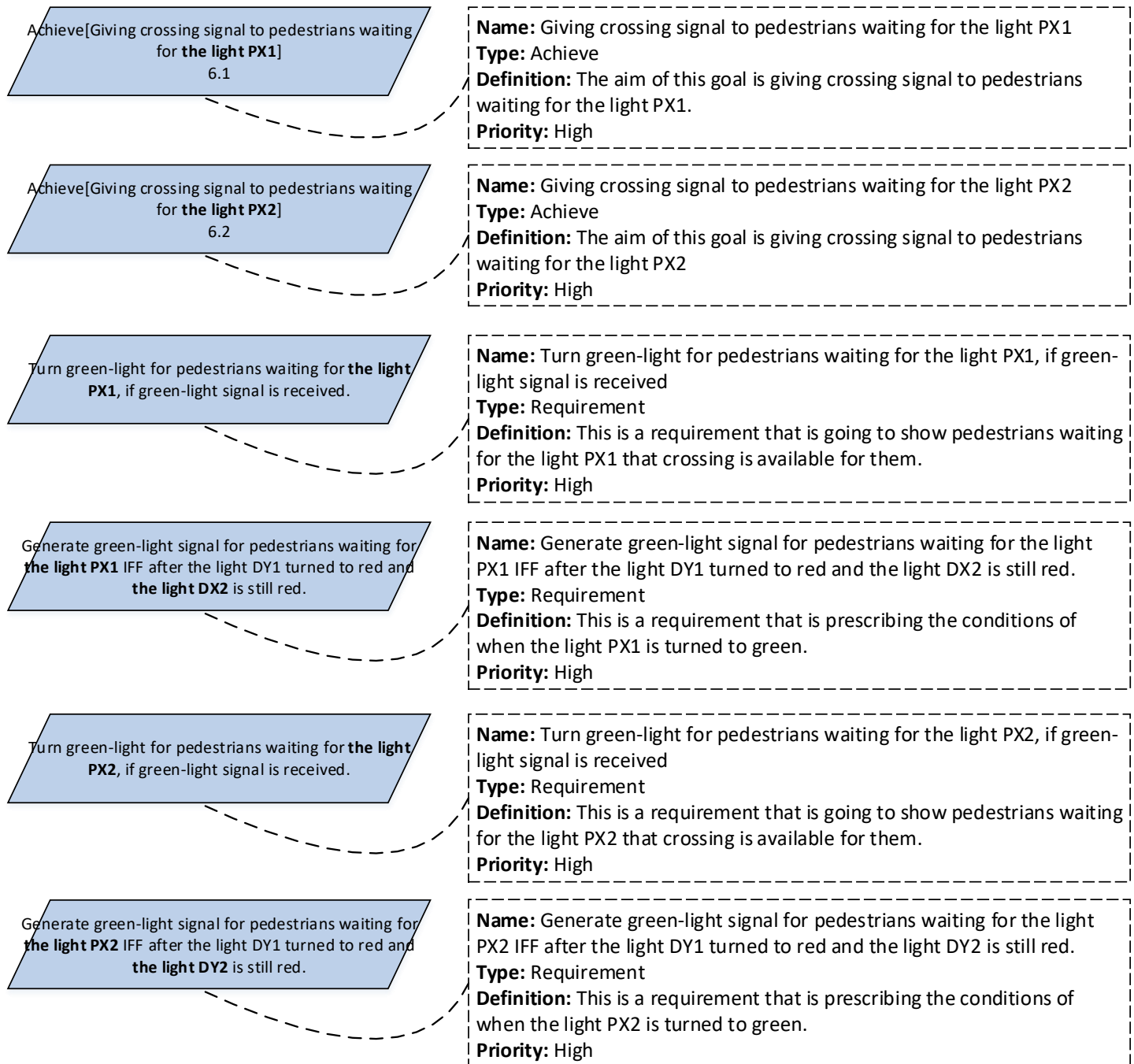


Figure 12 Annotations of sub goals of giving signal to pedestrians to cross on X direction with traffic lights

2.1.1.1.2 Sub goal - Giving signal to pedestrians to stop on X direction with traffic lights

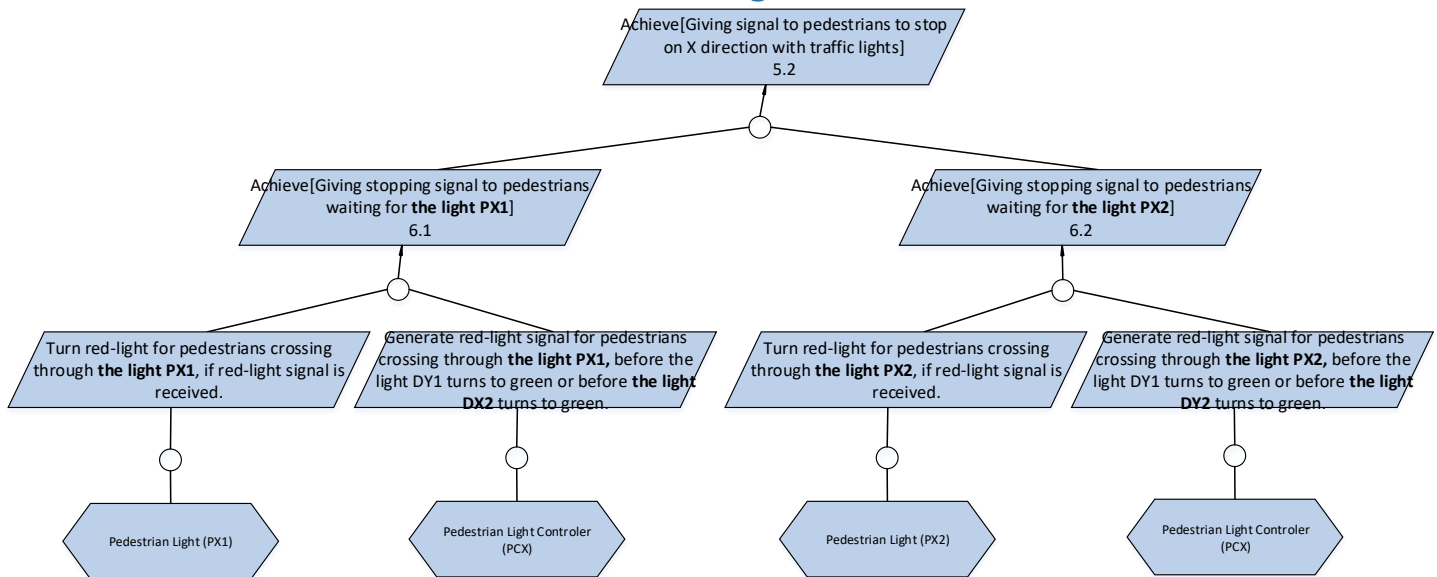
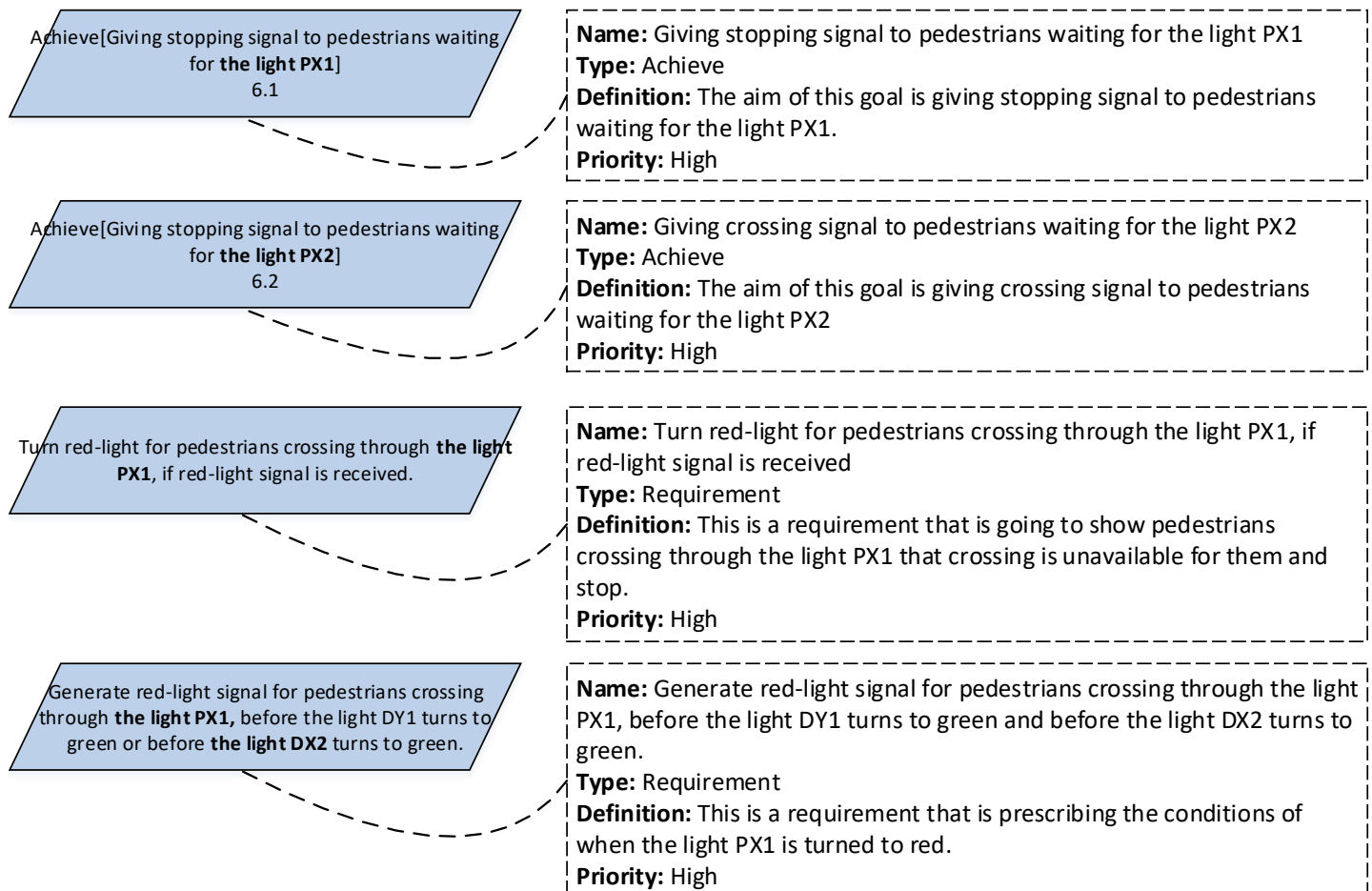


Figure 13 Sub goals of giving signal to pedestrians to stop on X direction with traffic lights



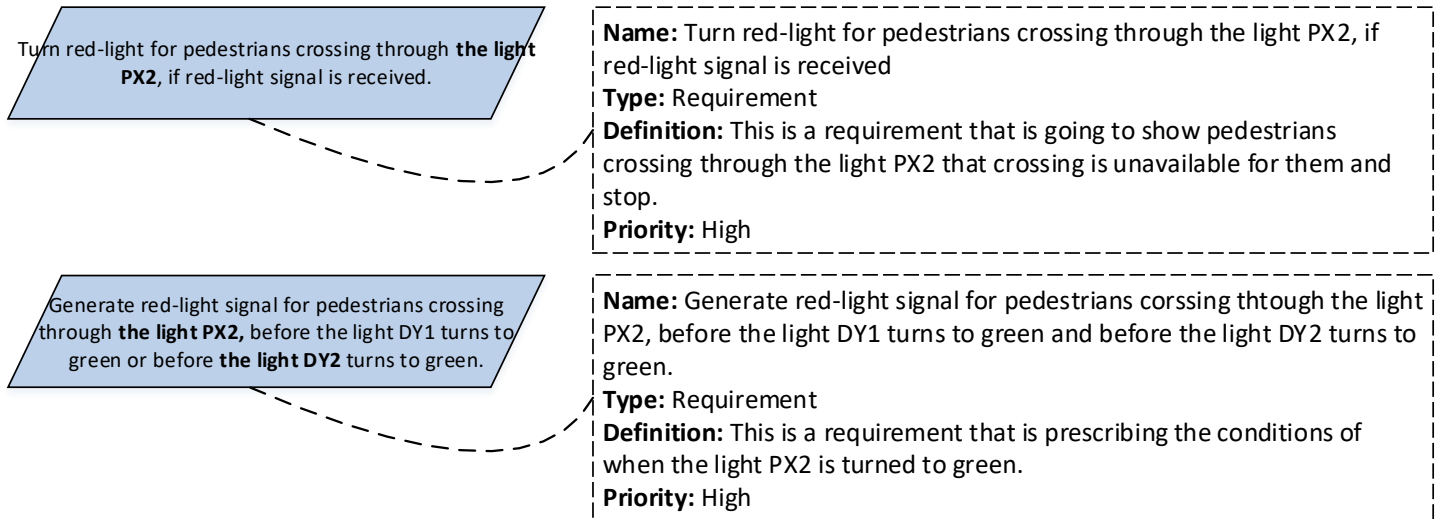


Figure 14 Annotations of sub goals of giving signal to pedestrians to stop on X direction with traffic lights

2.1.1.2 Sub goal - Warning pedestrians correctly on Y direction with visual ways

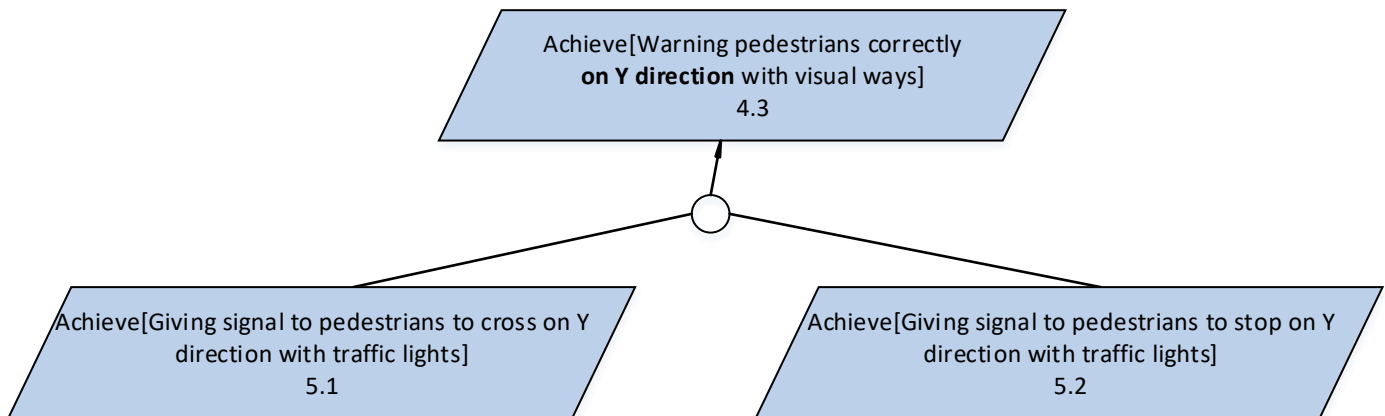


Figure 15 Sub goals of warning pedestrians correctly on Y direction with visual ways

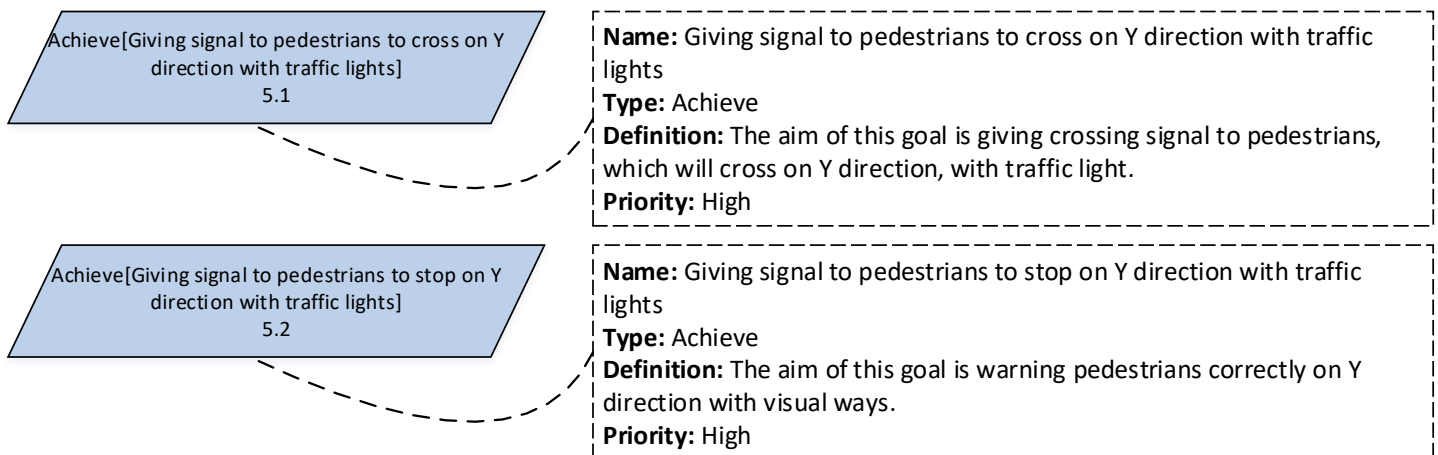


Figure 16 Annotations of sub goals of warning pedestrians correctly on Y direction with visual ways

2.1.1.2.1 Sub goal - Giving signal to pedestrians to cross on Y direction with traffic lights

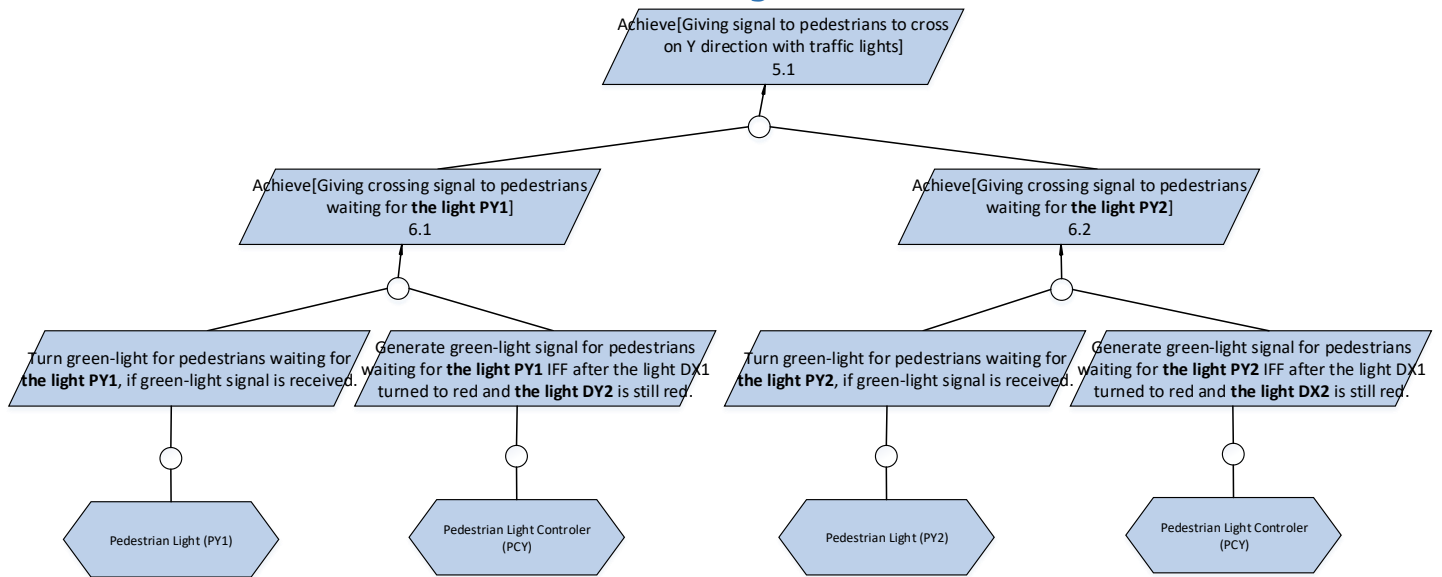
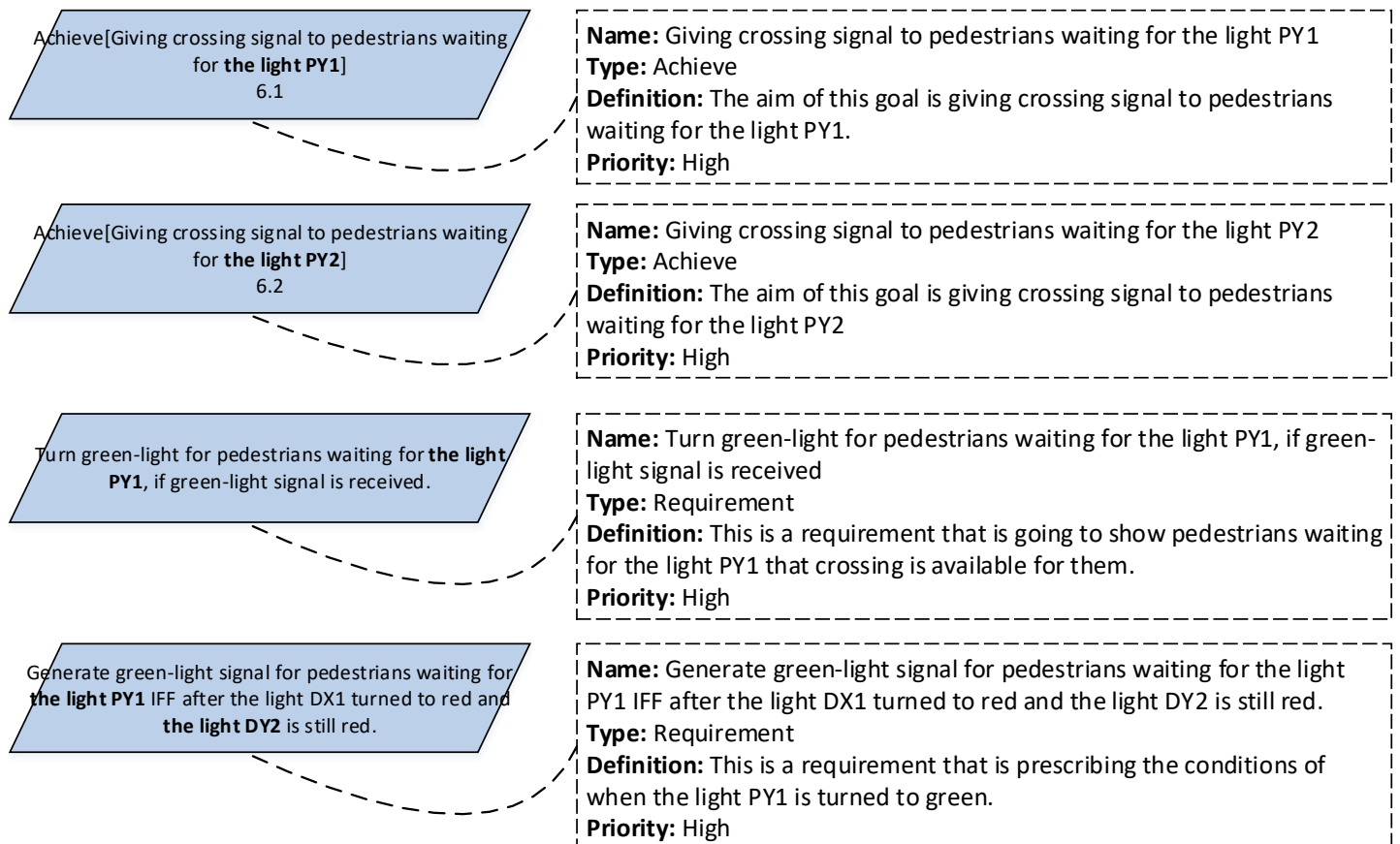


Figure 17 Sub goals of giving signal to pedestrians to cross on Y direction with traffic lights



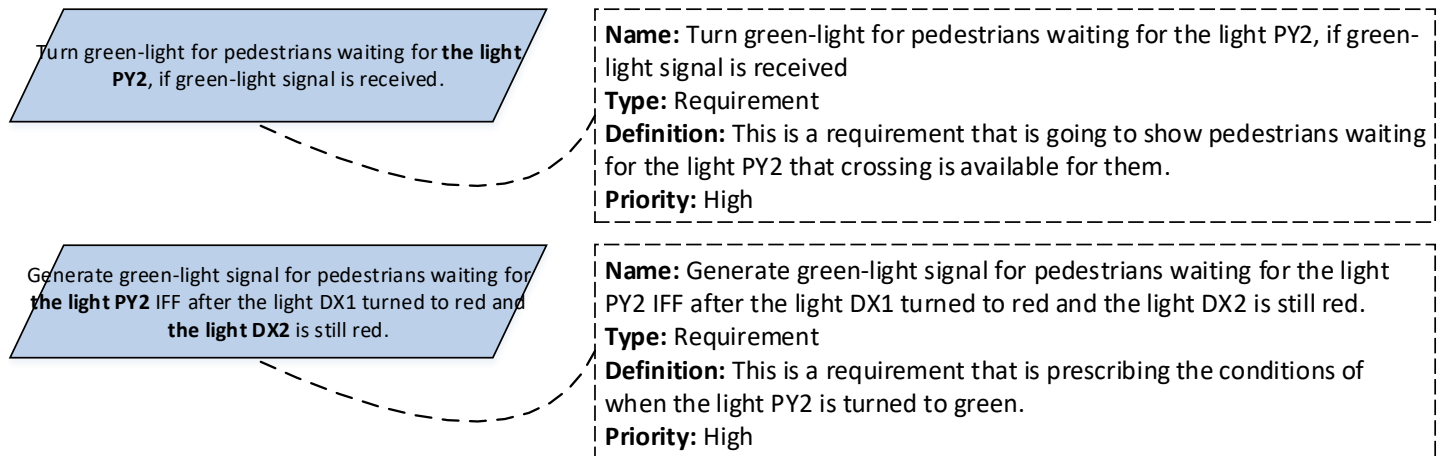


Figure 18 Annotations of sub goals of giving signal to pedestrians to cross on Y direction with traffic lights

