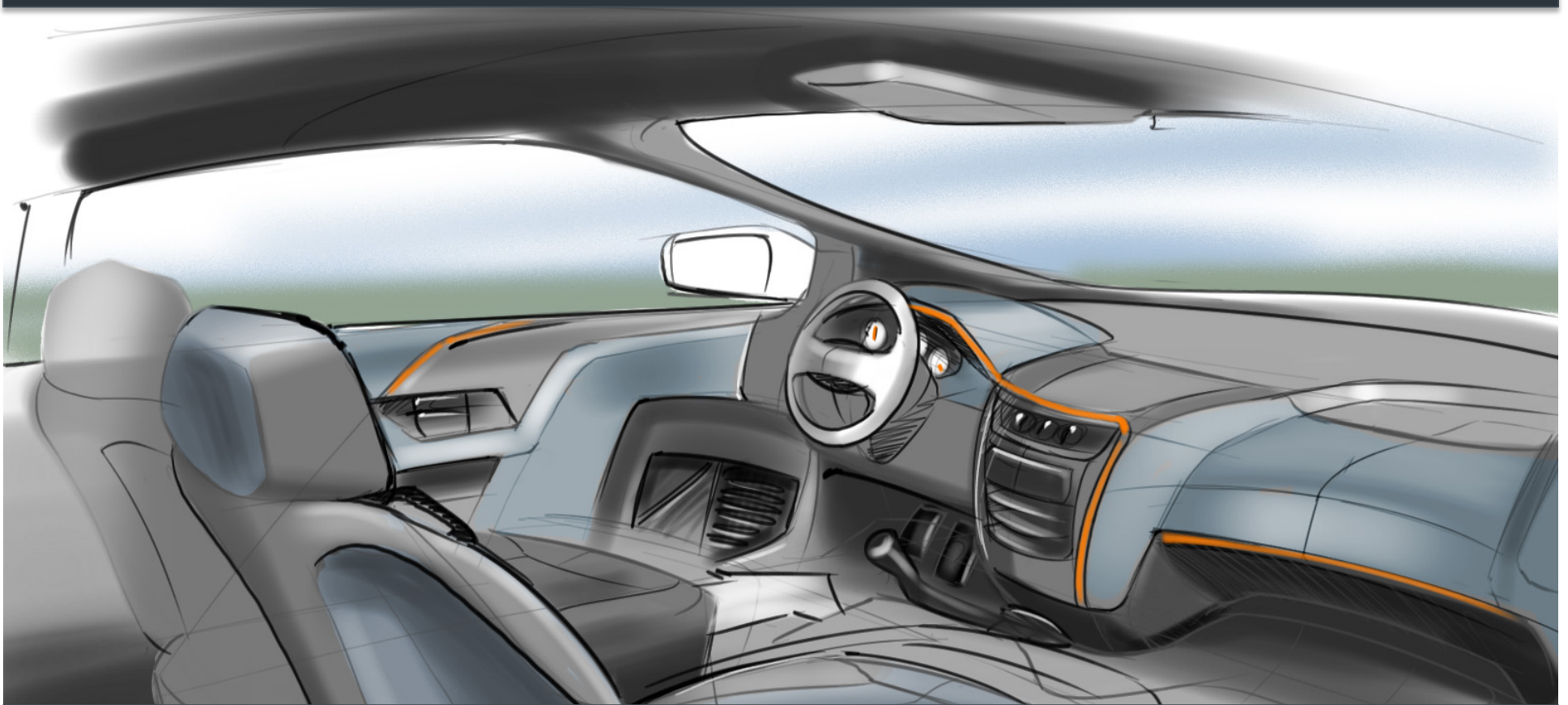


Automobile Collision Avoidance System (ACAS)



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Problem Statement

According to the National Highway Traffic Safety Administration (NHTSA), about 40,000 people are killed each year in automobile collisions in the United States. We will design a system to prevent automobile collisions.

Problem Statement

Who are the project stakeholders and what are their concerns?

- Drivers are concerned with ease of use and safety.
- Automobile manufacturers are concerned with cost and safety.

If successful, what are the potential benefits of this project?

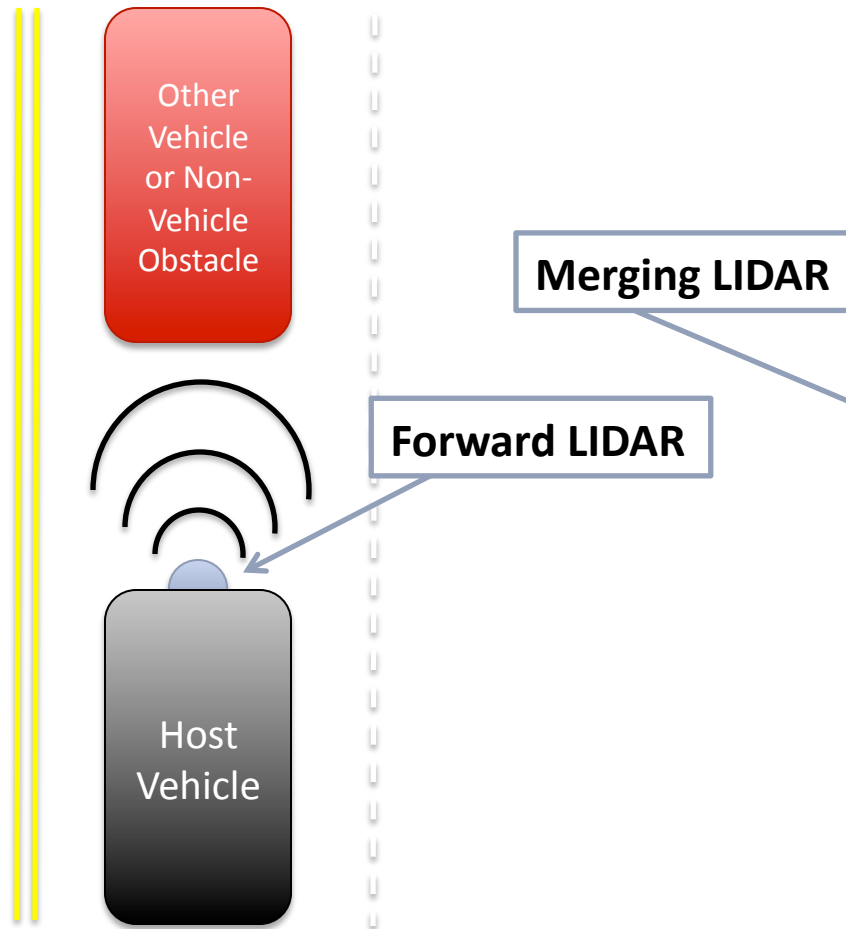
- Reduced human suffering caused by injury and death.
- Reduced financial burden on the health care industry.

Where will the system be implemented?