2.1.1.2.2 Sub goal - Giving signal to pedestrians to stop on Y direction with traffic lights

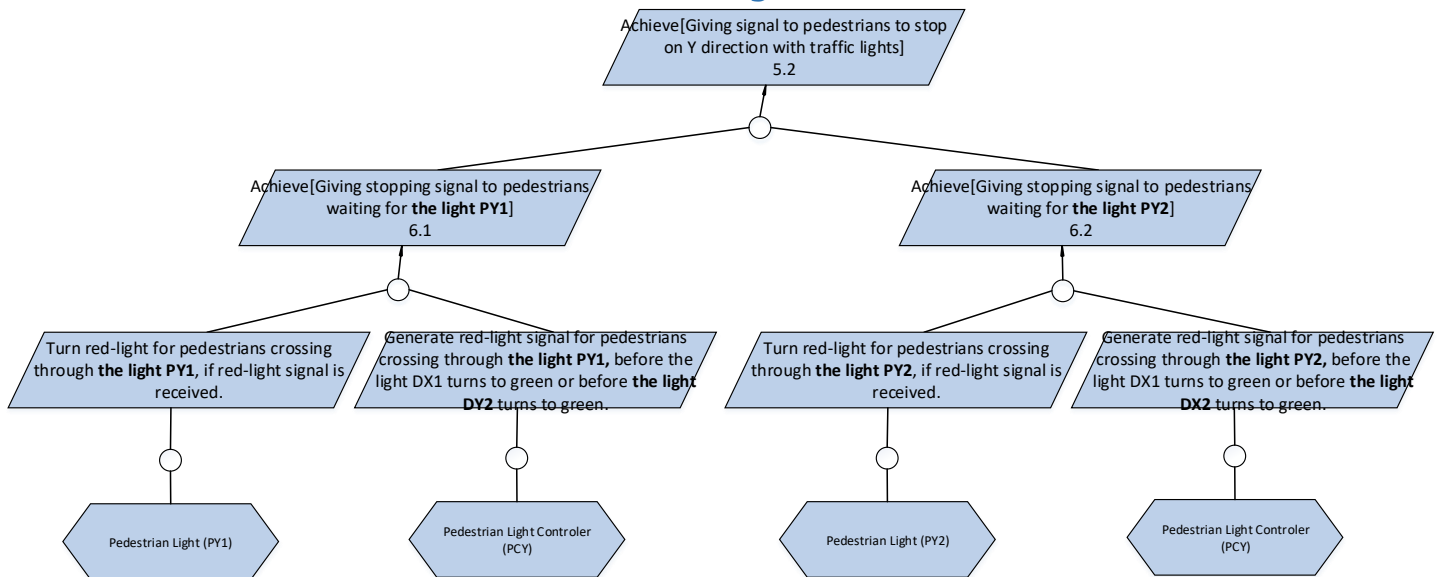
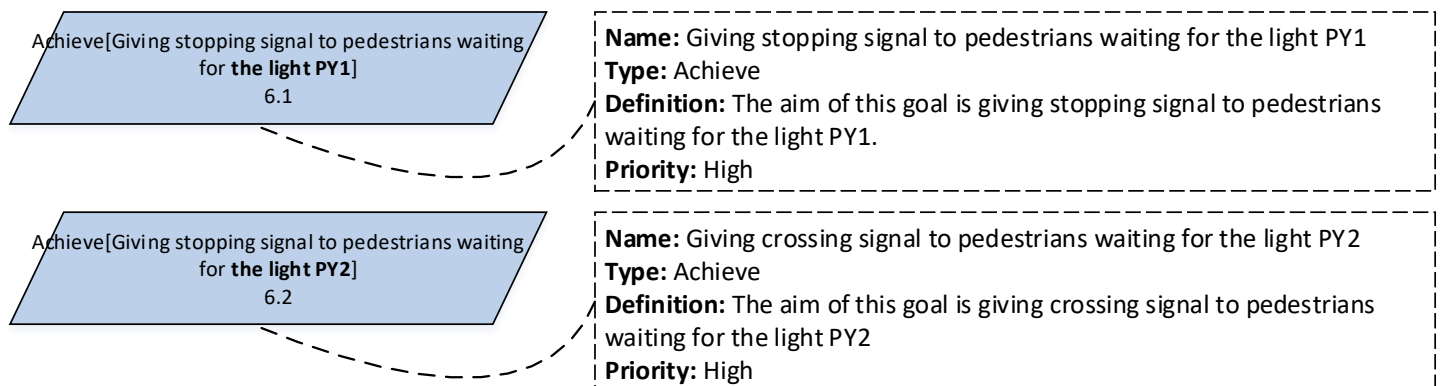


Figure 19 Sub goals of giving signal to pedestrians to stop on Y direction with traffic lights



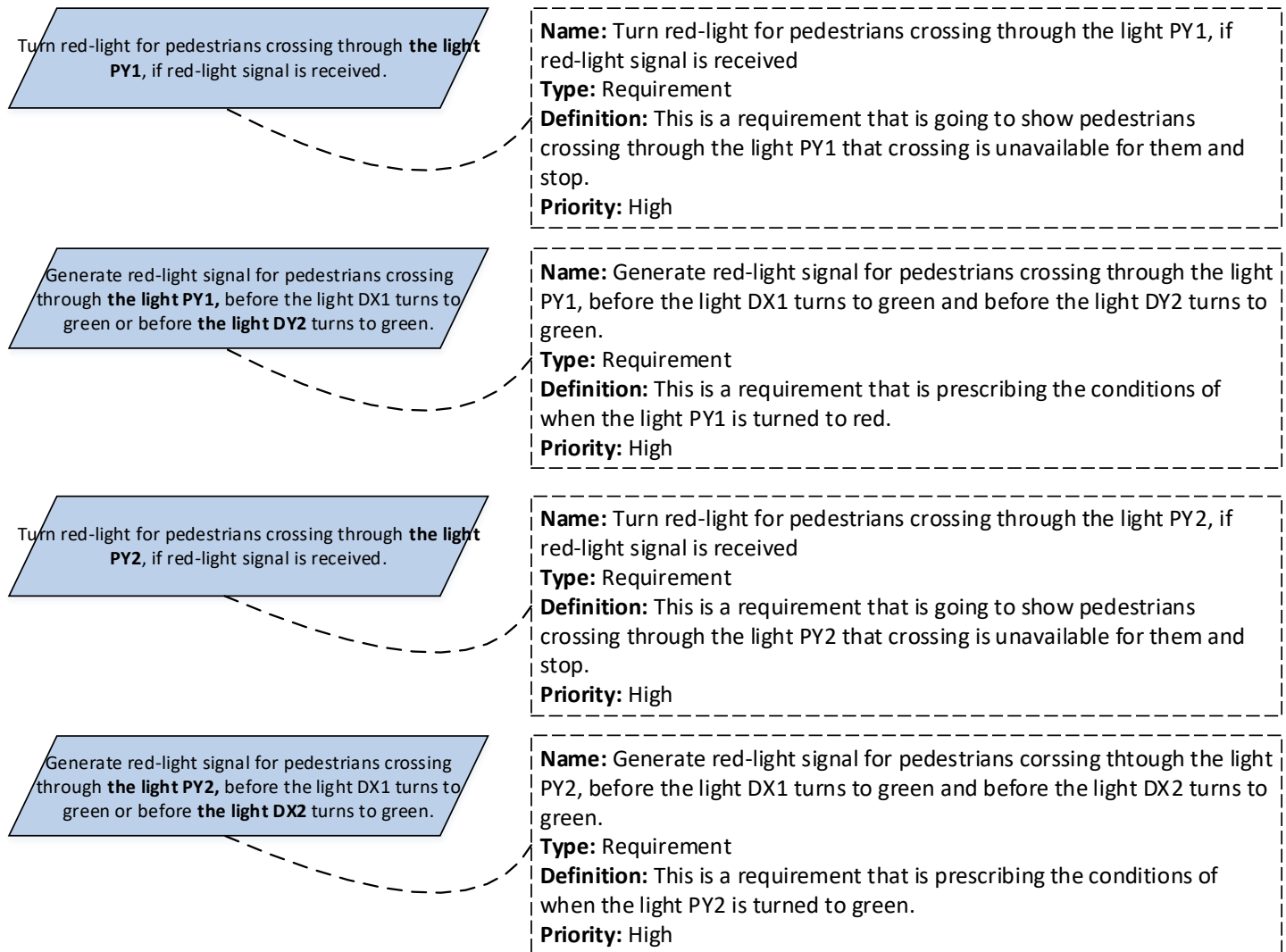


Figure 20 Annotations of sub goals of giving signal to pedestrians to stop on Y direction with traffic lights

2.1.2 Sub goal - Avoiding pedestrians and vehicles collision on the same direction

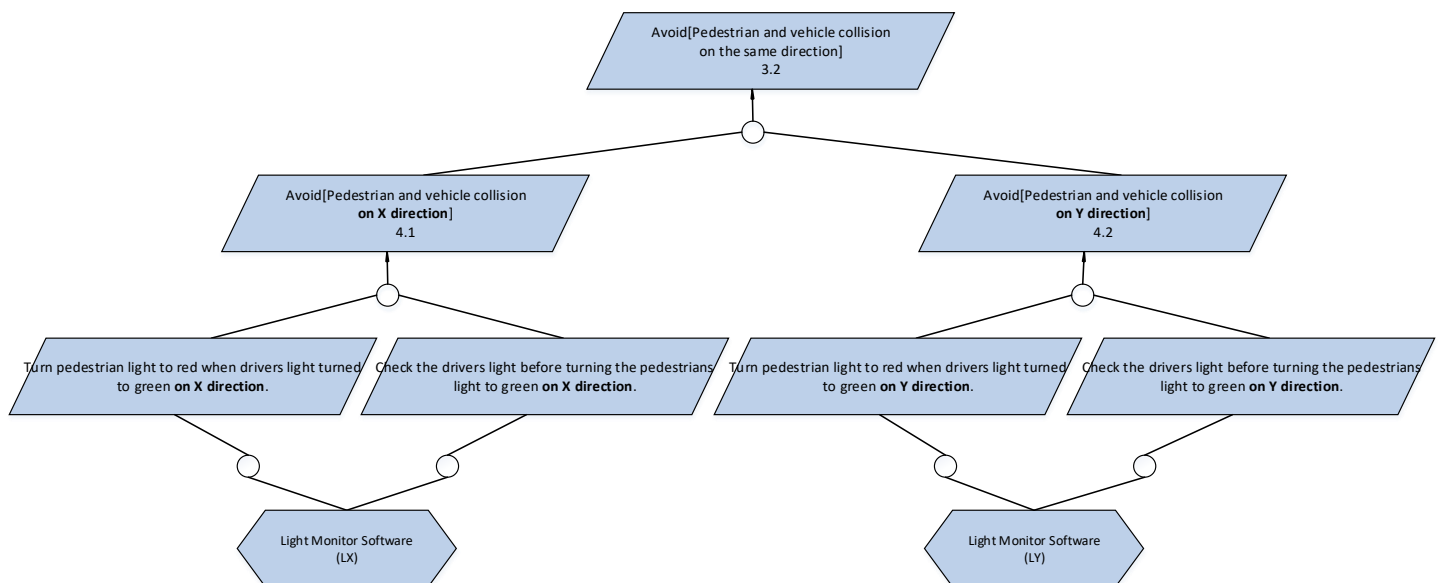


Figure 21 Sub goals of avoiding pedestrians and vehicles collision on the same direction

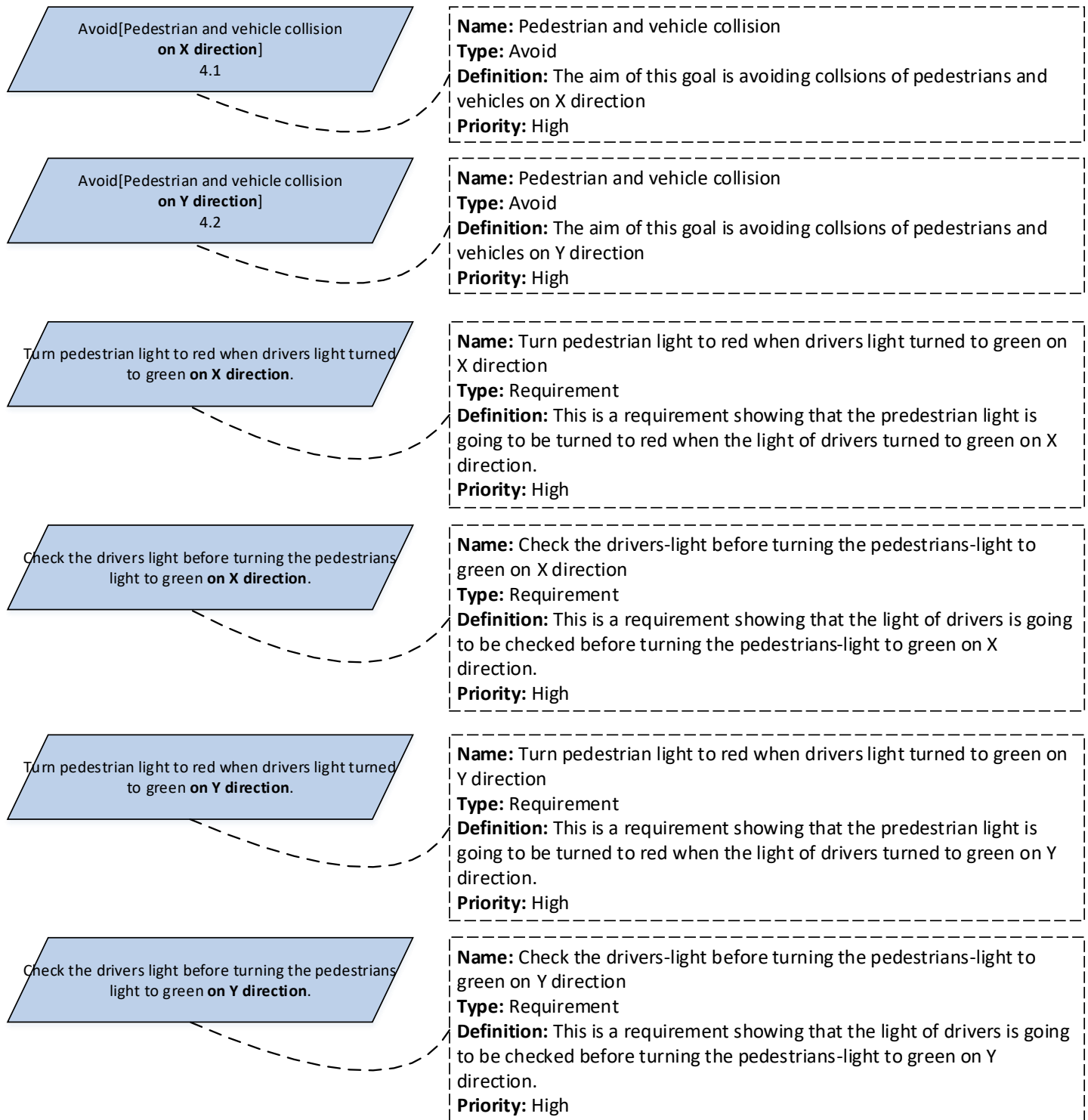


Figure 22 Annotations of sub goals of avoiding pedestrians and vehicles collision on the same direction

2.1.3 Sub goal - Avoiding vehicles and vehicles collision on the different directions

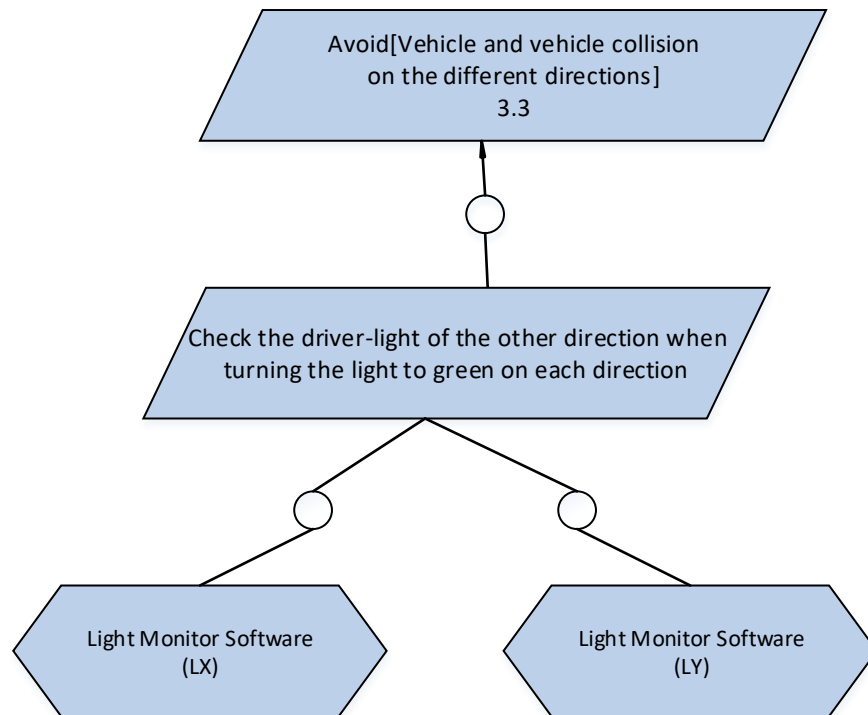


Figure 23 Sub goals of avoiding vehicles and vehicles collision on the different directions

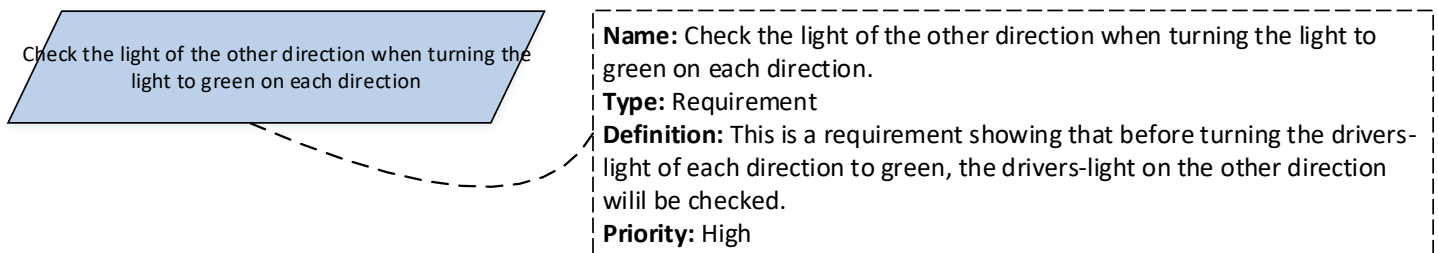


Figure 24 Annotations of sub goals of avoiding vehicles and vehicles collision on the different directions

2.1.4 Sub goal - Warning drivers with visual ways correctly

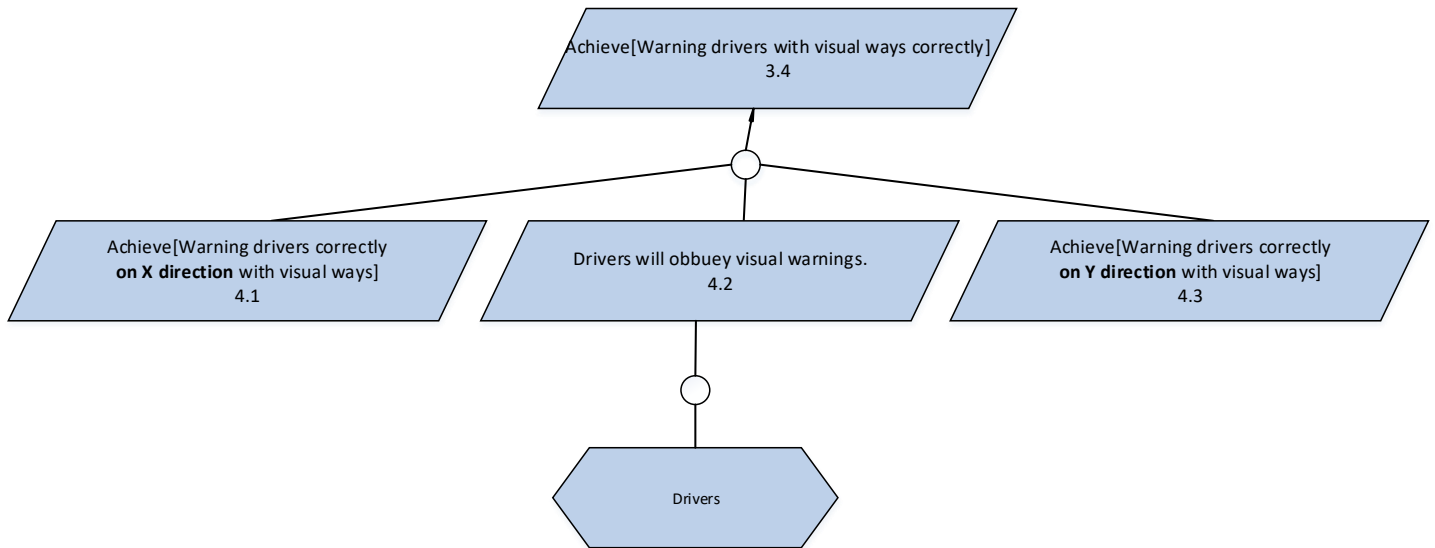


Figure 25 Sub goals of warning drivers with visual ways correctly

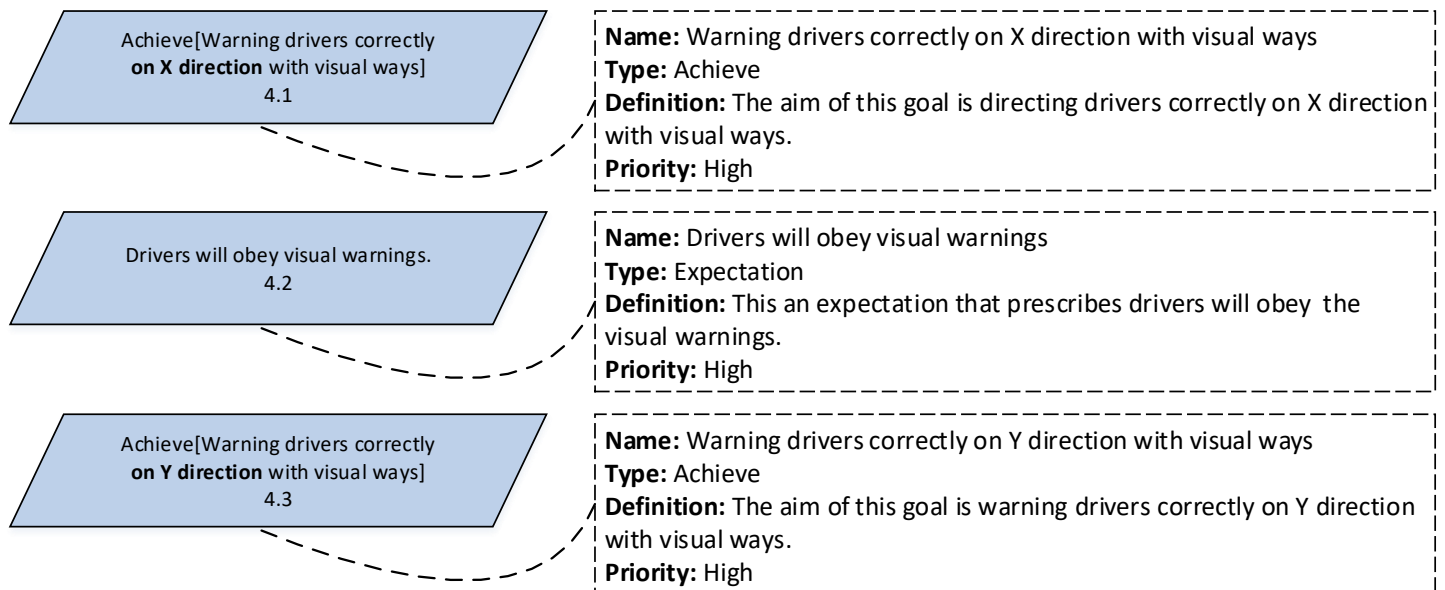


Figure 26 Annotations of sub goals of warning drivers with visual ways correctly

2.1.4.1 Sub goal - Warning drivers correctly on X direction with visual ways

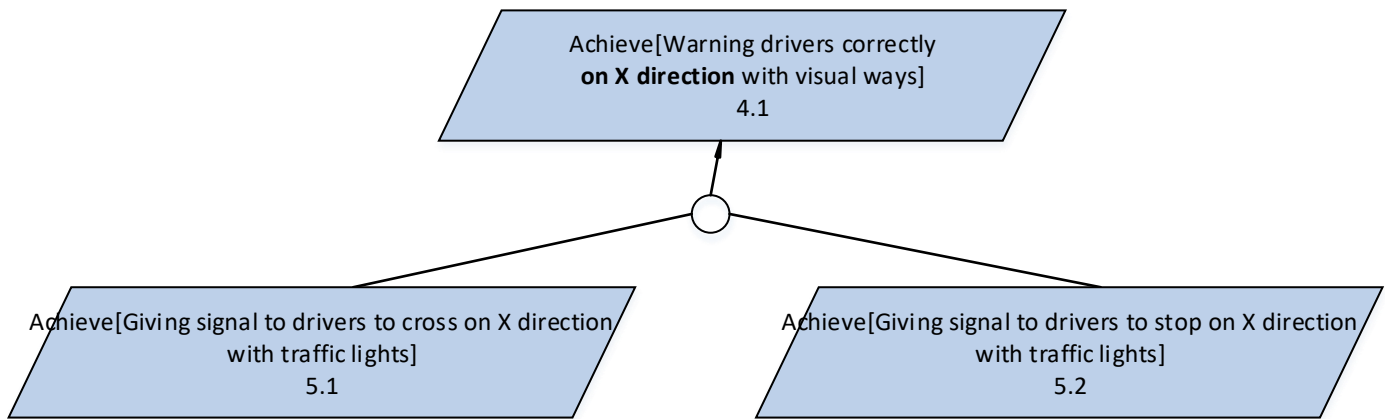


Figure 27 Sub goals of warning drivers correctly on X direction with visual ways

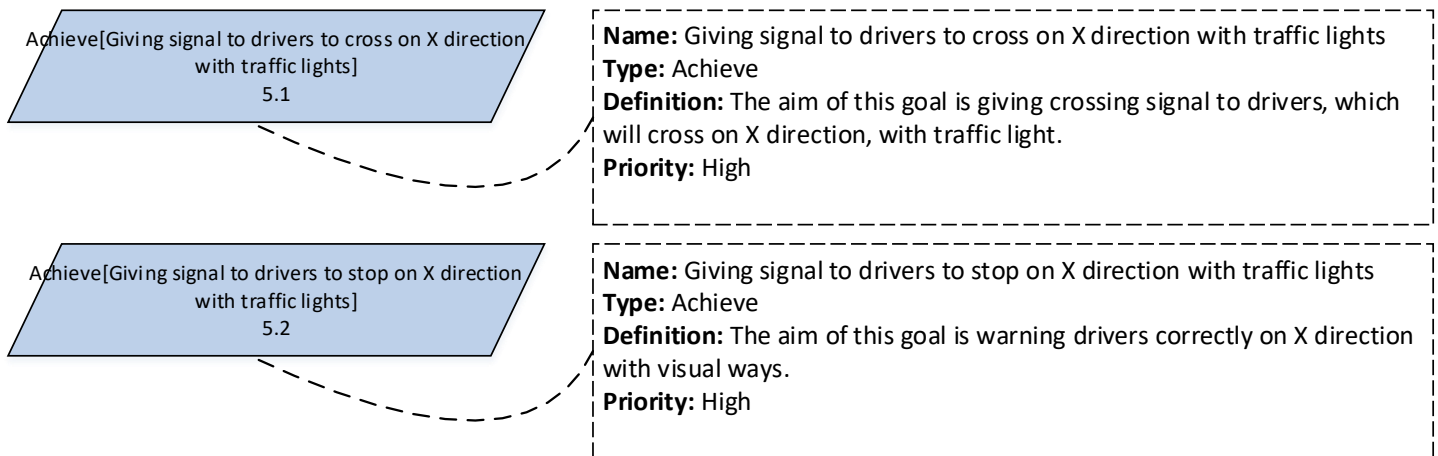


Figure 28 Annotations of sub goals of warning drivers correctly on X direction with visual ways

2.1.4.1.1 Sub goal - Giving signal to drivers to cross on X direction with traffic lights

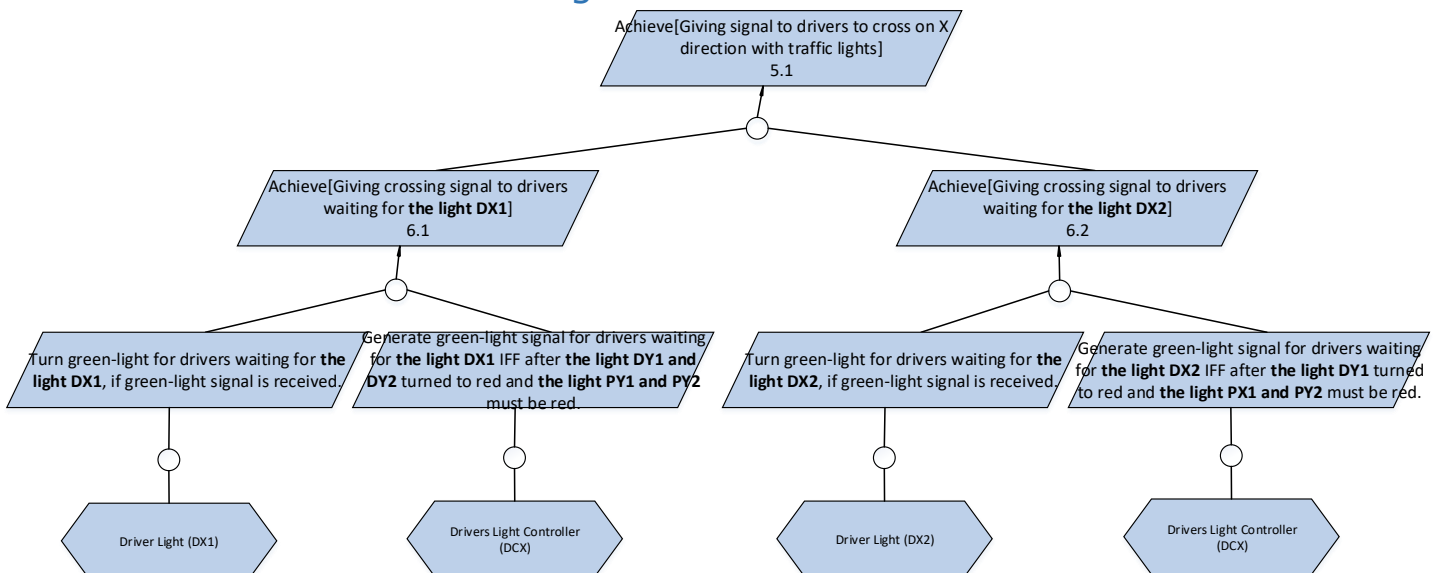


Figure 29 Sub goals of giving signal to drivers to cross on X direction with traffic lights

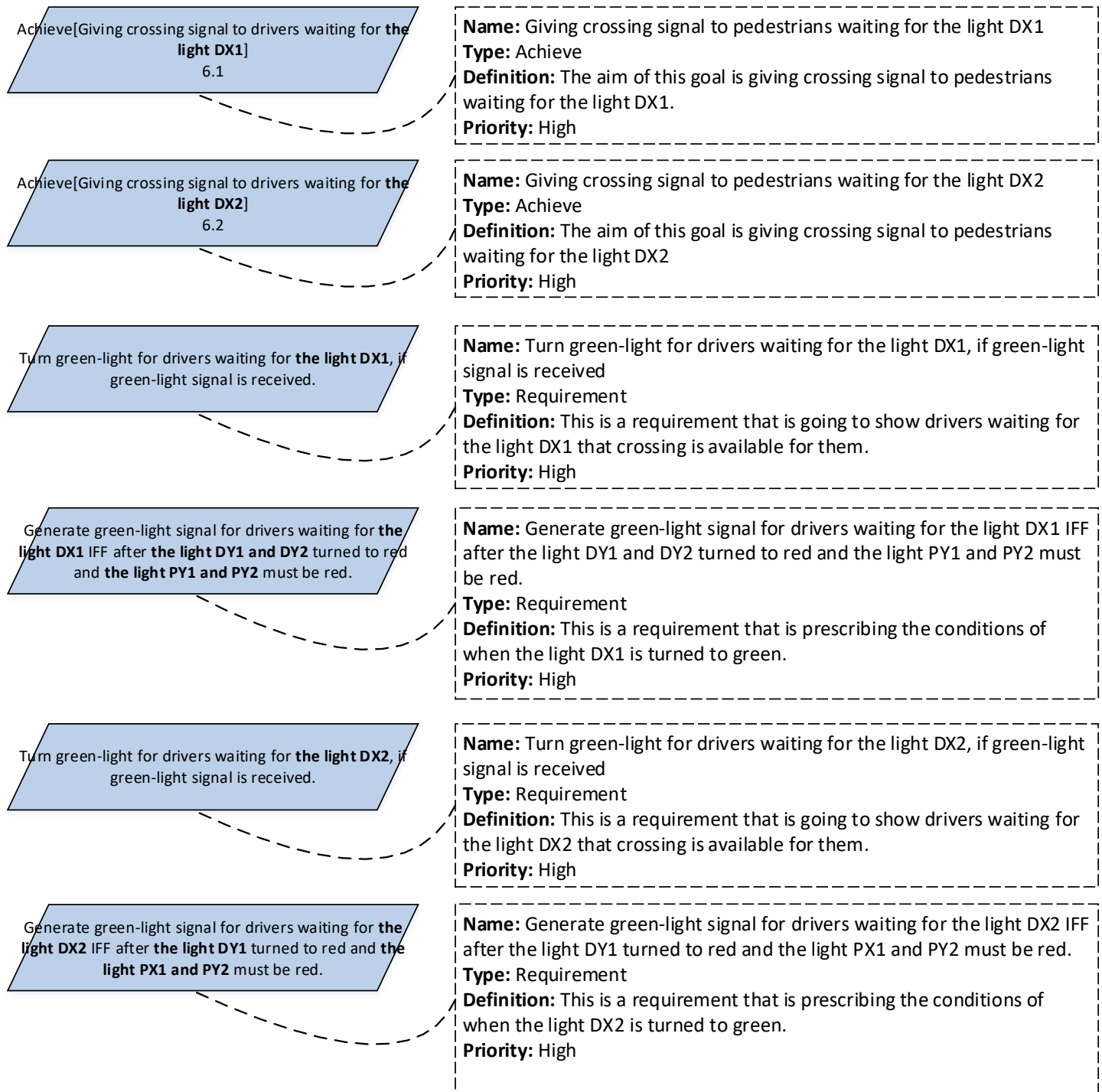


Figure 30 Annotations of sub goals of giving signal to drivers to cross on X direction with traffic lights

2.1.4.1.2 Sub goal - Giving signal to drivers to stop on X direction with traffic lights

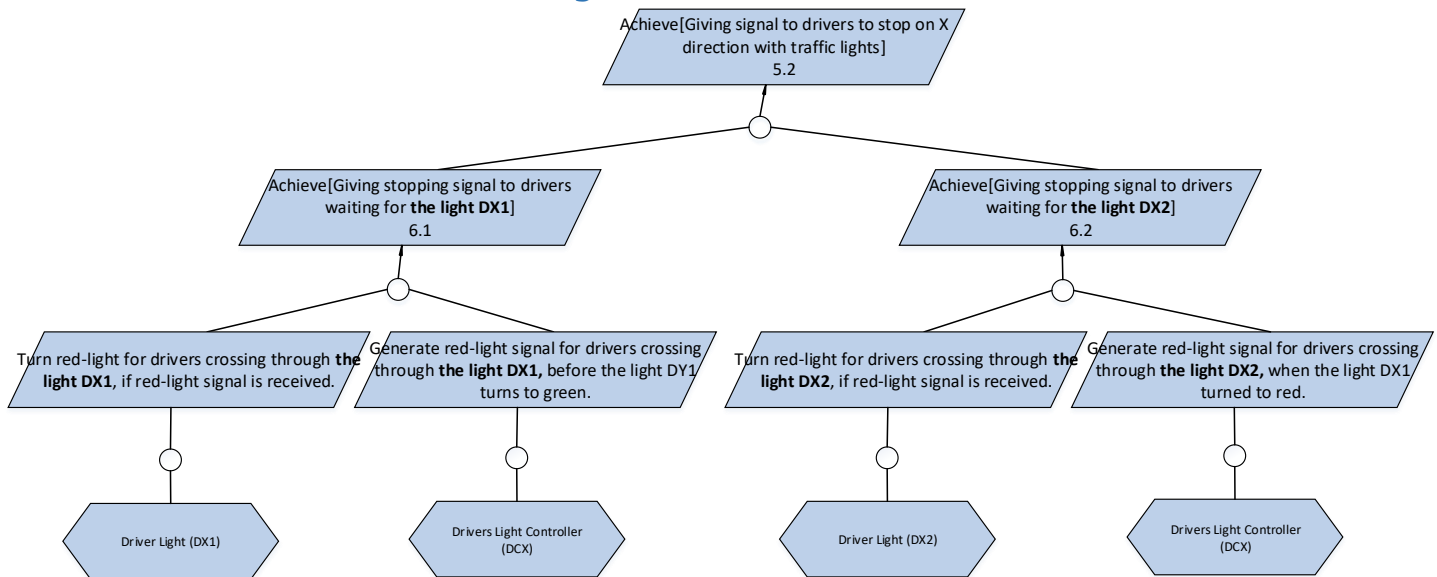
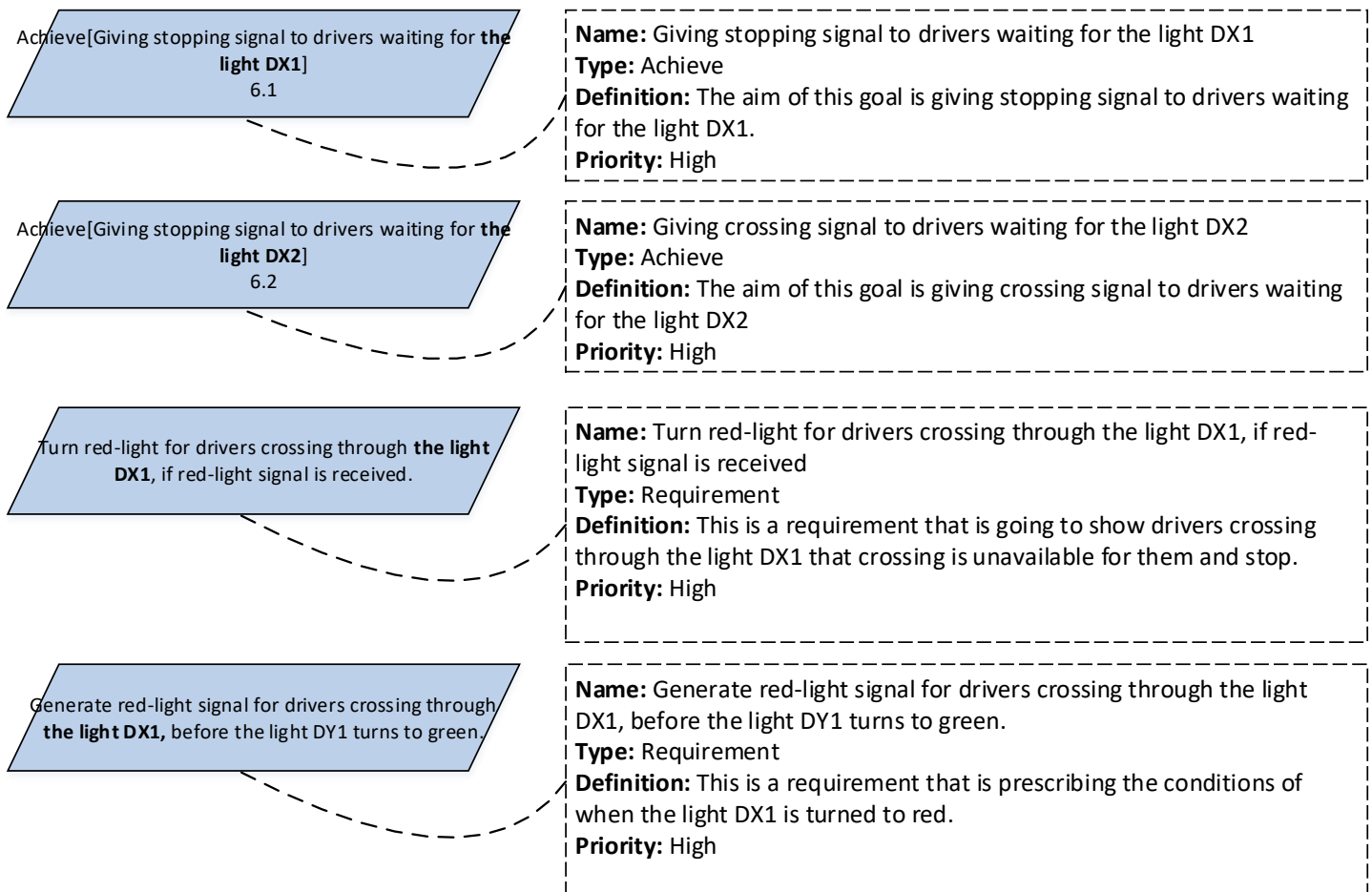


Figure 31 Sub goals of giving signal to drivers to stop on X direction with traffic lights



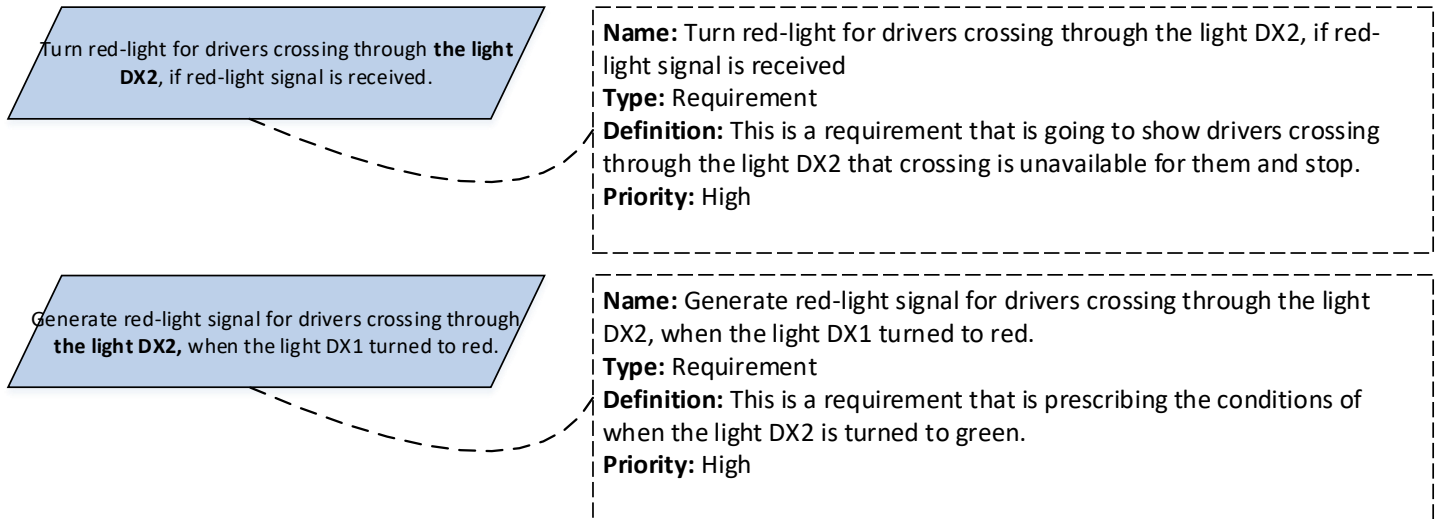


Figure 32 Annotations of sub goals of giving signal to drivers to stop on X direction with traffic lights

2.1.4.2 Sub goal - Warning drivers correctly on Y direction with visual ways

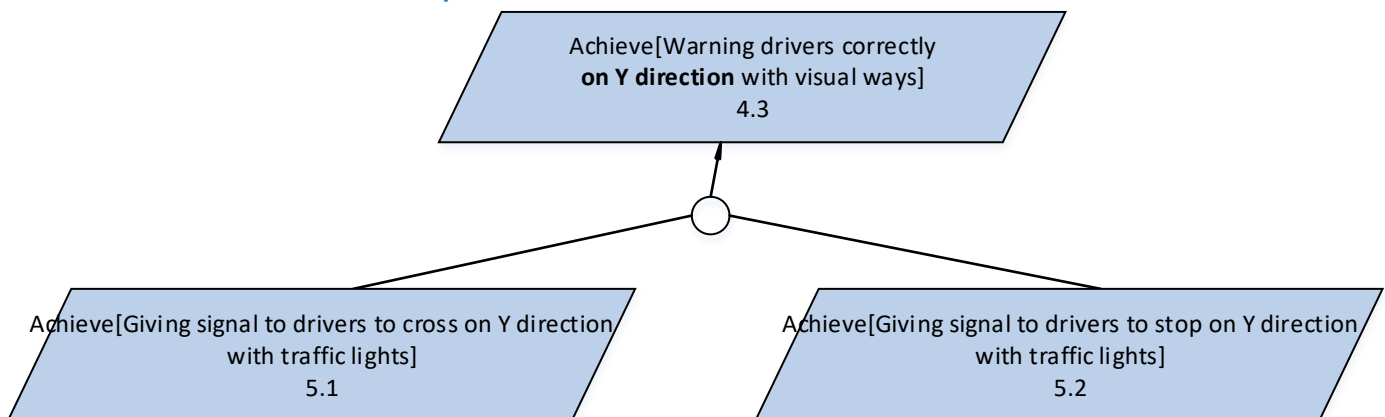


Figure 33 Sub goals of warning drivers correctly on Y direction with visual ways

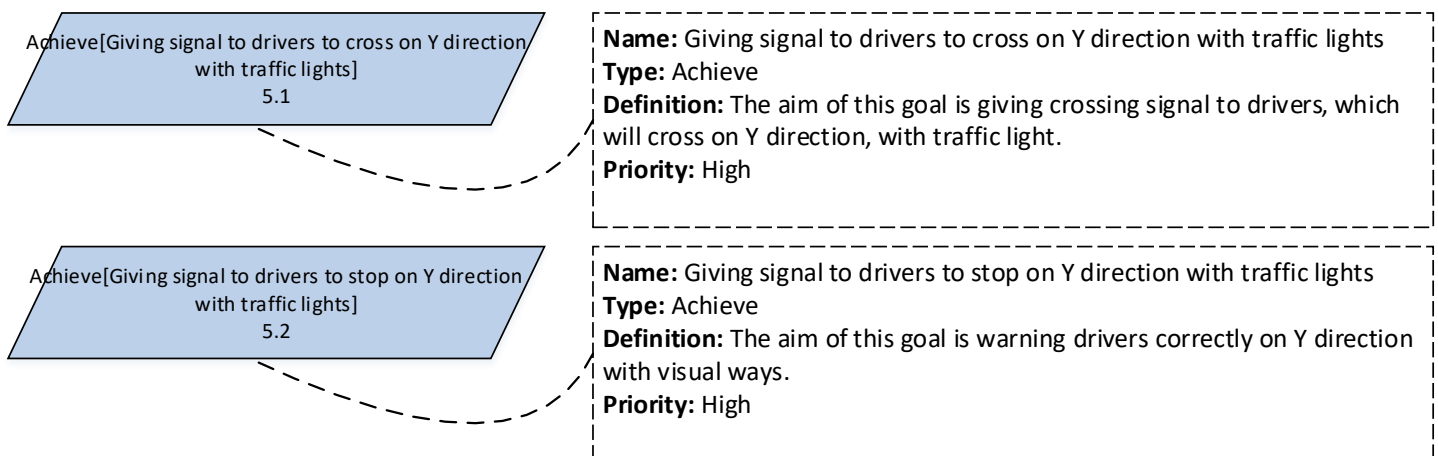


Figure 34 Annotations of sub goals of warning drivers correctly on Y direction with visual ways

2.1.4.2.1 Sub goal - Giving signal to drivers to cross on Y direction with traffic lights

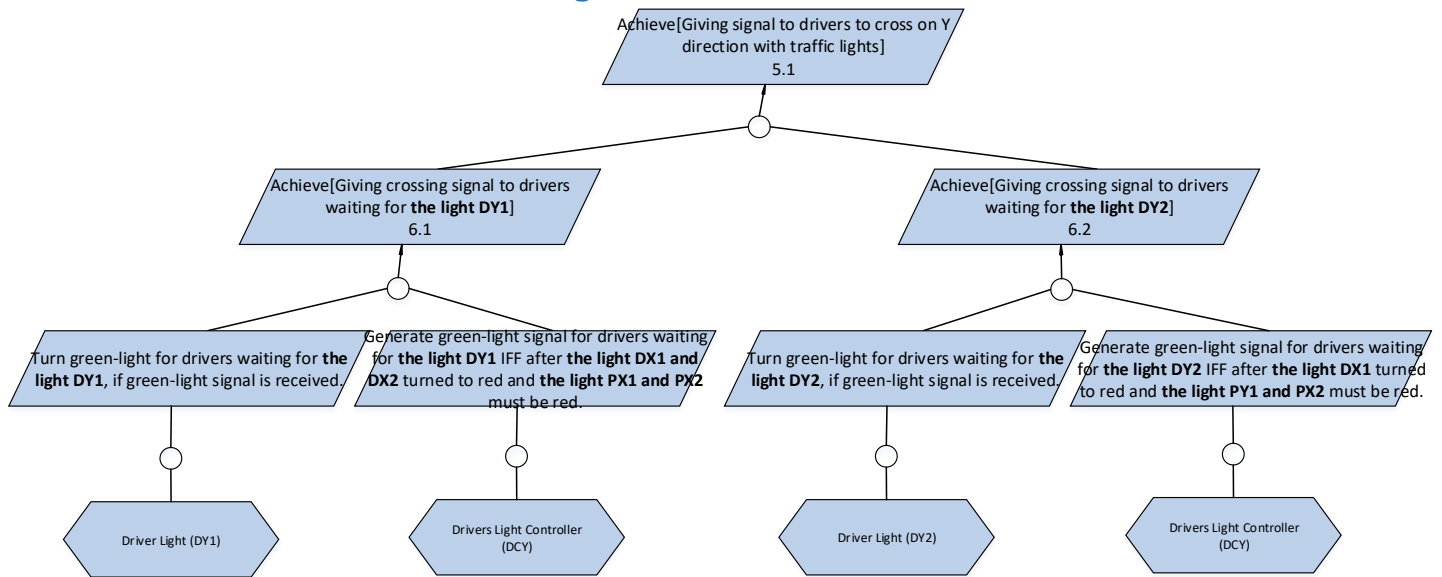
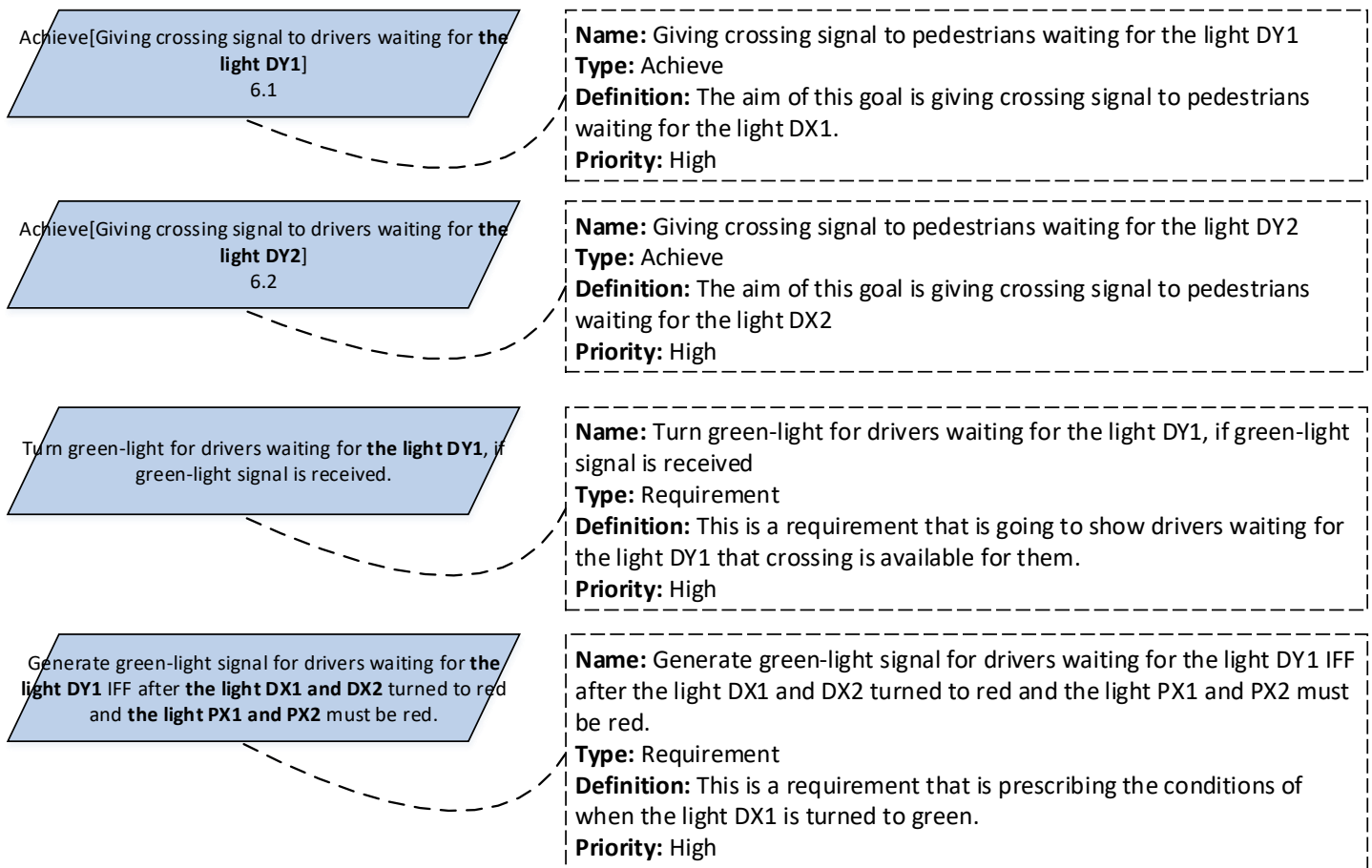


Figure 35 Sub goals of giving signal to drivers to cross on Y direction with traffic lights



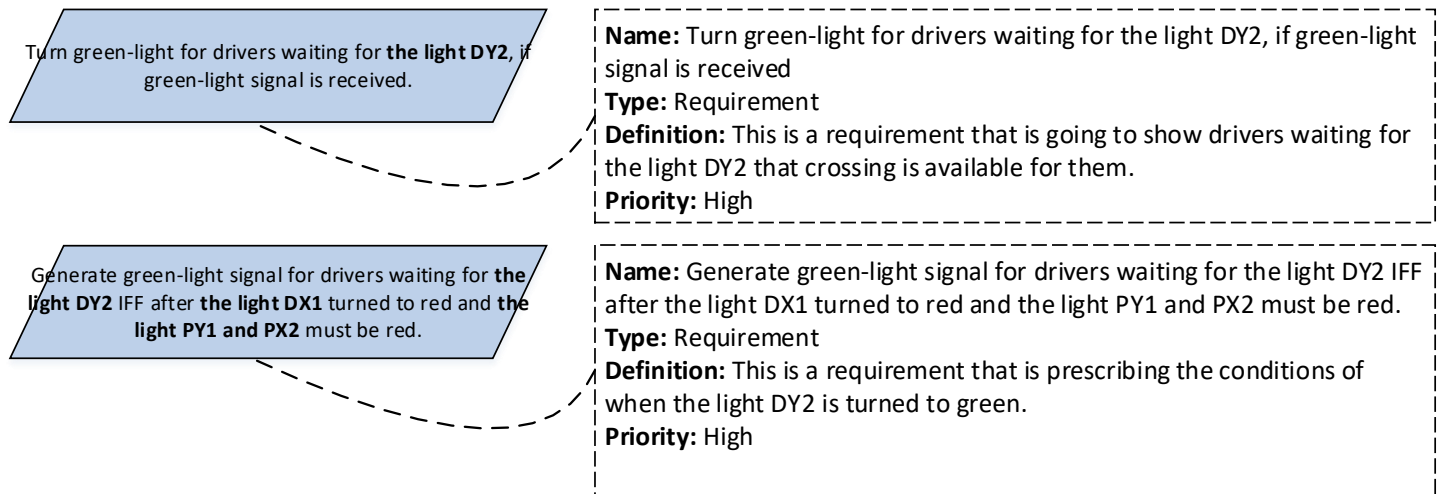


Figure 36 Annotations of sub goals of giving signal to drivers to cross on Y direction with traffic lights

2.1.4.2.2 Sub goal - Giving signal to drivers to stop on Y direction with traffic lights

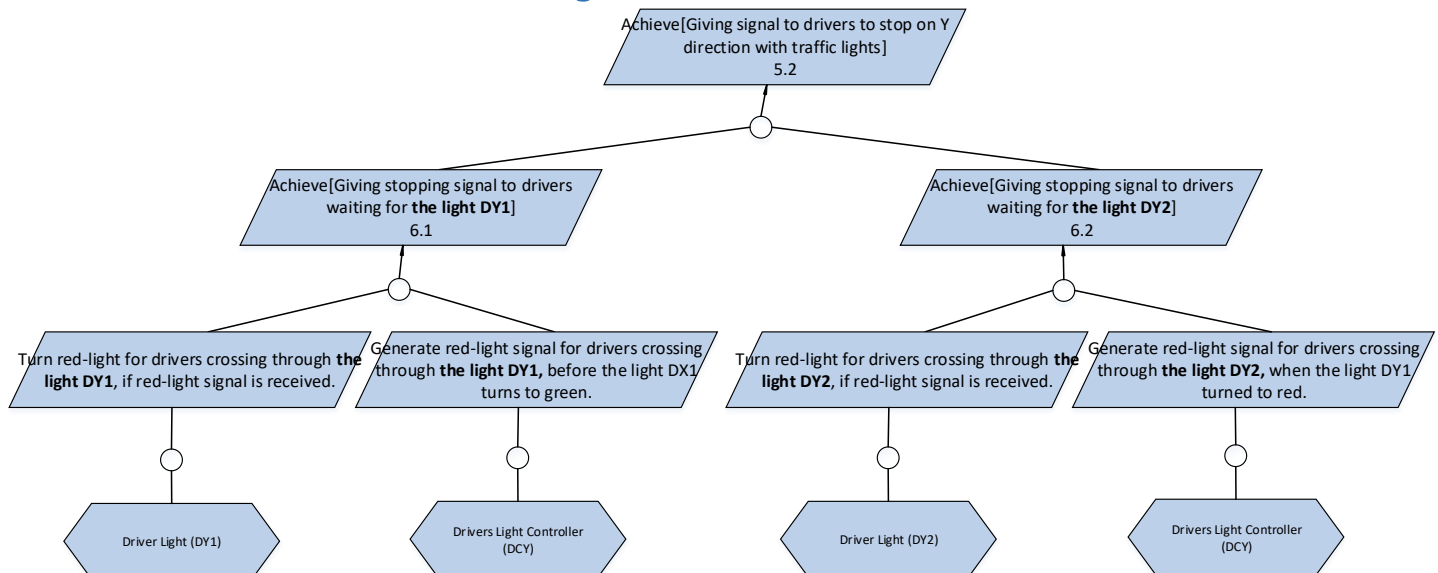
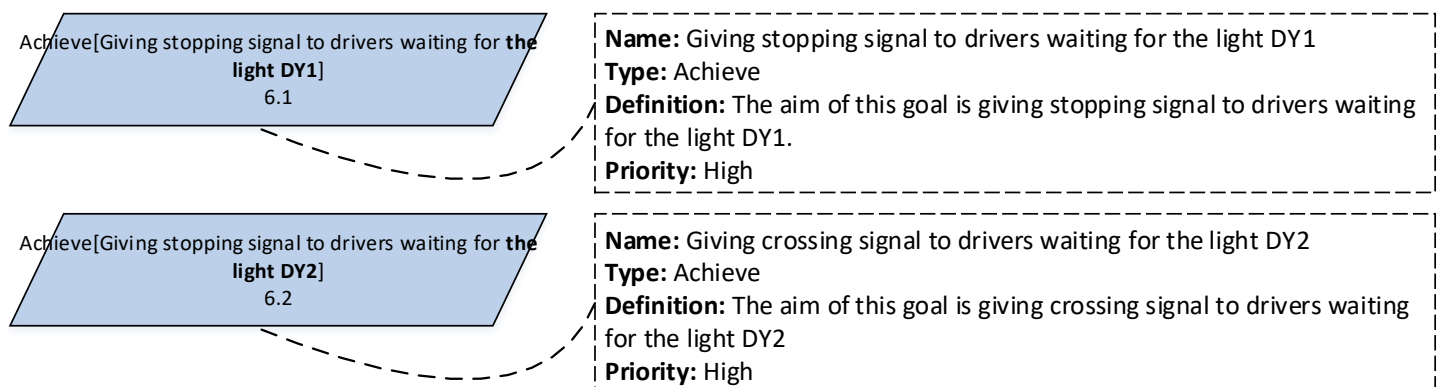


Figure 37 Sub goals of giving signal to drivers to stop on Y direction with traffic lights



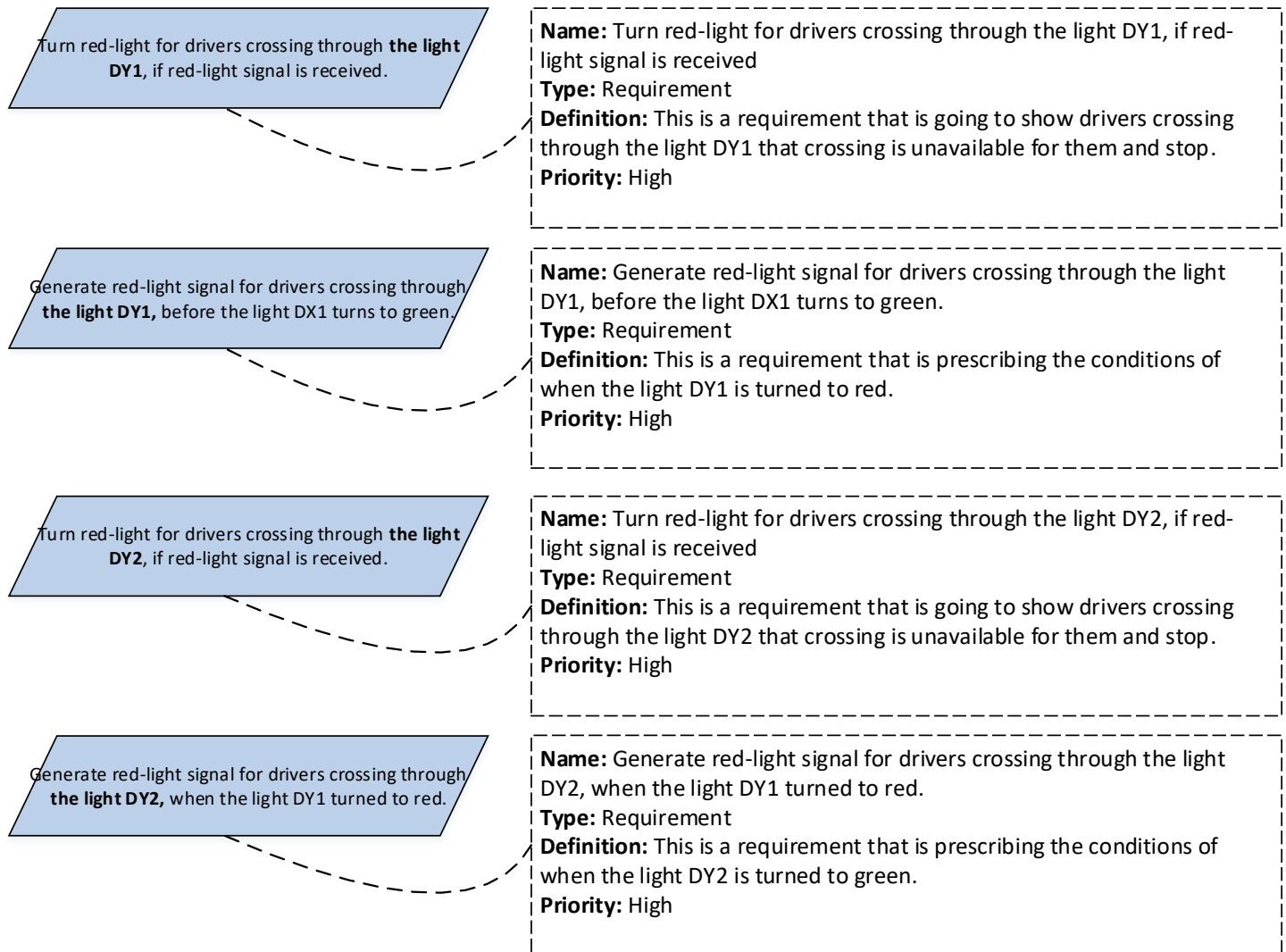


Figure 38 Annotations of sub goals of giving signal to drivers to stop on Y direction with traffic lights

2.2 Sub goal - Efficient traffic flow

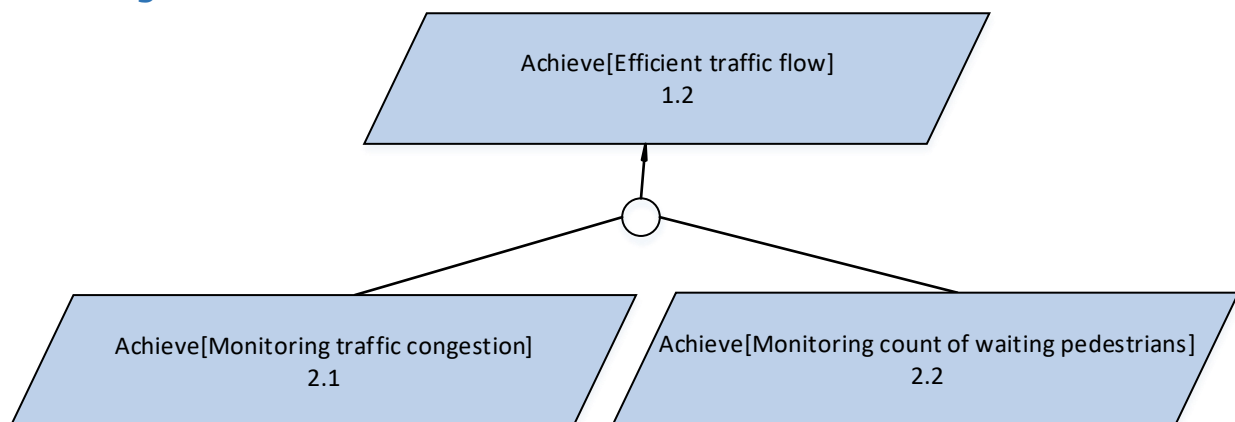


Figure 39 Sub goals of efficient traffic flow

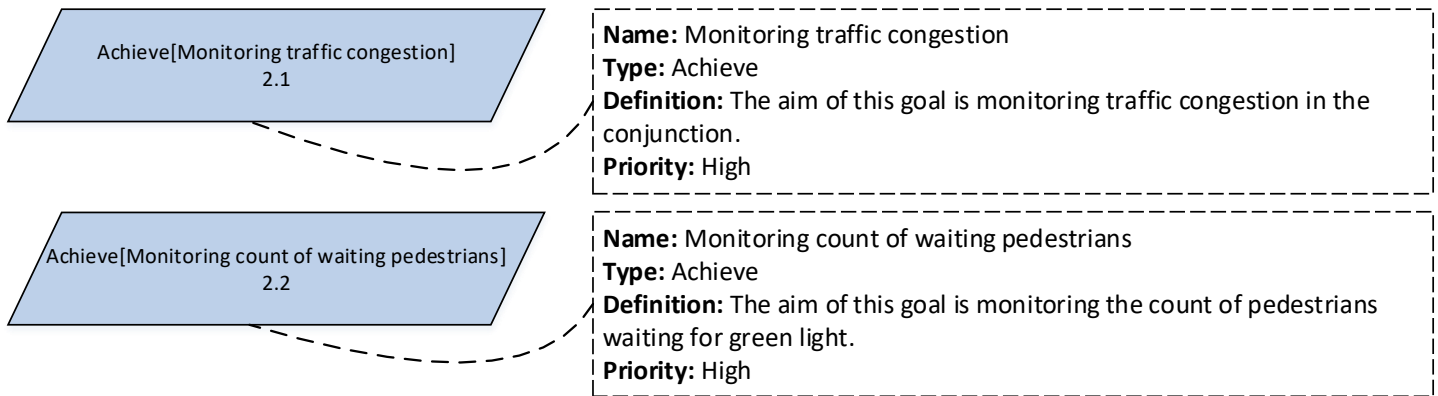


Figure 40 Annotations of sub goals of efficient traffic flow

2.2.1 Sub goal - Monitoring traffic congestion

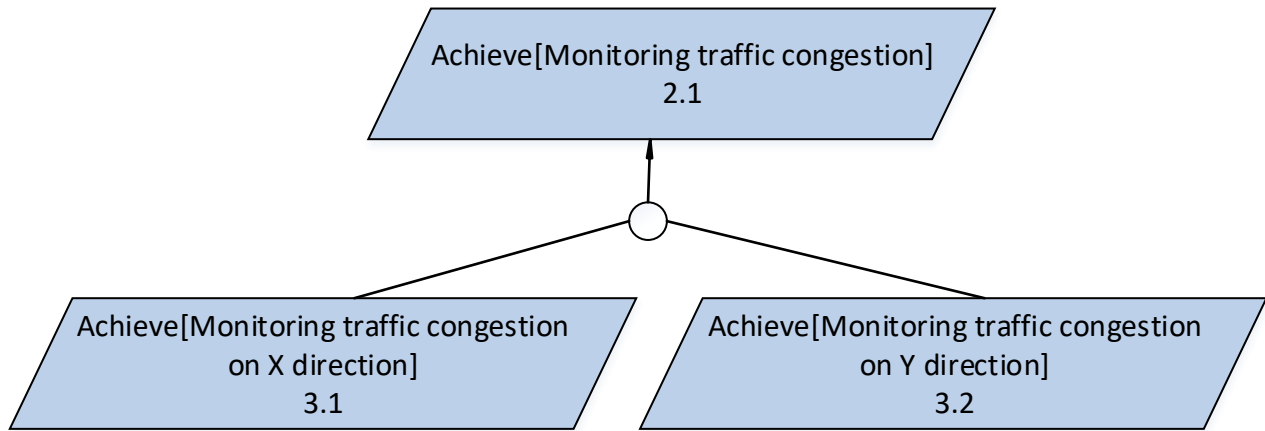


Figure 41 Sub goals of monitoring traffic congestion

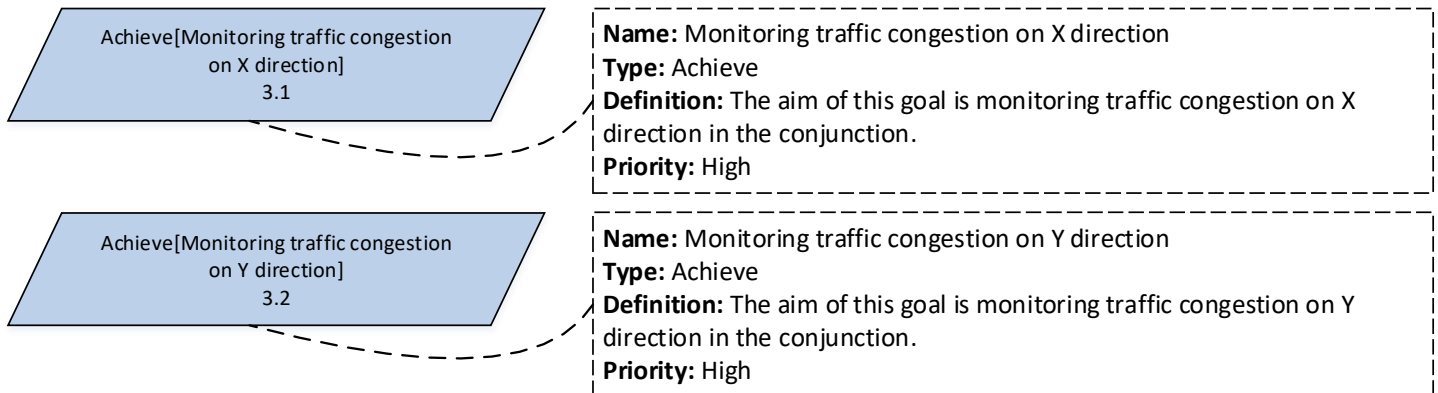


Figure 42 Annotations of sub goals of monitoring traffic congestion

2.2.1.1 Sub goal - Monitoring traffic congestion on X direction

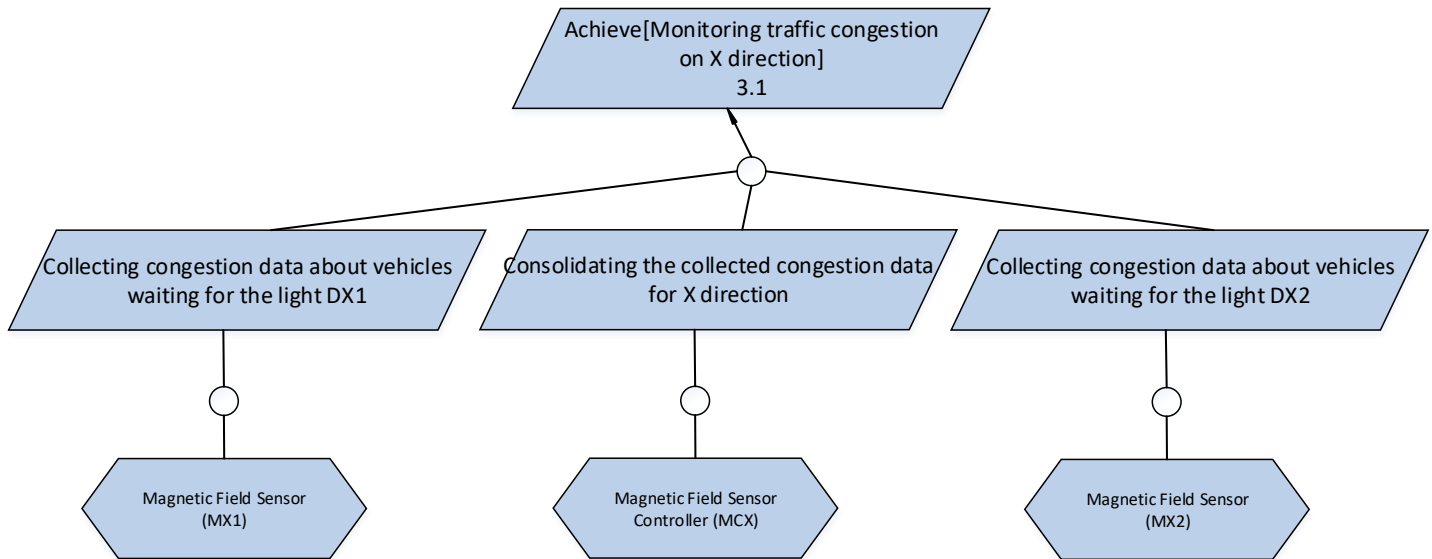


Figure 43 Sub goals of monitoring traffic congestion on X direction

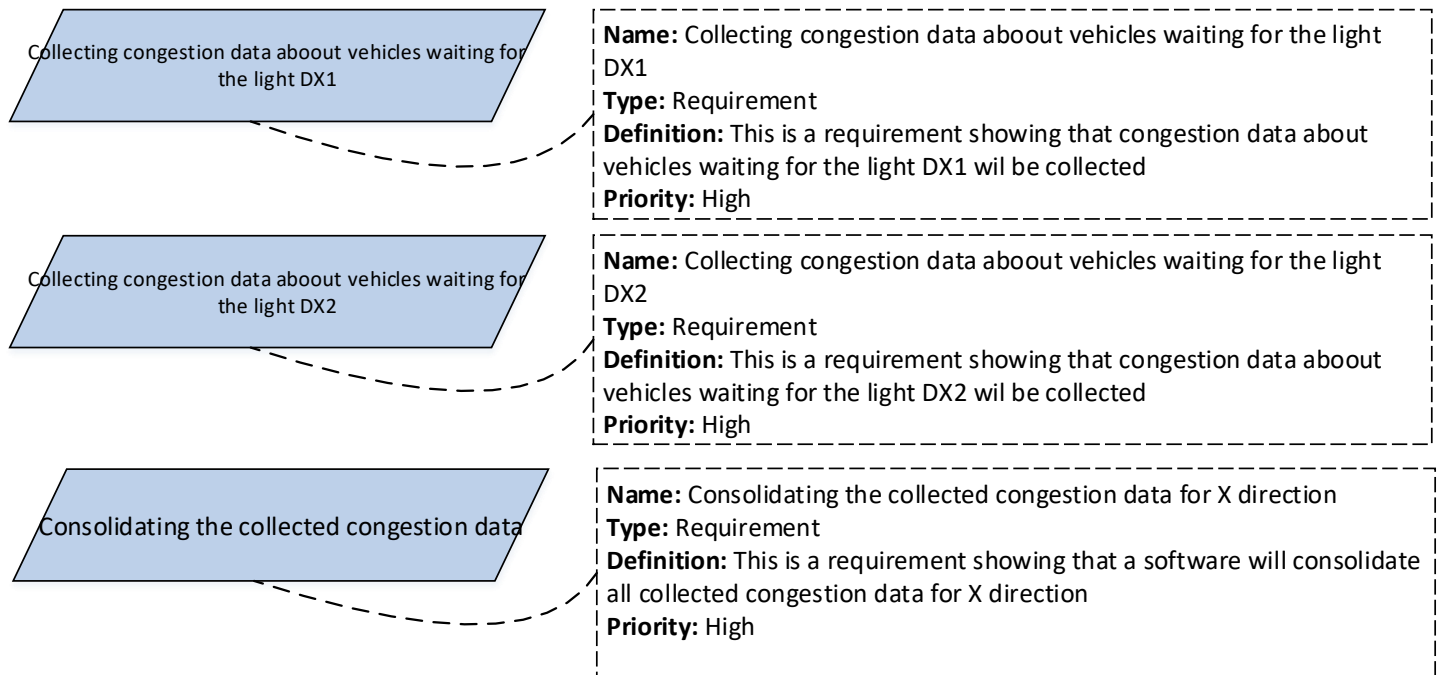


Figure 44 Annotations of sub goals of monitoring traffic congestion on X direction

2.2.1.2 Sub goal - Monitoring traffic congestion on Y direction

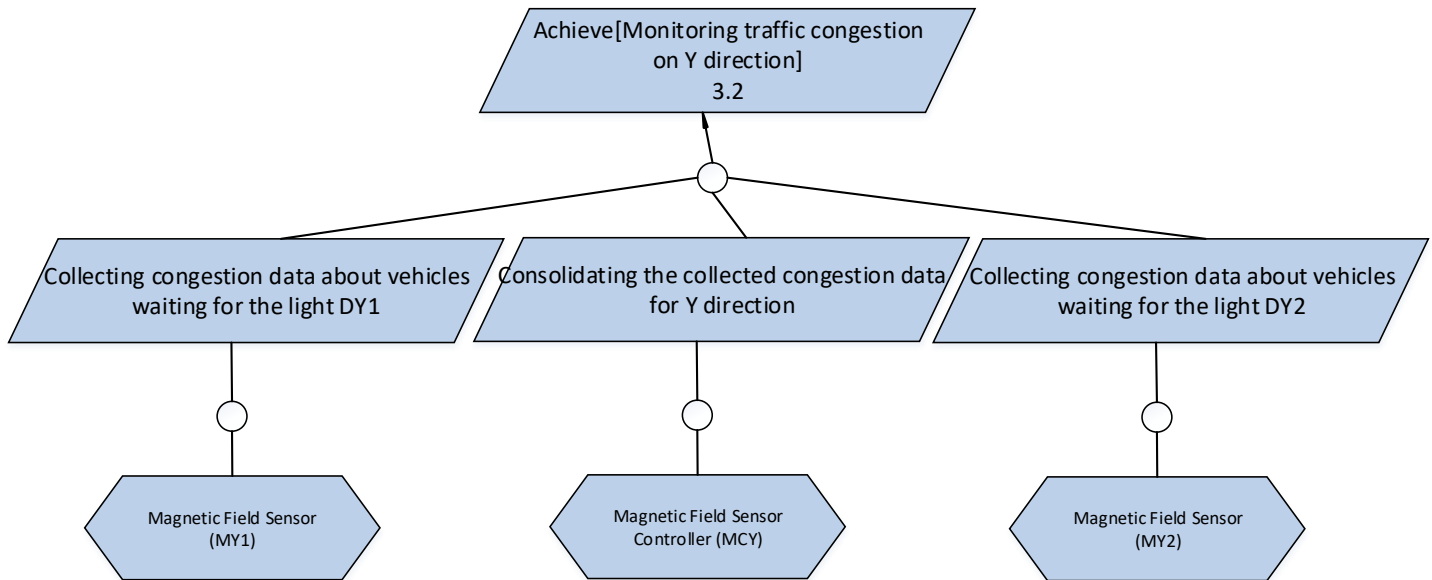


Figure 45 Sub goals of monitoring traffic congestion on Y direction

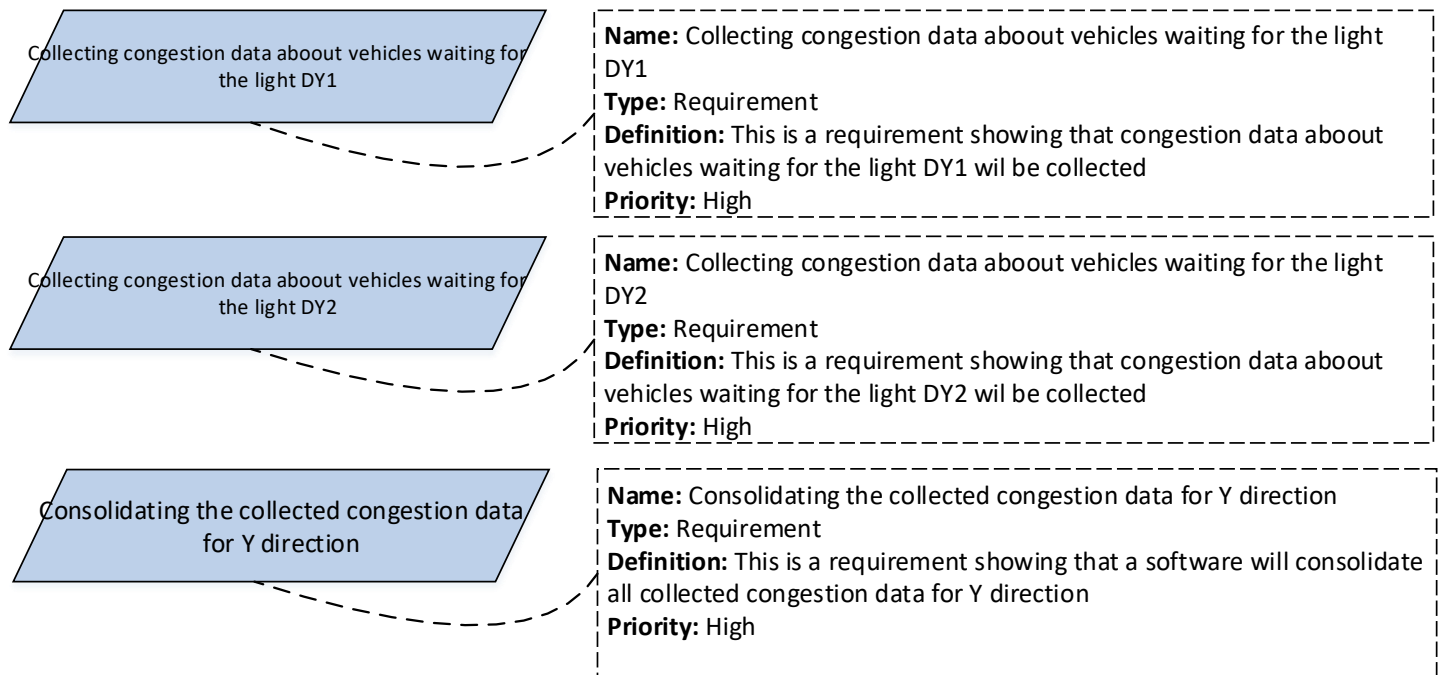


Figure 46 Annotations of sub goals of monitoring traffic congestion on Y direction

2.2.2 Sub goal - Monitoring count of waiting pedestrians

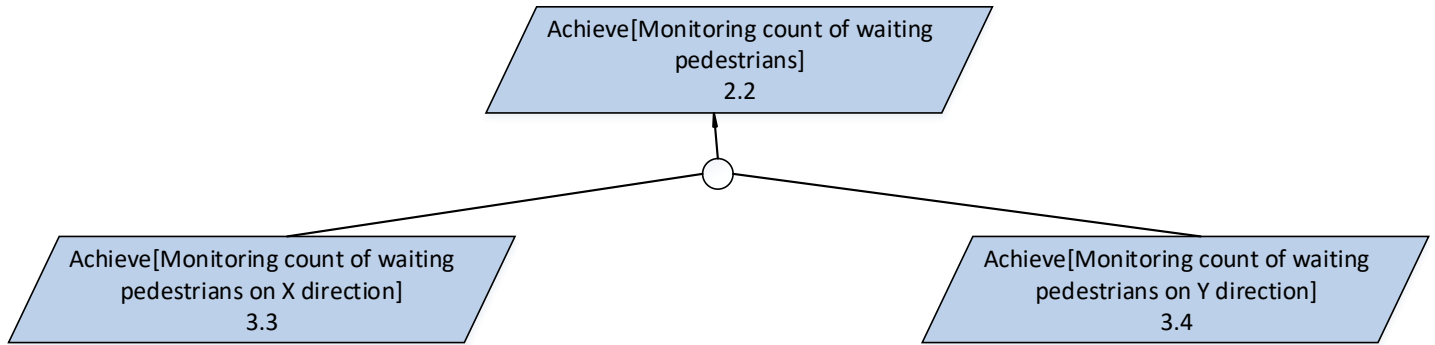


Figure 47 Sub goals of monitoring count of waiting pedestrians

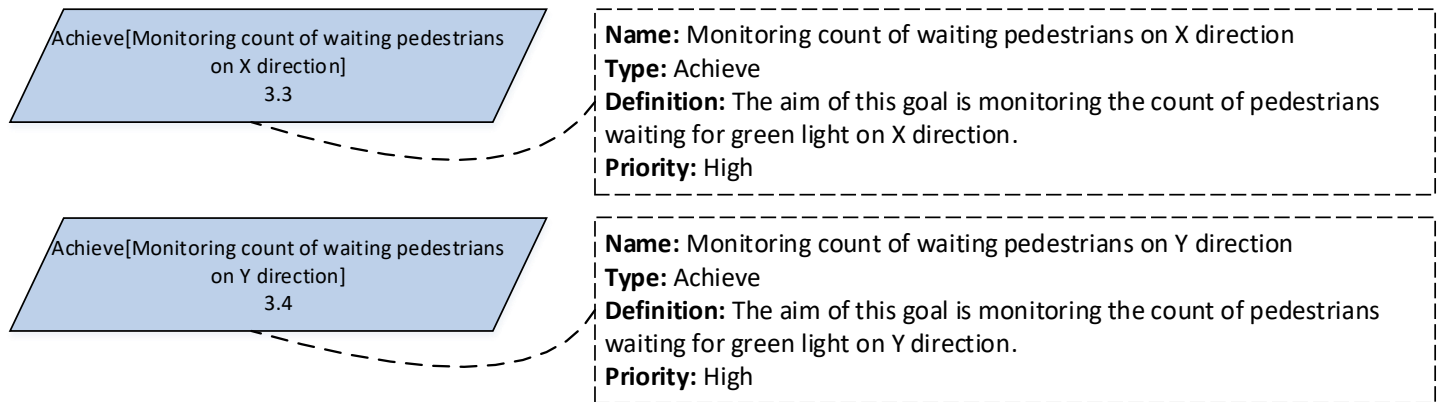


Figure 48 Annotations of sub goals of monitoring count of waiting pedestrians

2.2.2.1 Sub goal - Monitoring count of waiting pedestrians on X direction

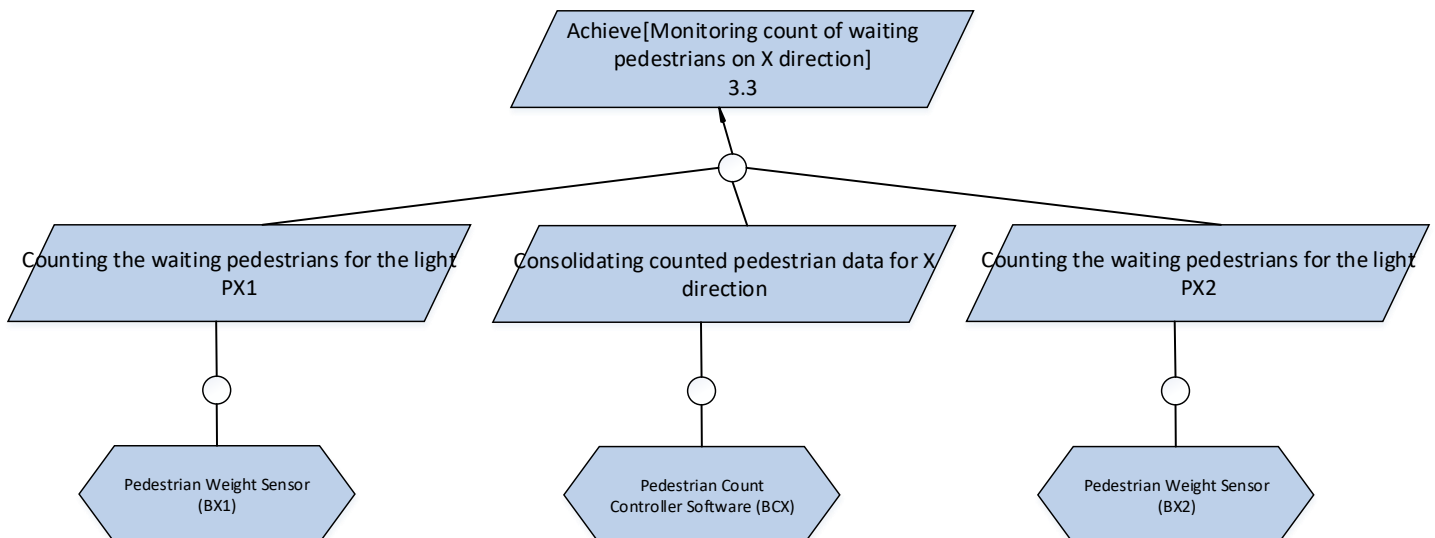


Figure 49 Sub goals of monitoring count of waiting pedestrians on X direction

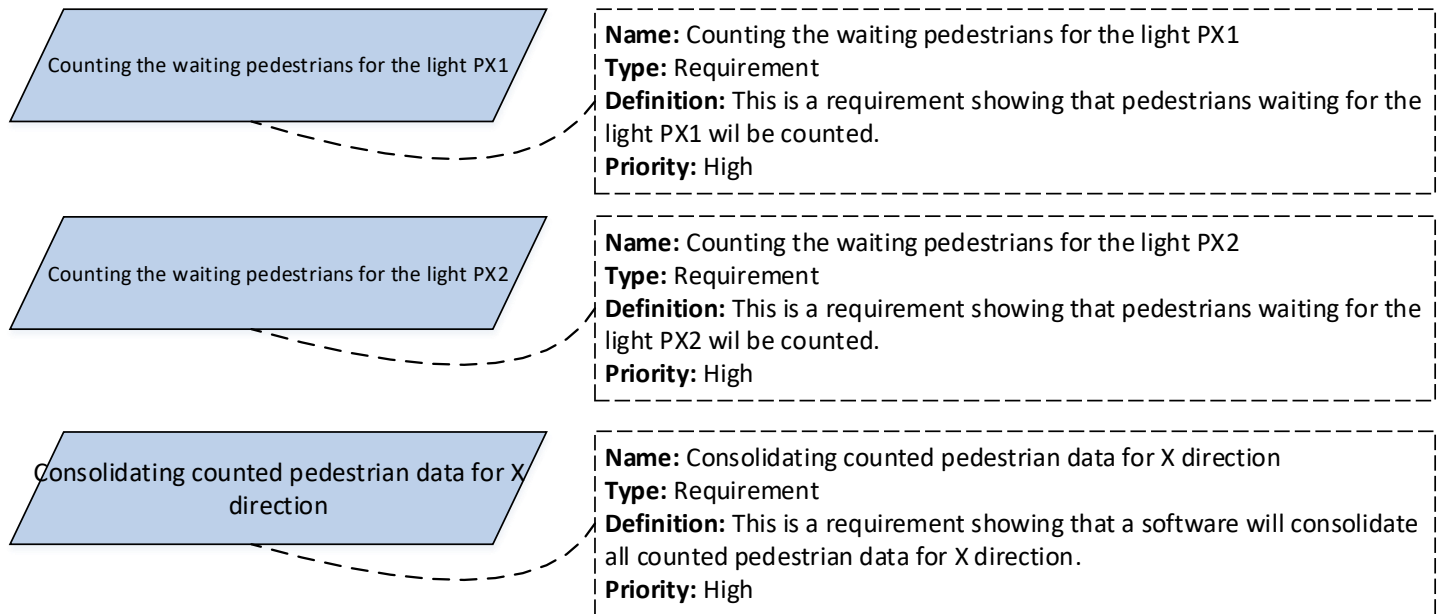


Figure 50 Annotations of sub goals of monitoring count of waiting pedestrians on X direction

2.2.2.2 Sub goal - Monitoring count of waiting pedestrians on Y direction

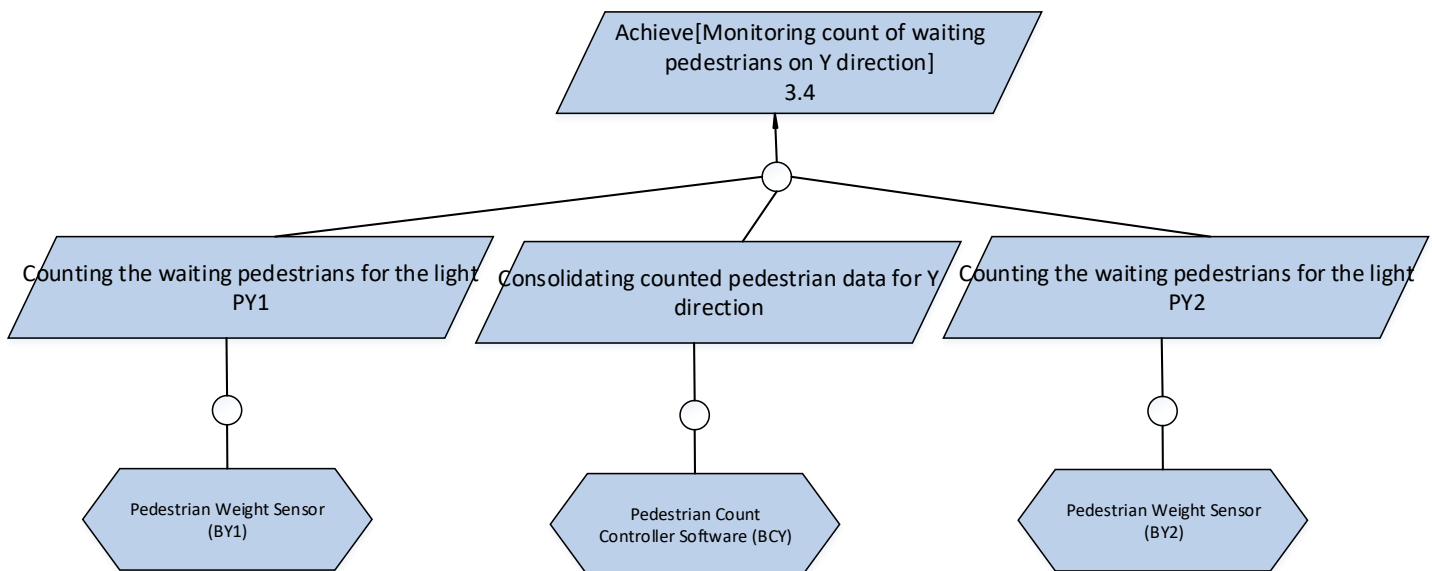


Figure 51 Sub goals of monitoring count of waiting pedestrians on Y direction

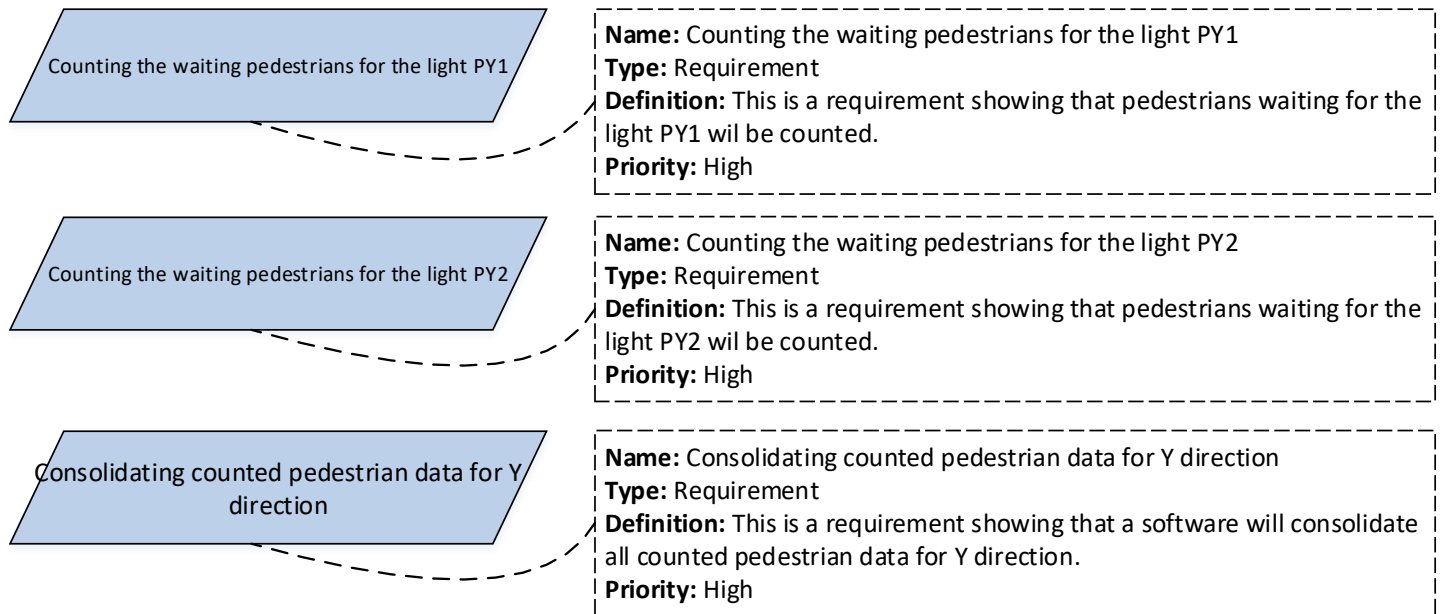


Figure 52 Annotations of sub goals of monitoring count of waiting pedestrians on Y direction

3. OBSTRUCTION MODEL

Obstruction modeling identifies the obstacles that cause the system not to work properly. Each agent might have the obstacles presented below, but to keep it simple, only two instances of them were given. First one will state the situation that if the system cannot be able to collect congestion data and the second one will state the situation of not changing the lights.

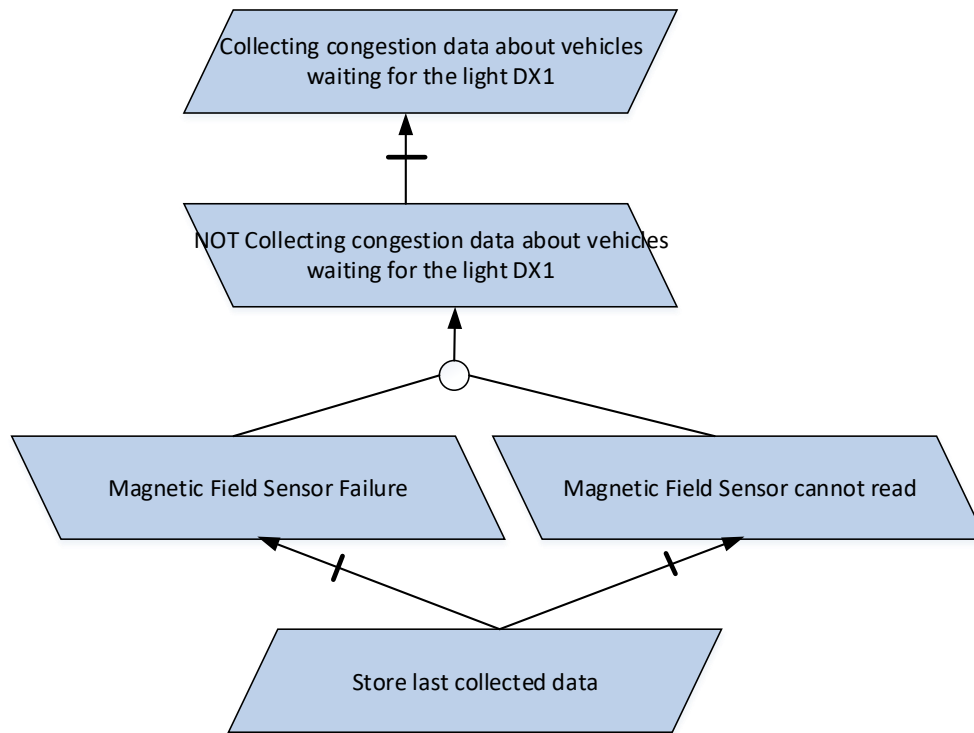


Figure 53 Obstacle of not collecting congestion data

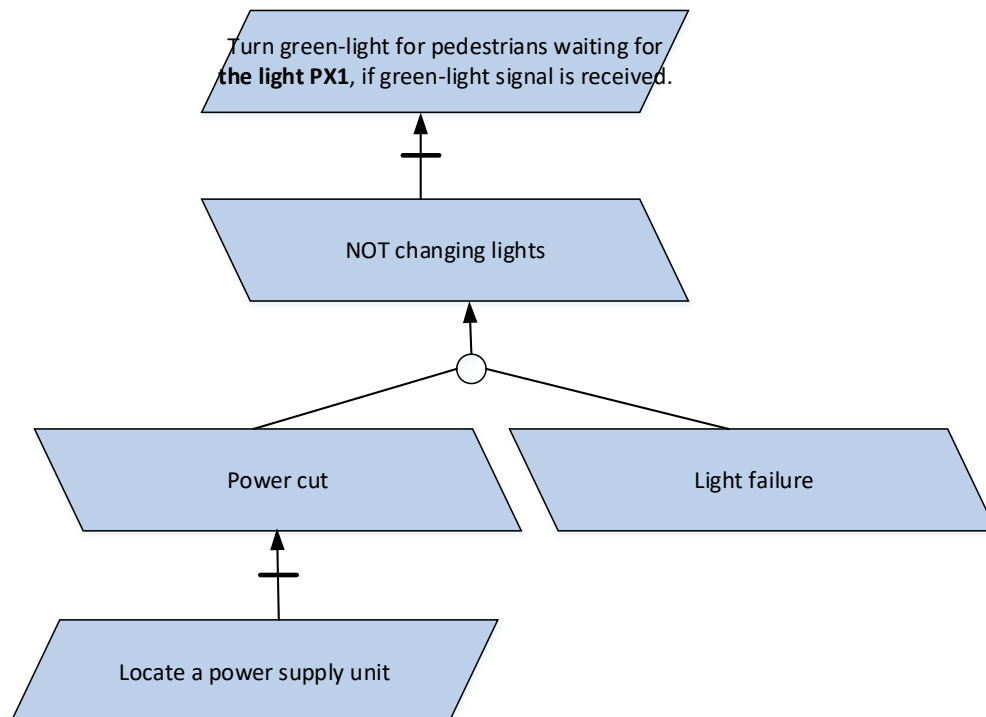


Figure 54 Obstacle of not changing lights

4. AGENT MODEL

The agents are responsible from the satisfaction of goals. They satisfies the goals by performing the operations (which will be identified in the conceptual model section).

4.1 Agent – Pedestrian light controller (PCX)

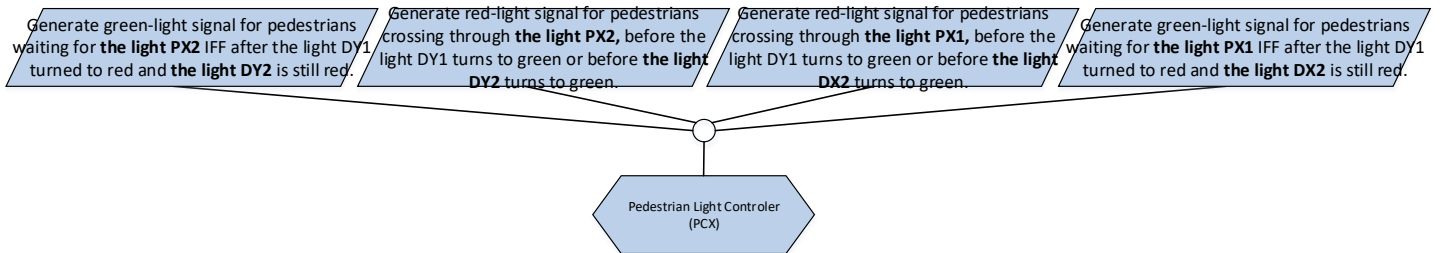


Figure 55 Pedestrian light controller (PCX) agent diagram

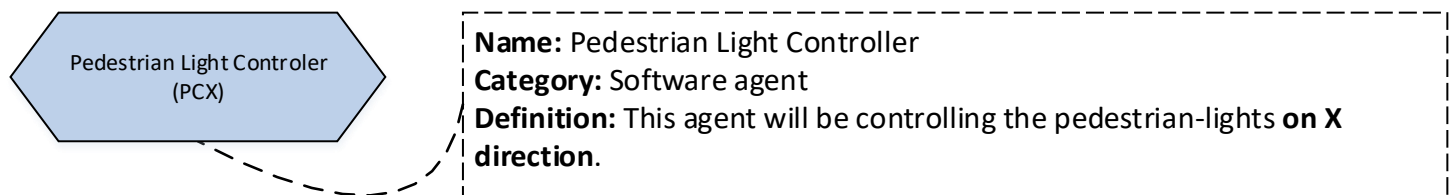


Figure 56 Annotations of pedestrian light controller (PCX) agent

4.2 Agent – Pedestrian light controller (PCY)

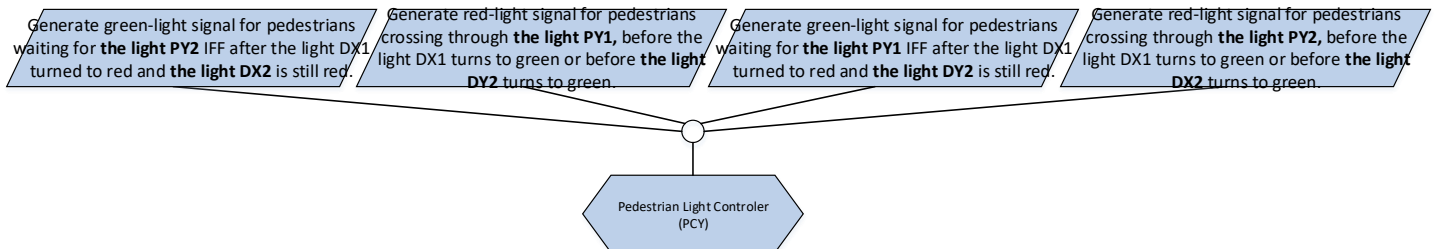


Figure 57 Pedestrian light controller (PCY) agent diagram

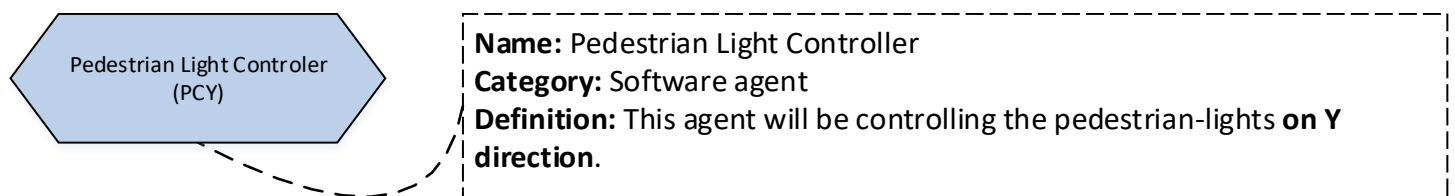


Figure 58 Annotations of pedestrian light controller (PCY) agent

4.3 Agent – Light Monitor Software (LX)

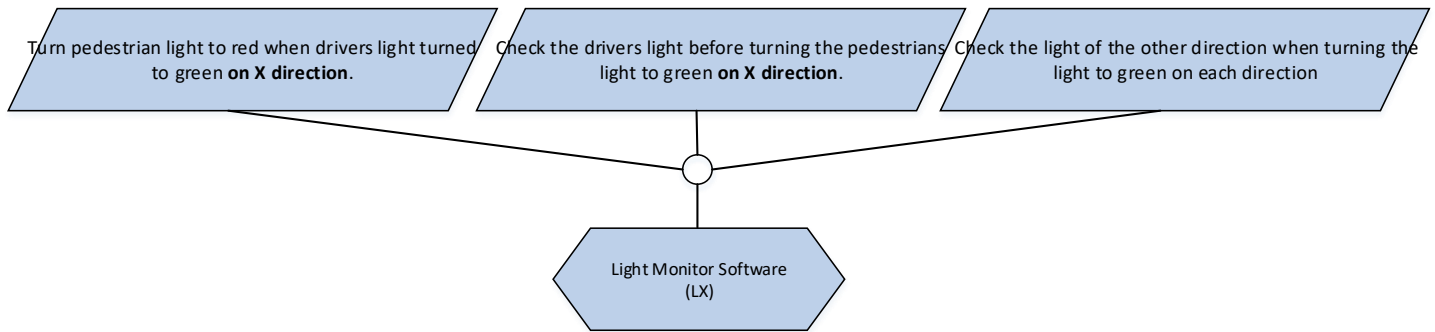


Figure 59 Light Monitor Software (LX) agent diagram

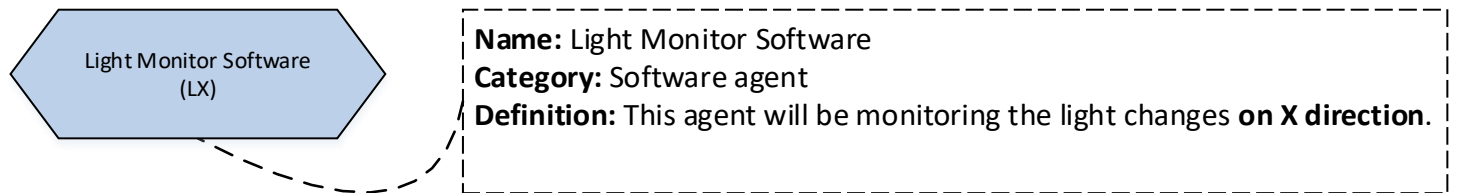


Figure 60 Annotations of Light Monitor Software (LX) agent

4.4 Agent – Light Monitor Software (LY)

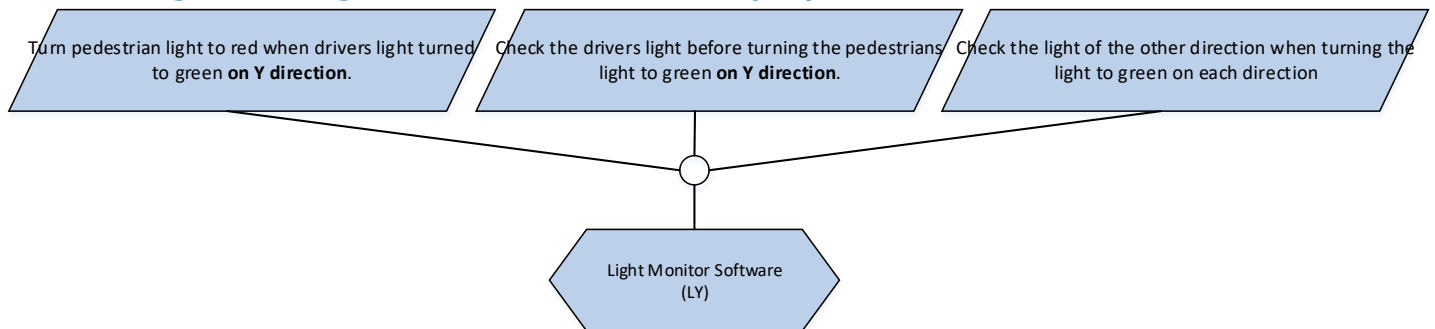


Figure 61 Light Monitor Software (LY) agent diagram

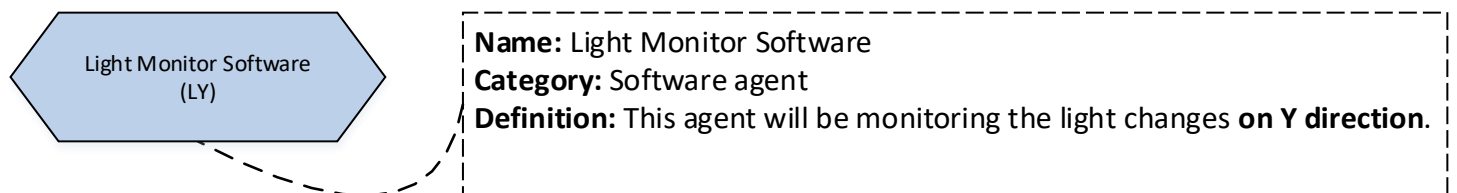


Figure 62 Annotations of Light Monitor Software (LY) agent

4.5 Agent – Drivers Light Controller (DCX)

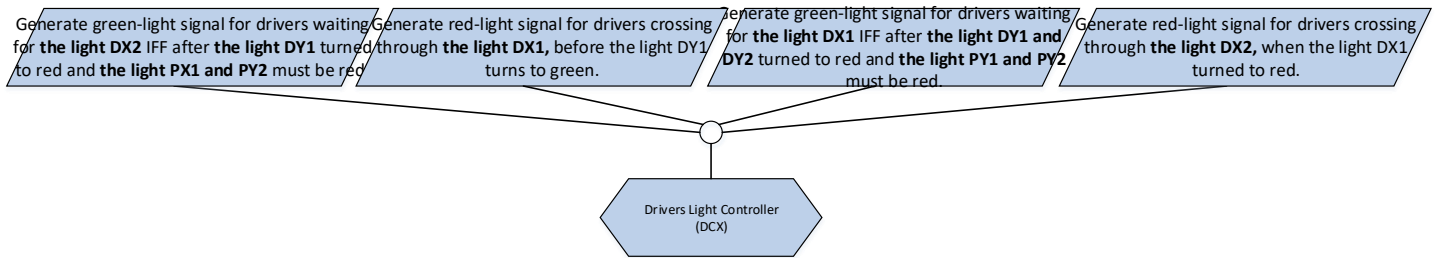


Figure 63 Drivers Light Controller (DCX) agent diagram

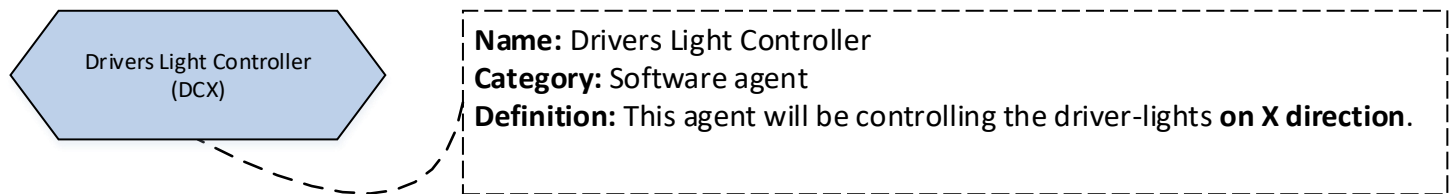


Figure 64 Annotations of Drivers Light Controller (DCX) agent

4.6 Agent – Drivers Light Controller (DCY)

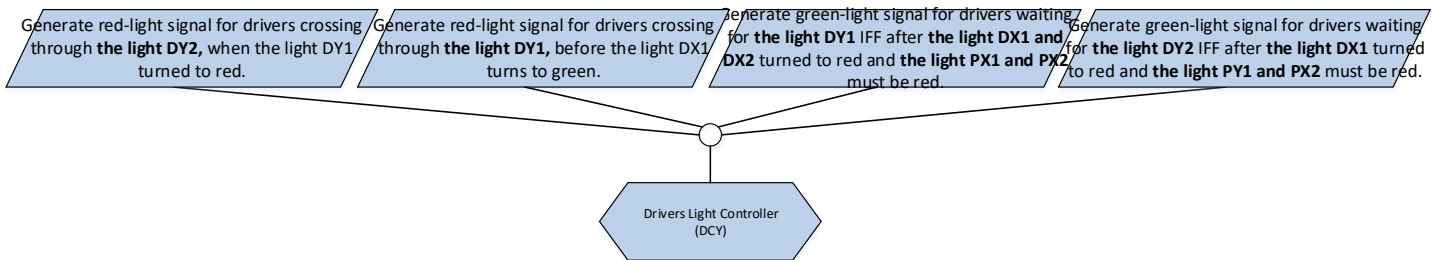


Figure 65 Drivers Light Controller (DCY) agent diagram

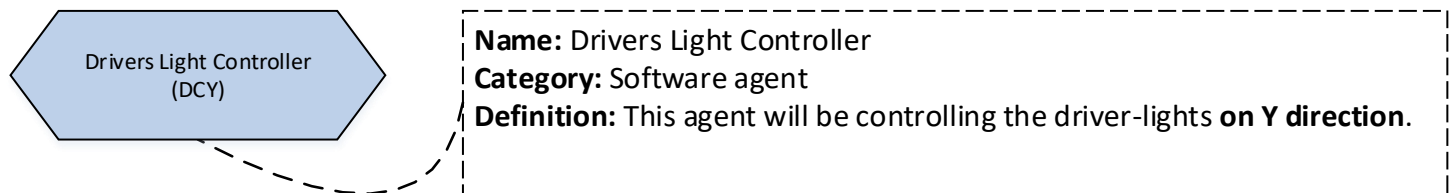
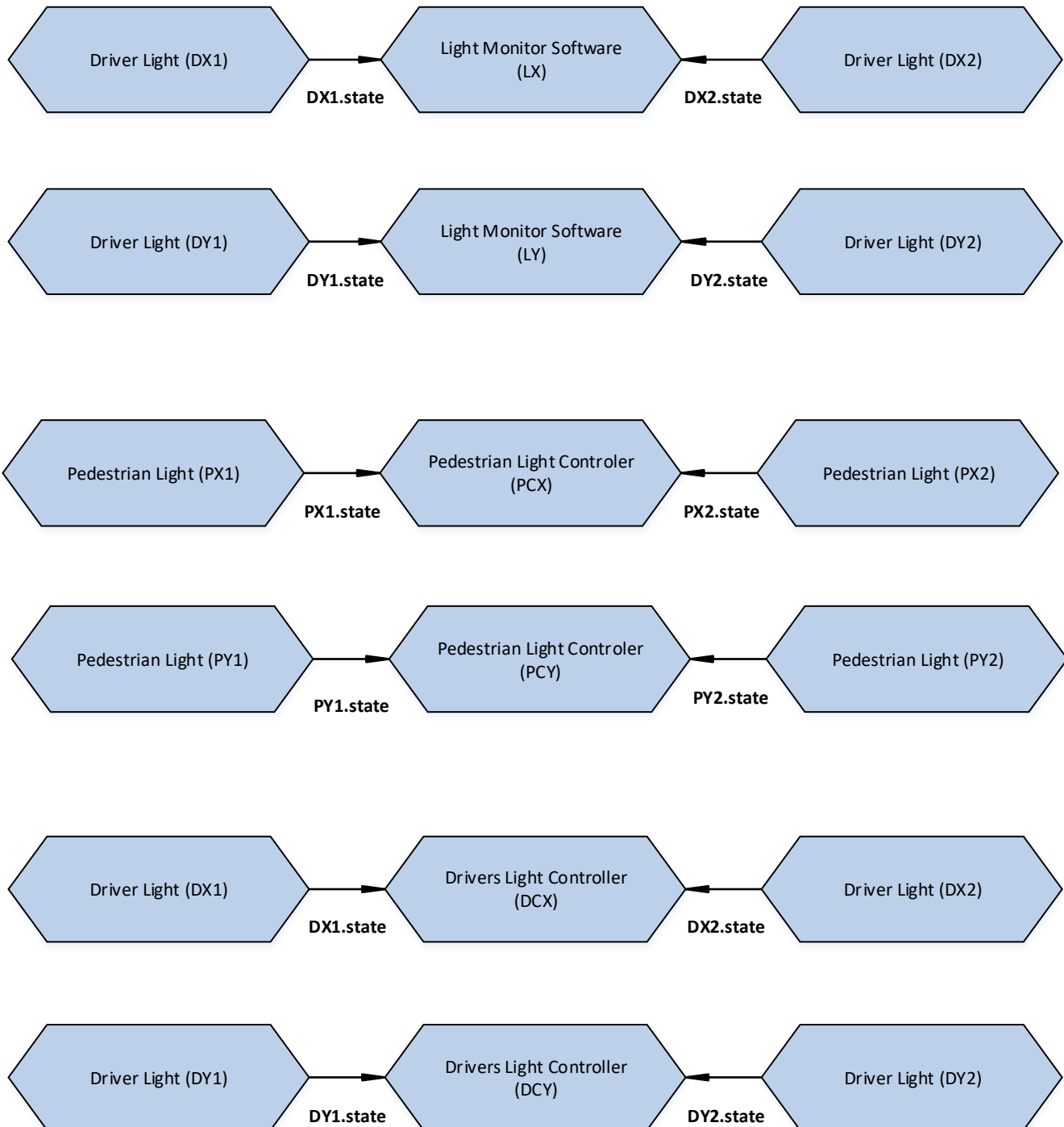


Figure 66 Annotations of Drivers Light Controller (DCY) agent

4.7 Agent – Context Diagrams

Context model of agents represents the agents and their relationships with each other.



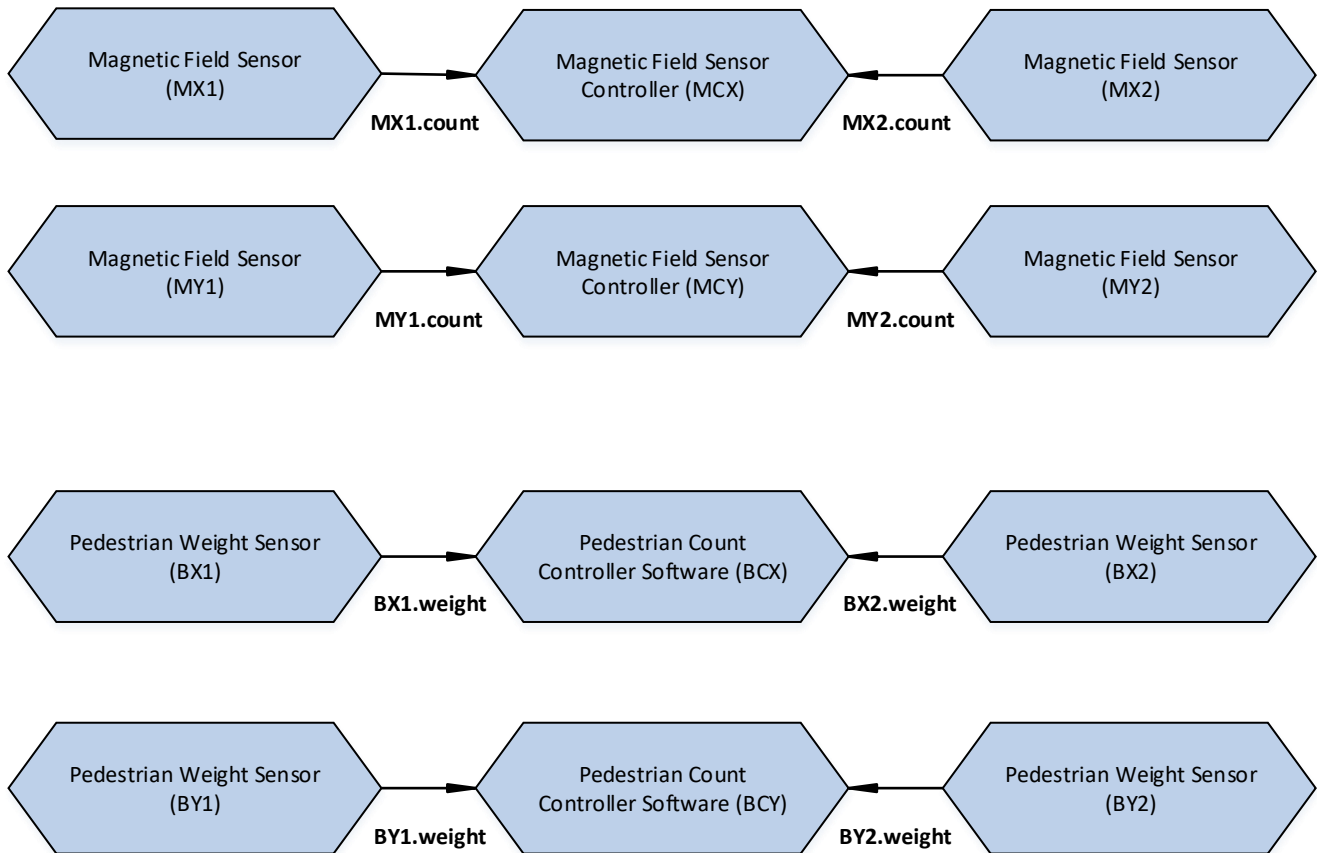
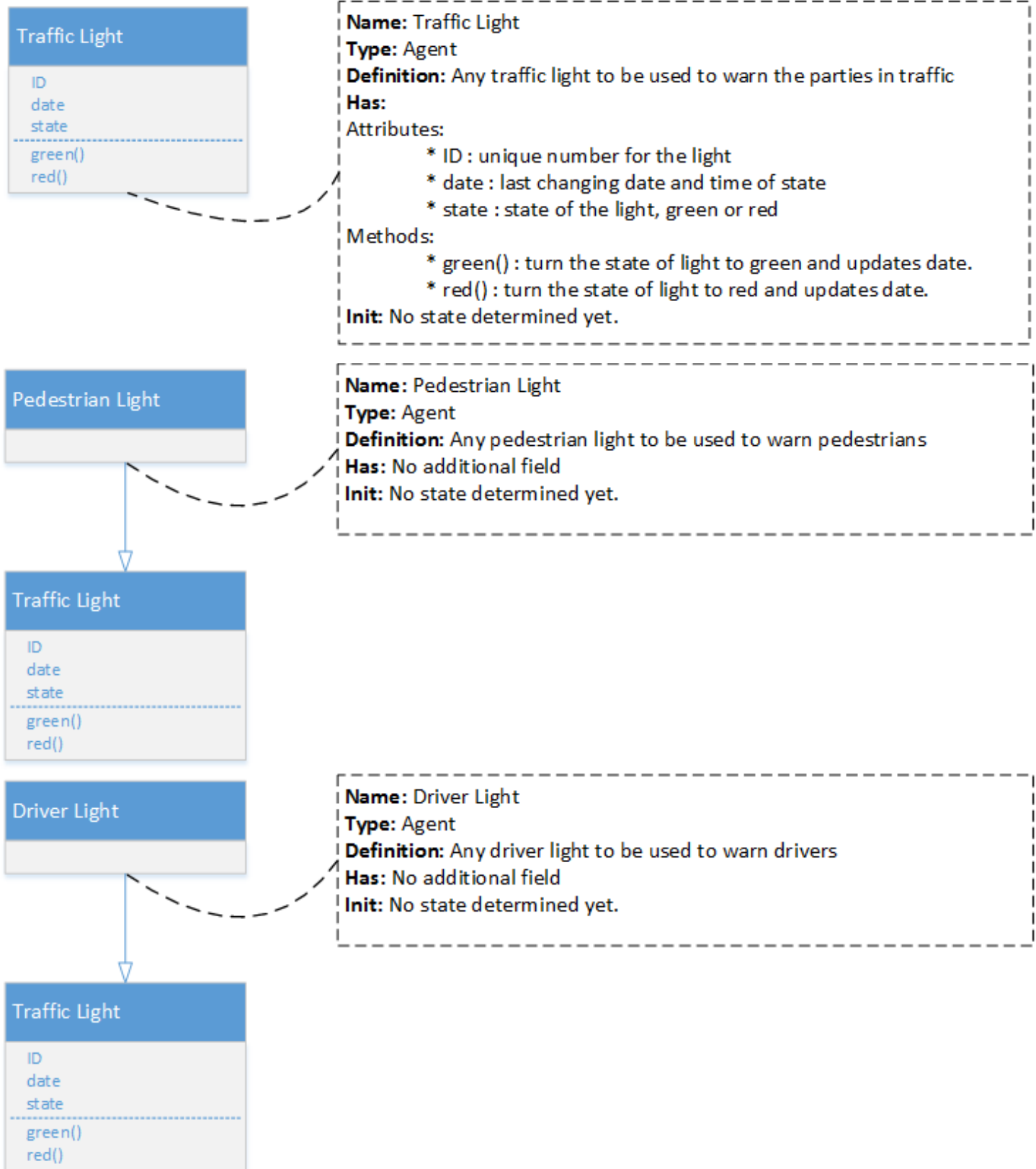


Figure 67 Context diagrams of agents

5. CONCEPTUAL MODEL

Conceptual modeling underpins software development process, especially in object-oriented software development. The conceptual model of given system is depicted as below.



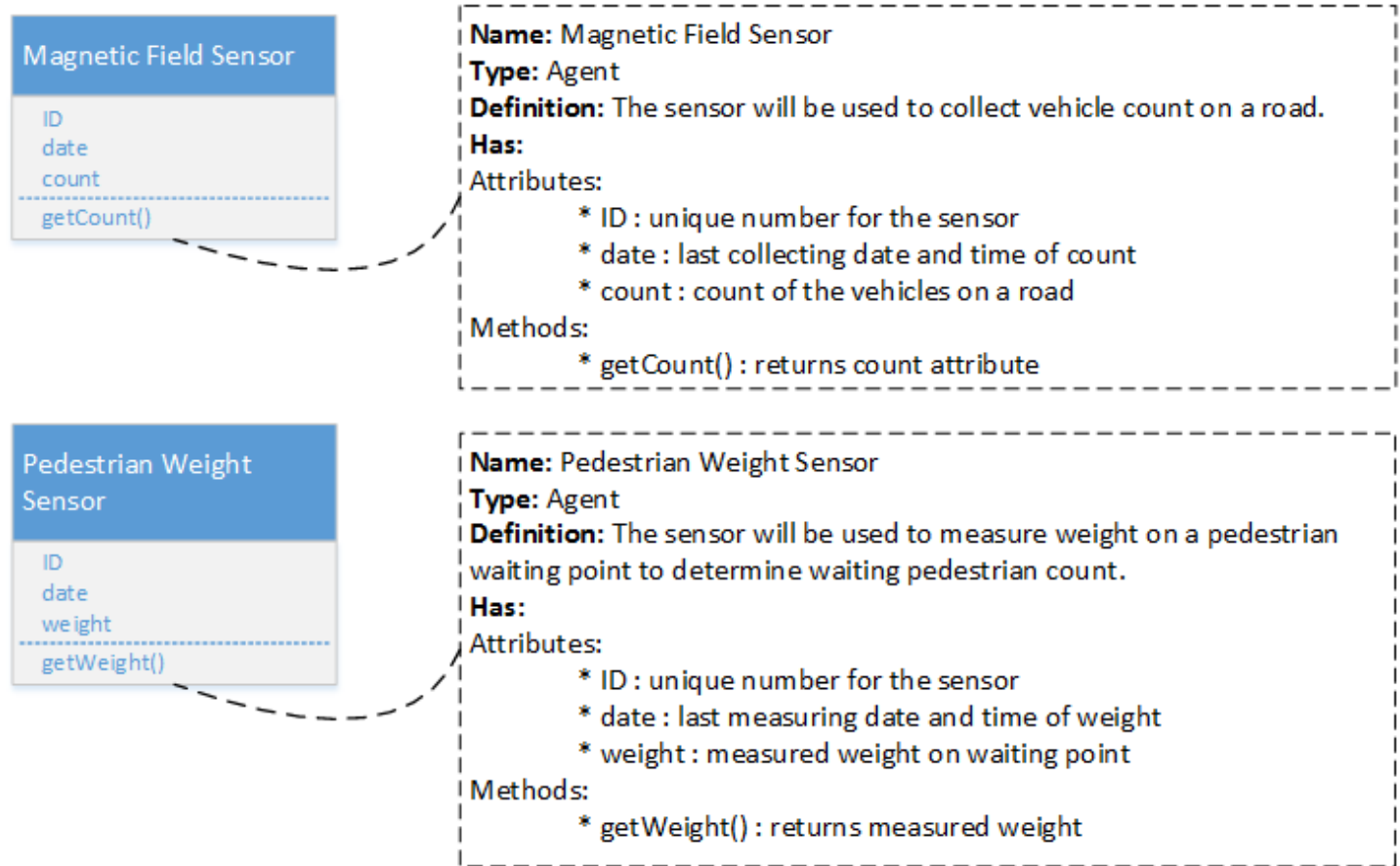


Figure 68 Conceptual diagram of agents

6. OPERATION MODEL

An operation is something that an agent will carry out to meet a requirement. Operation model will capture the operations with agents, which are responsible from the operations, objects, which will be monitored and/or controlled by the operations and the goal that the operations will be satisfied.

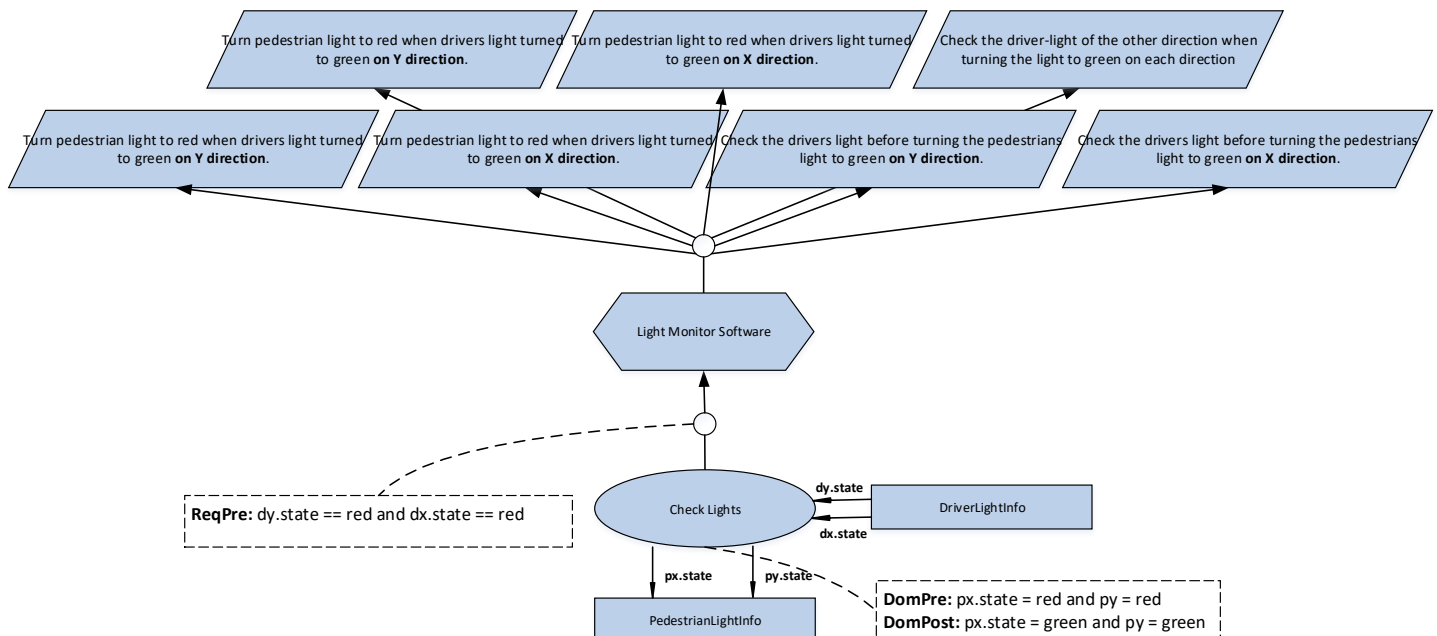


Figure 69 Operation – Check Lights

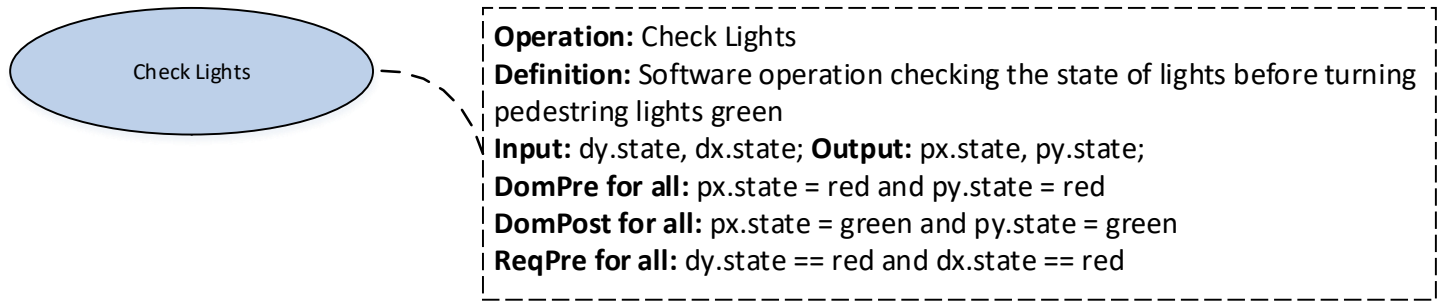


Figure 70 Annotation – Check Lights

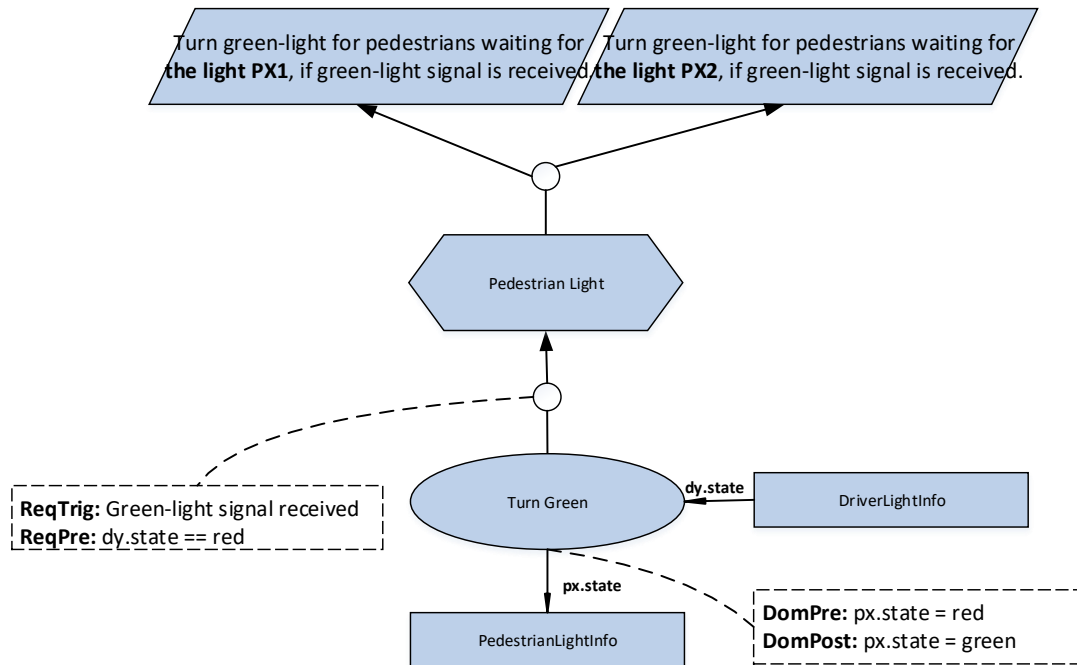


Figure 71 Operation - Turn pedestrian lights to green on X direction

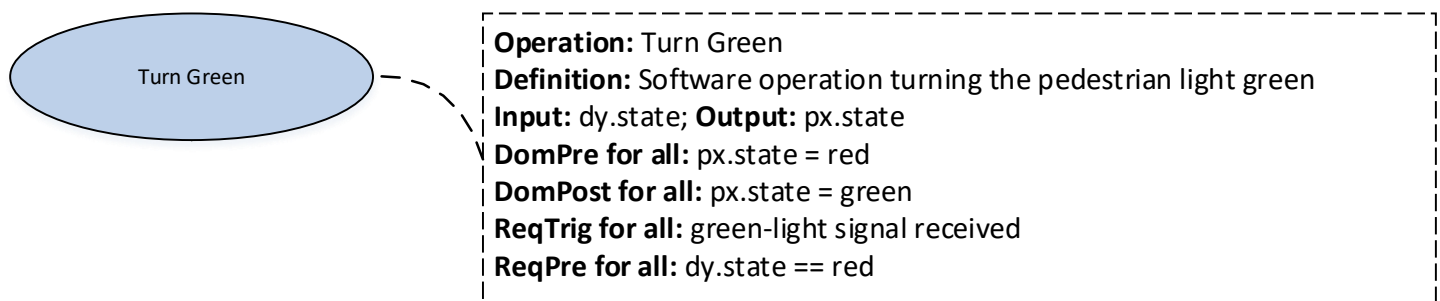


Figure 72 Annotation - Turn pedestrian lights to green on X direction

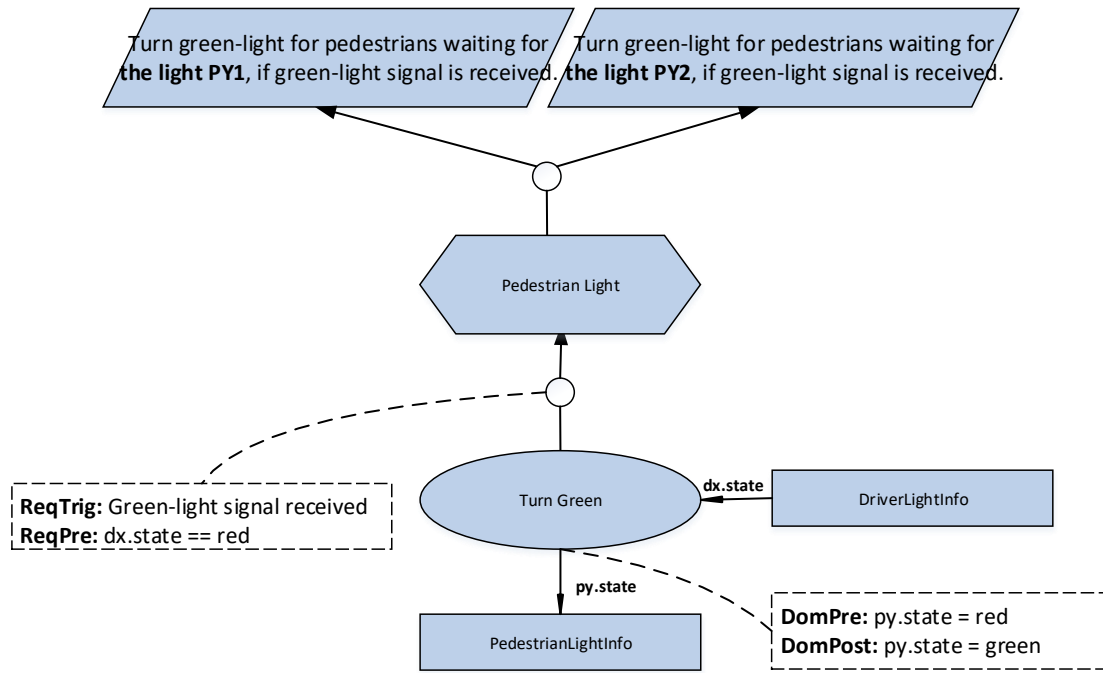


Figure 73 Operation - Turn pedestrian lights to green on Y direction

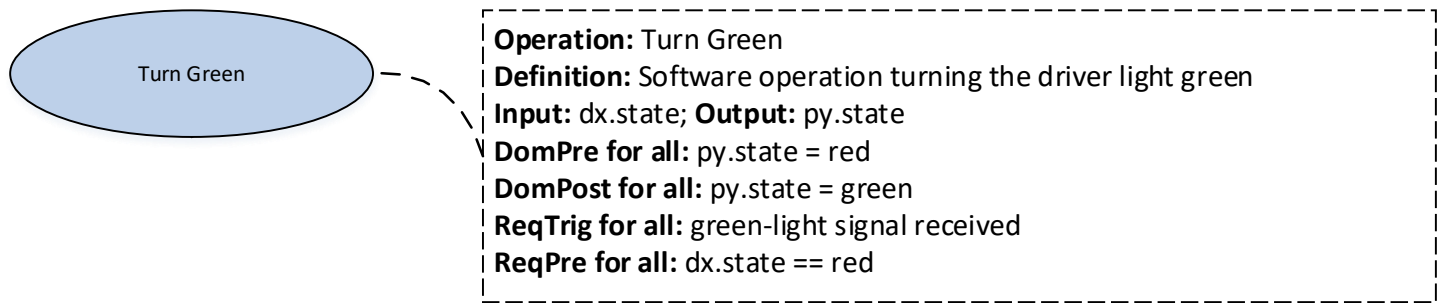


Figure 74 Annotation - Turn pedestrian lights to green on Y direction

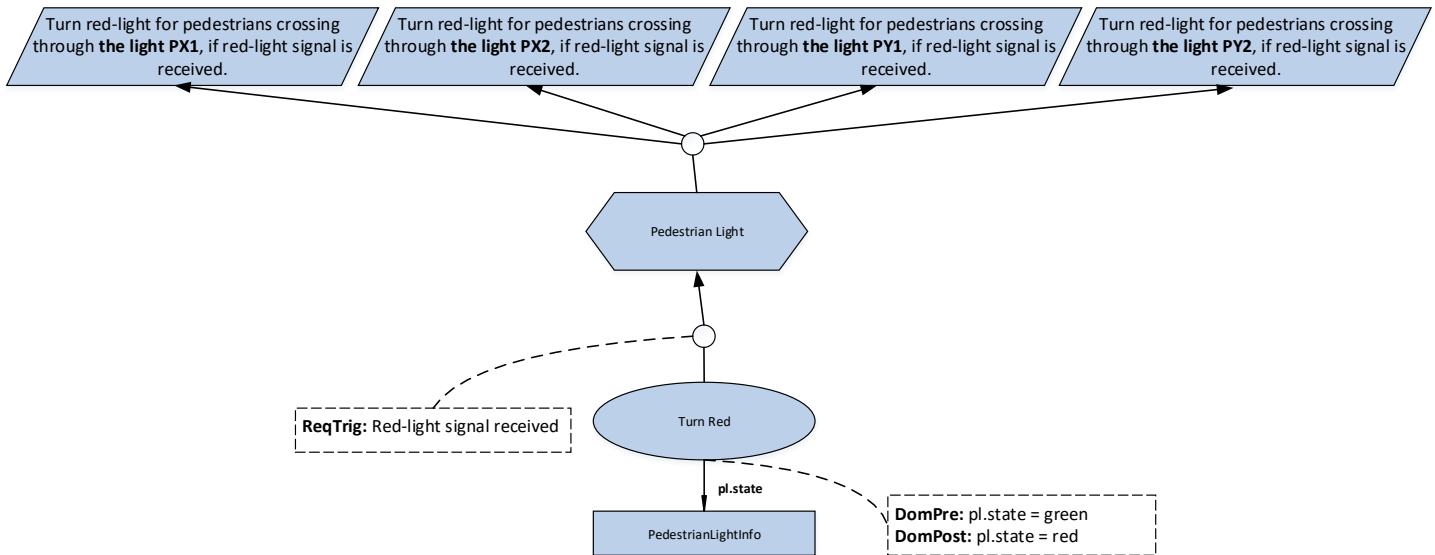


Figure 75 Operation - Turn pedestrian lights to red

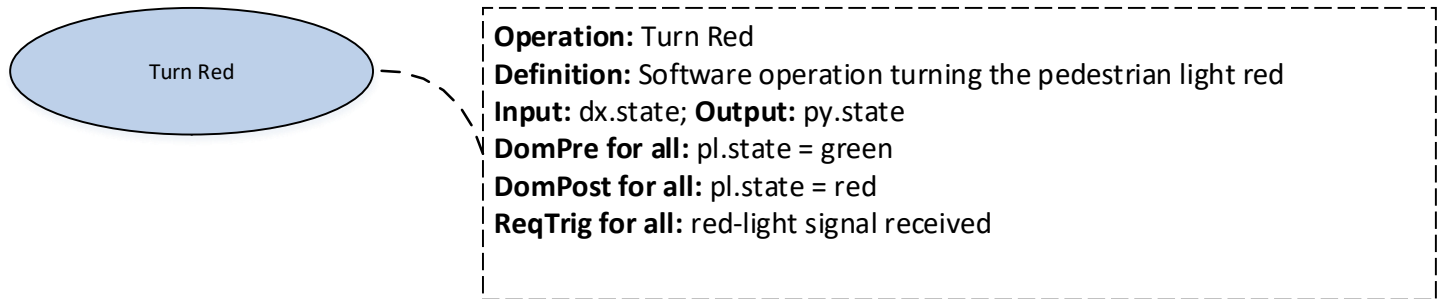


Figure 76 Annotation - Turn pedestrian lights to red

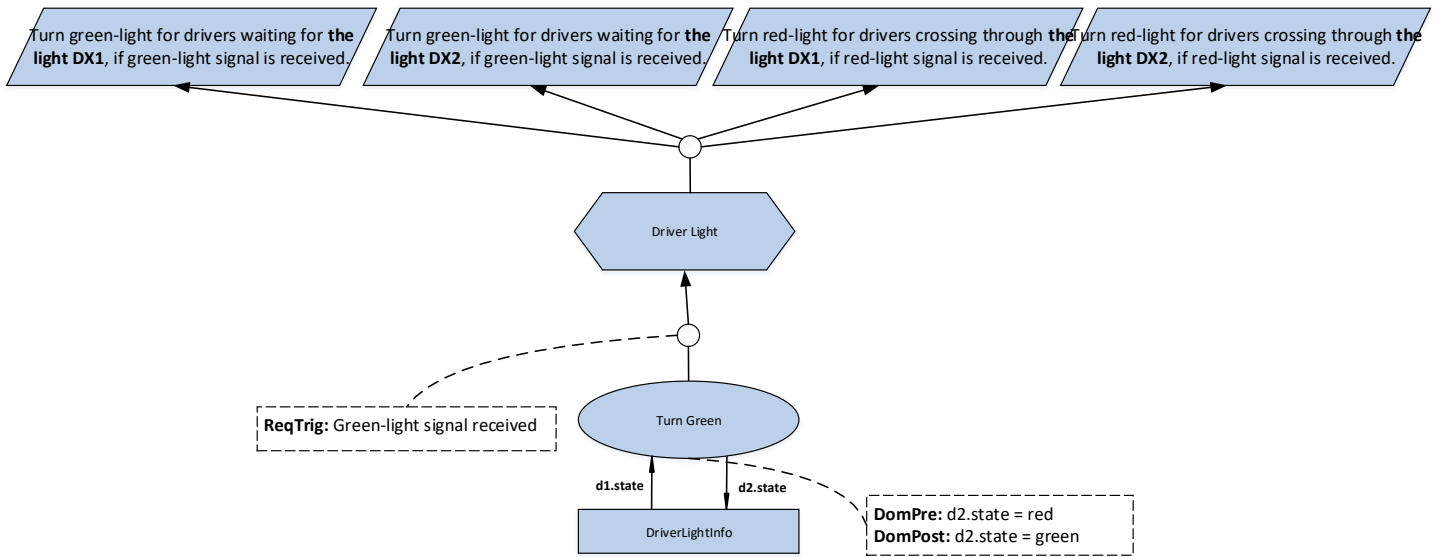


Figure 77 Operation - Turn driver lights to green

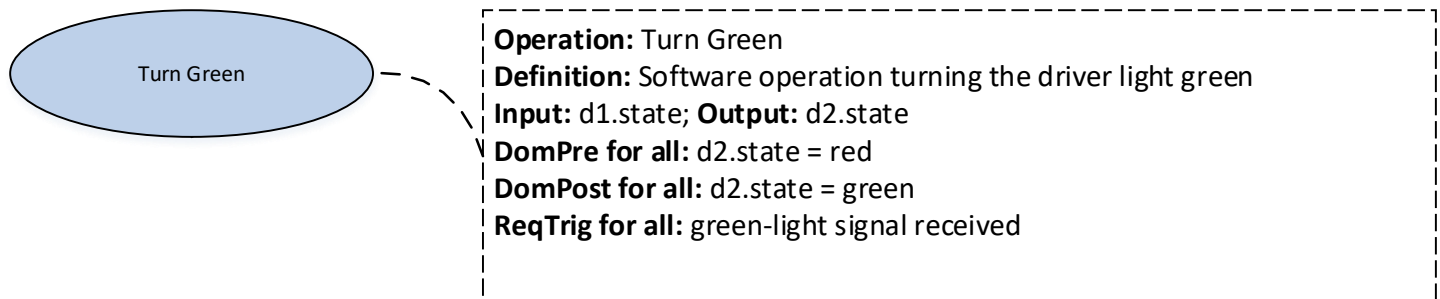


Figure 78 Annotation - Turn driver lights to green

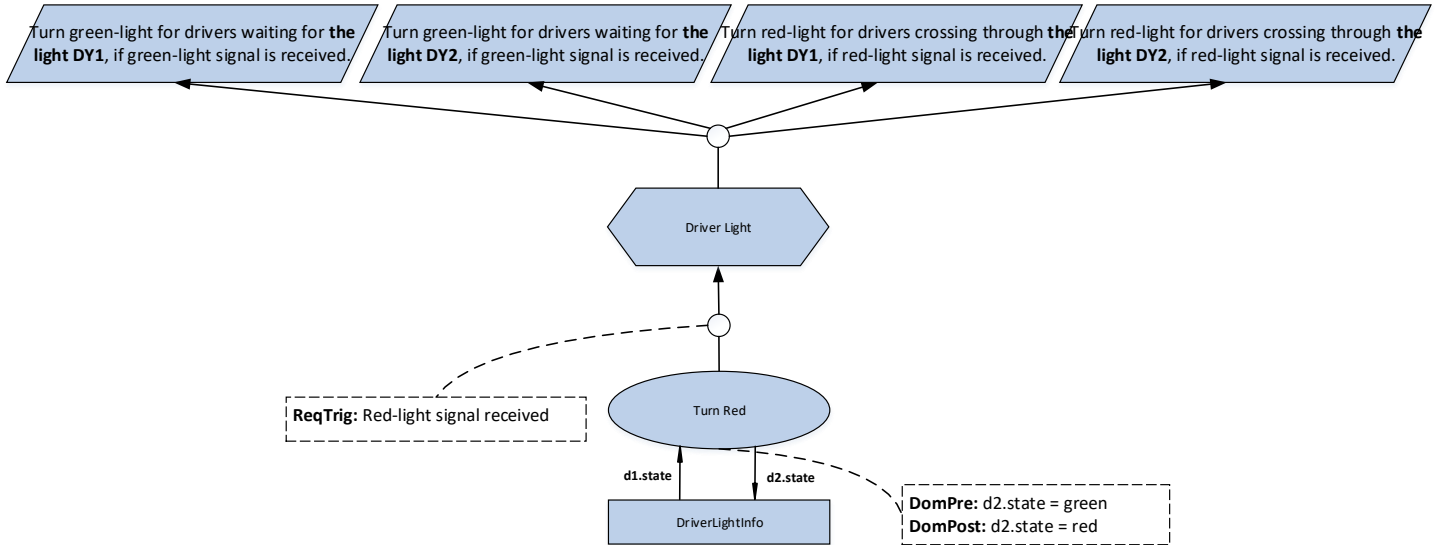


Figure 79 Operation - Turn driver light to red

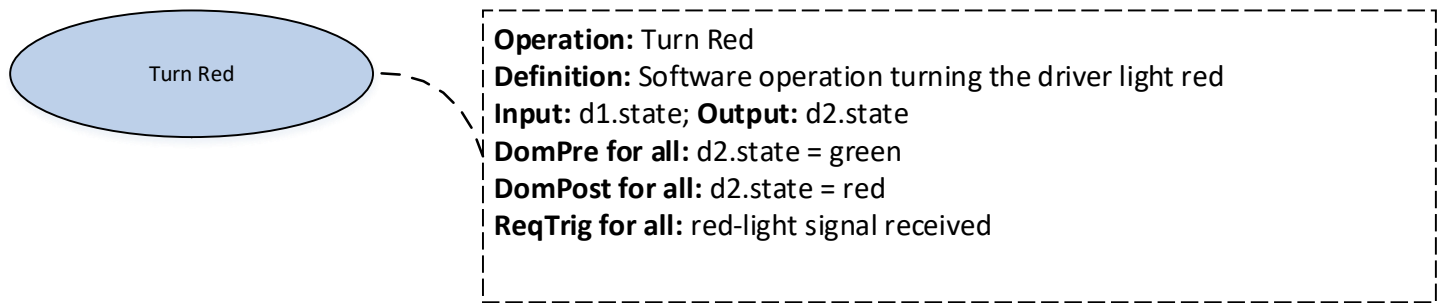


Figure 80 Annotation - Turn driver light to red

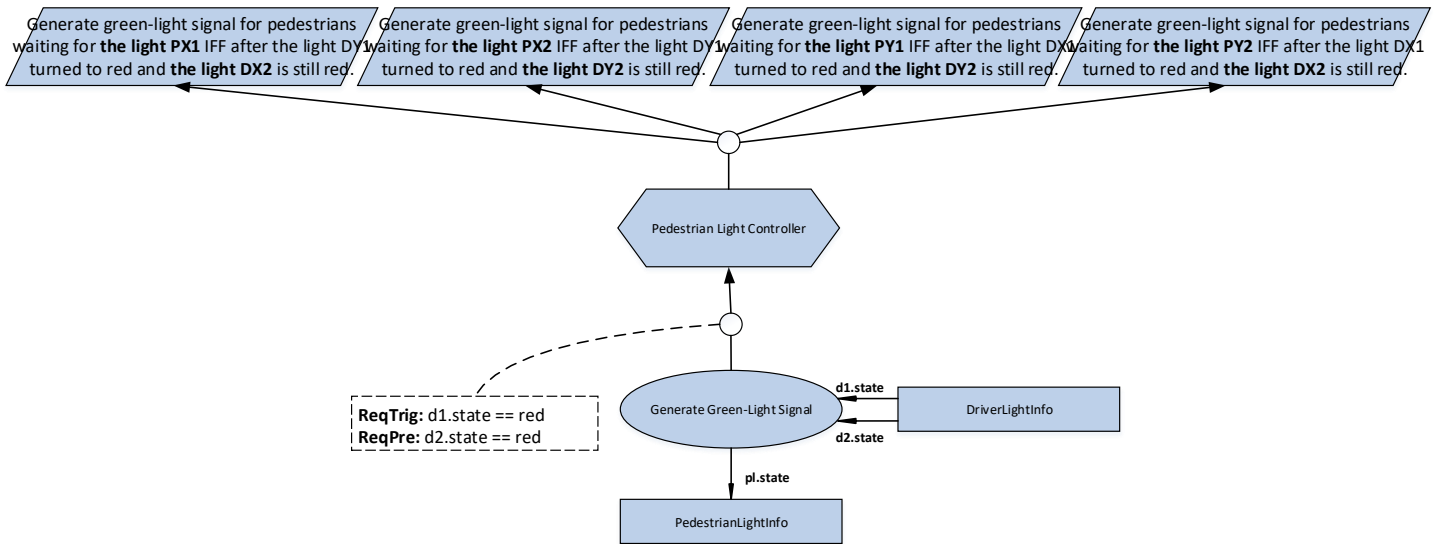


Figure 81 Operation - Generate green-light signal for pedestrian

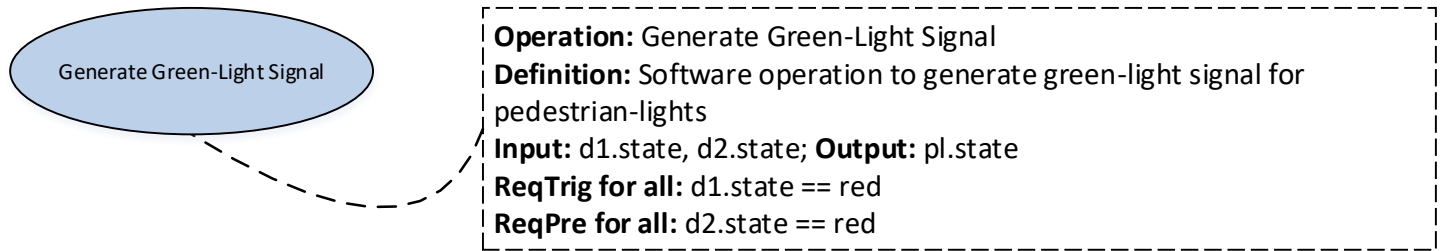


Figure 82 Annotation - Generate green-light signal for pedestrian

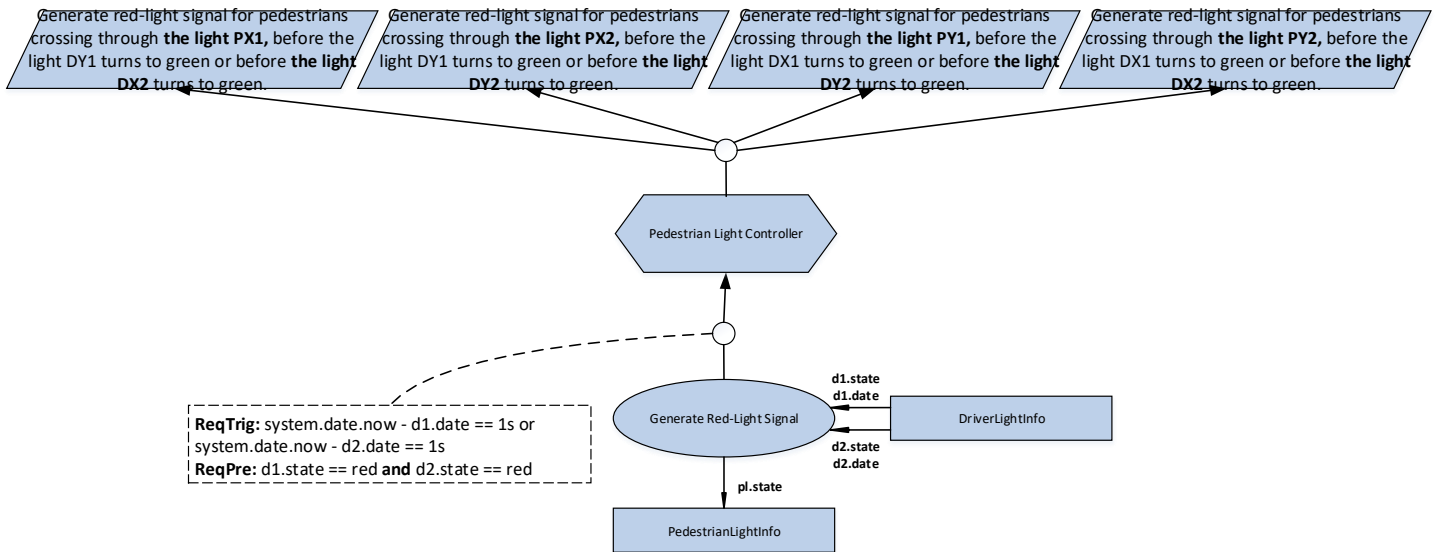


Figure 83 Operation - Generate red-light signal for pedestrian

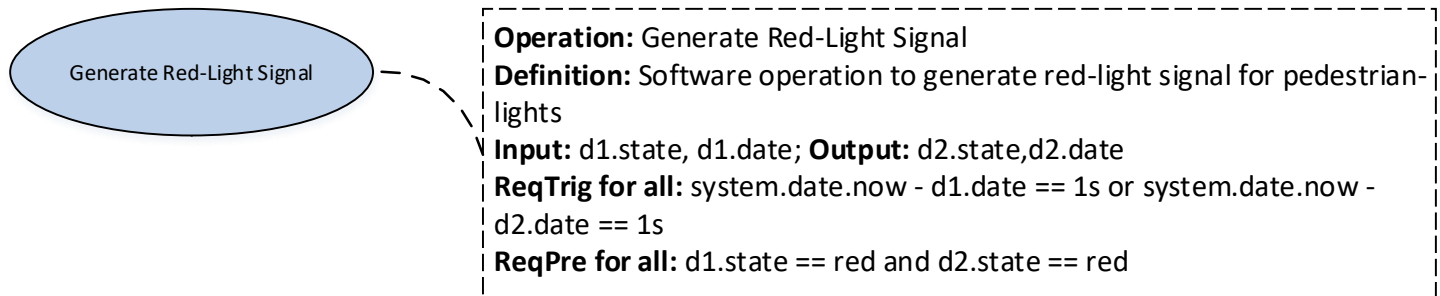


Figure 84 Annotation - Generate red-light signal for pedestrian

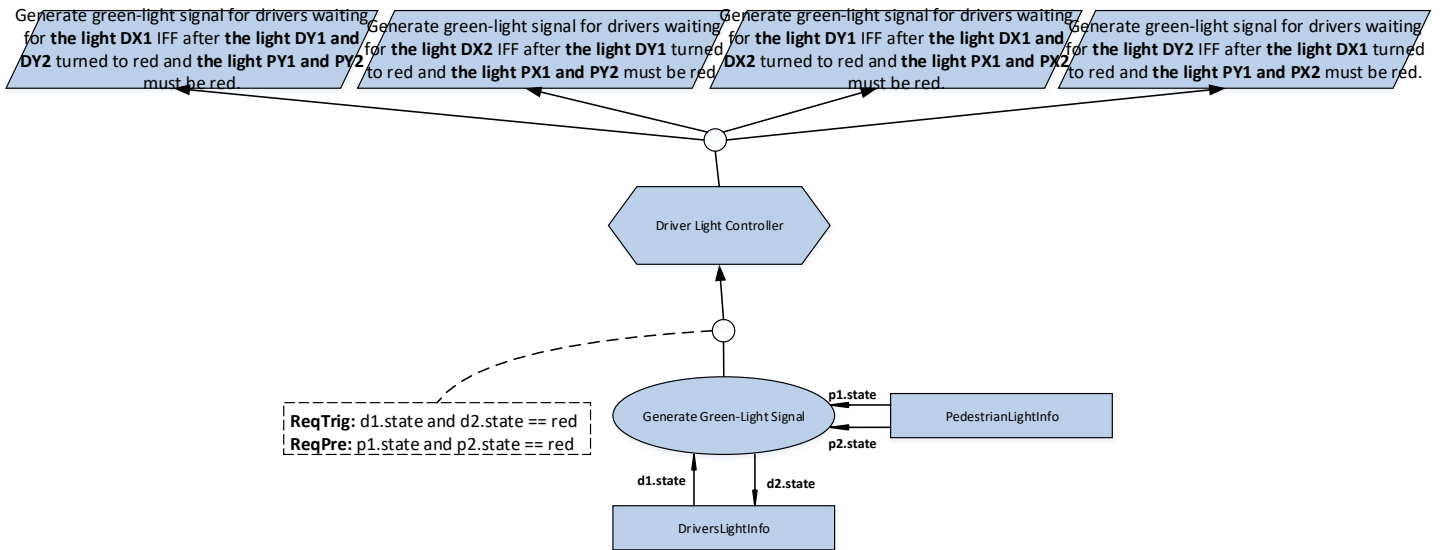


Figure 85 Operation - Generate green-light signal for driver

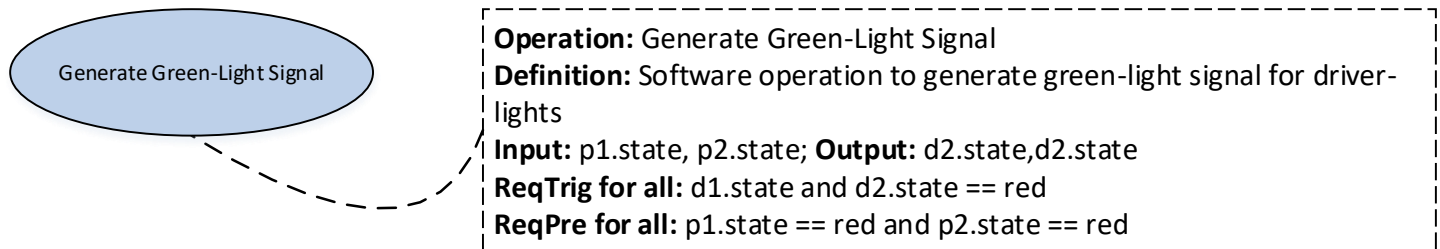


Figure 86 Annotation - Generate green-light signal for driver

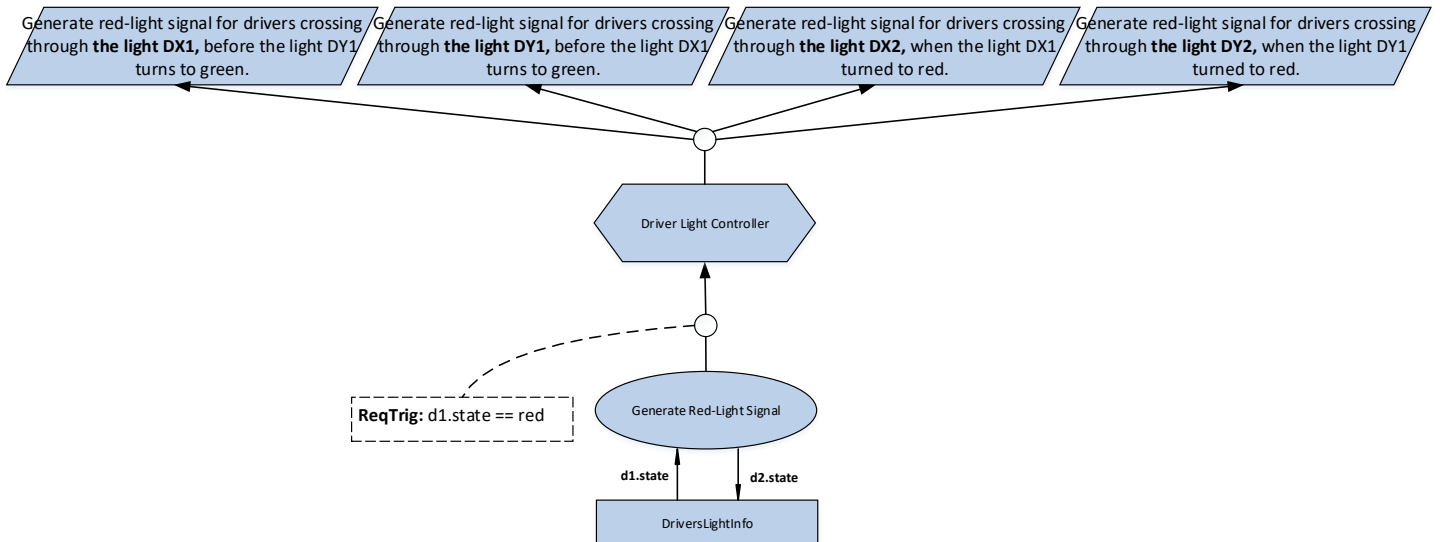


Figure 87 Operation - Generate red-light signal for driver

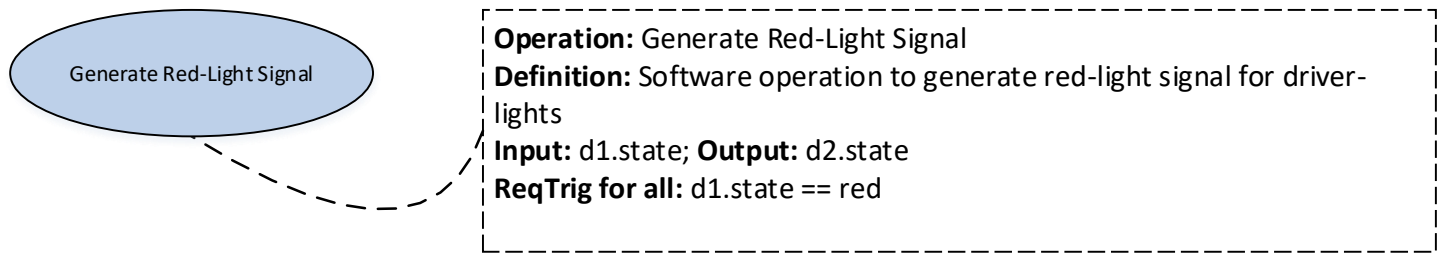


Figure 88 Annotation - Generate red-light signal for driver

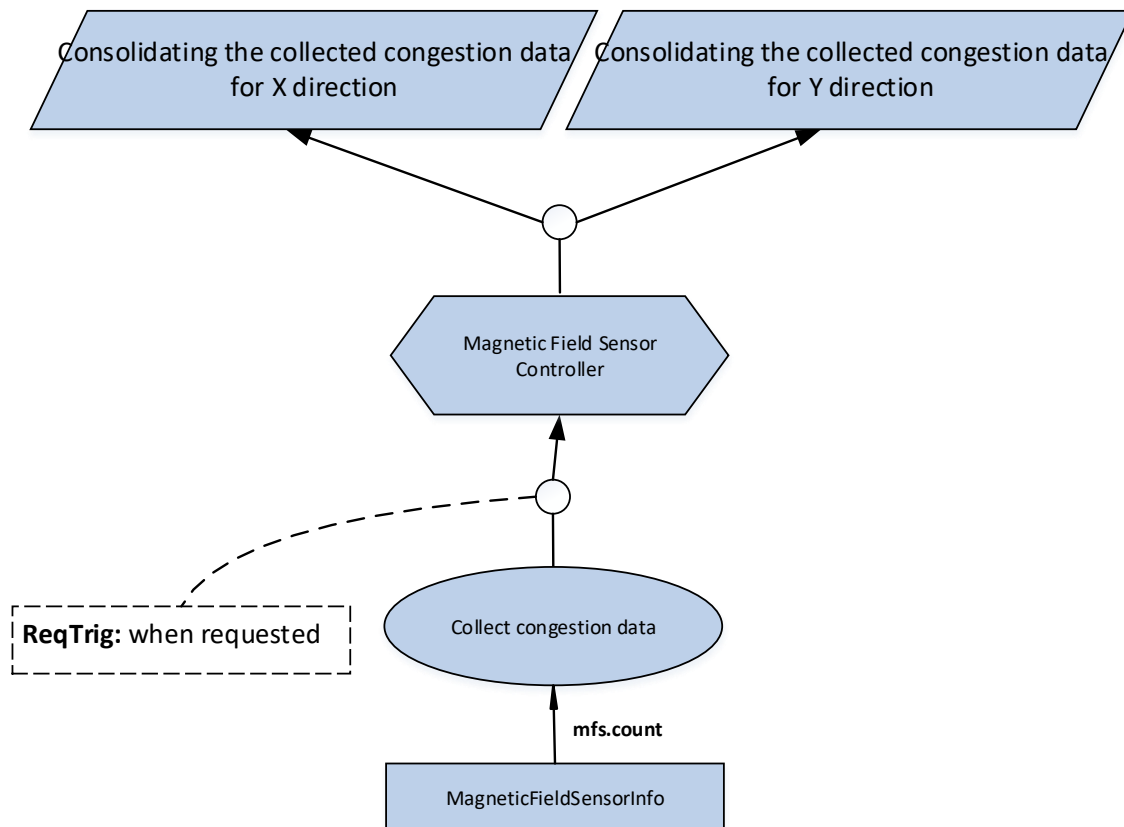


Figure 89 Operation - Collect congestion data

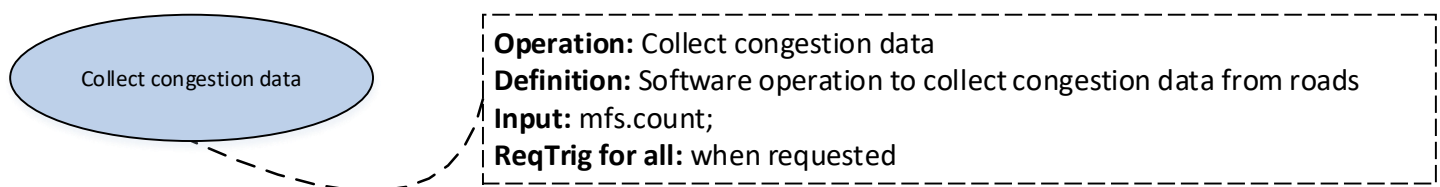


Figure 90 Annotation - Collect congestion data

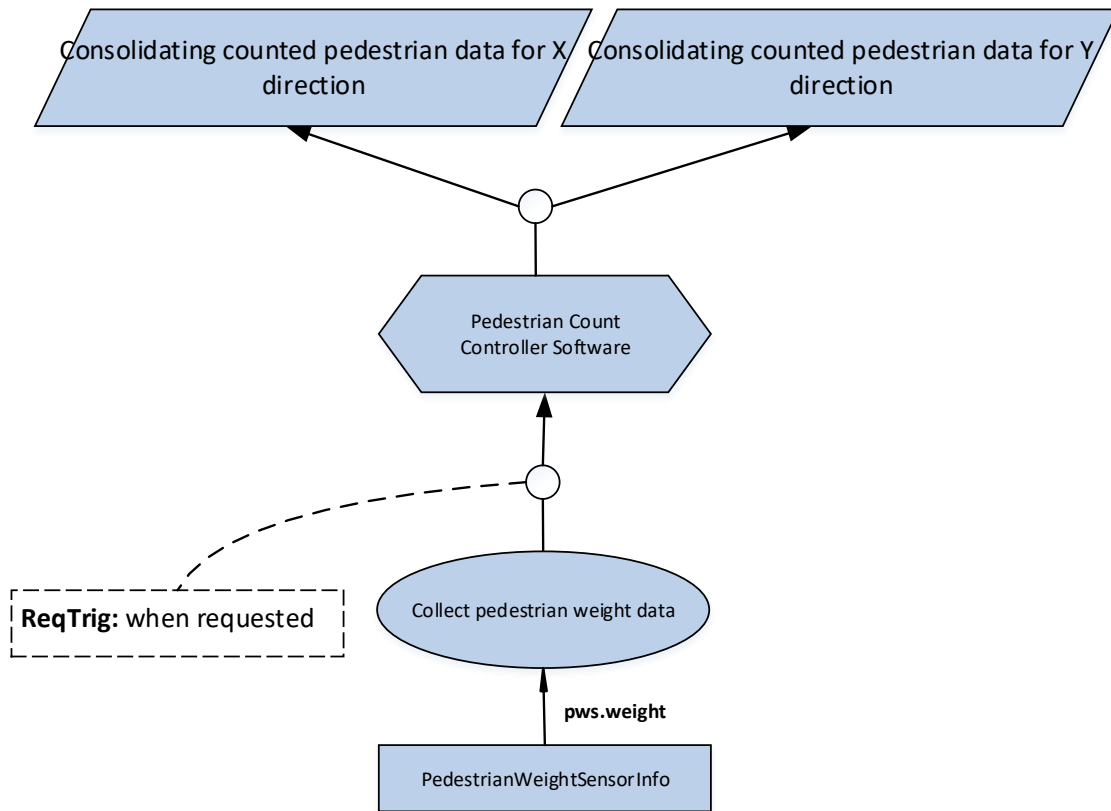


Figure 91 Operation - Collect pedestrian weight data

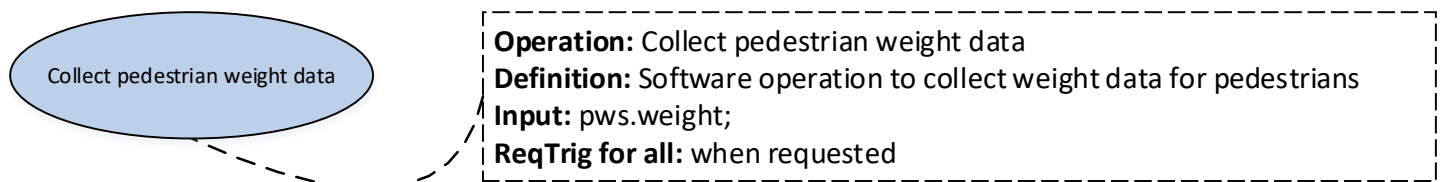


Figure 92 Annotation - Collect pedestrian weight data

7. CONCLUSION

To conclude, traffic lights were used to make the traffic flow safe and efficient at the intersection. In our system-to-be, only two separate lights were utilized to direct pedestrian and drivers for satisfying safety-related goals and two separate sensors were used to satisfy the efficiency-related goals.

First of all, goal model was provided and addressed the obstacles against the system-to-be. The agent model, conceptual (object) model and lastly operation model were presented.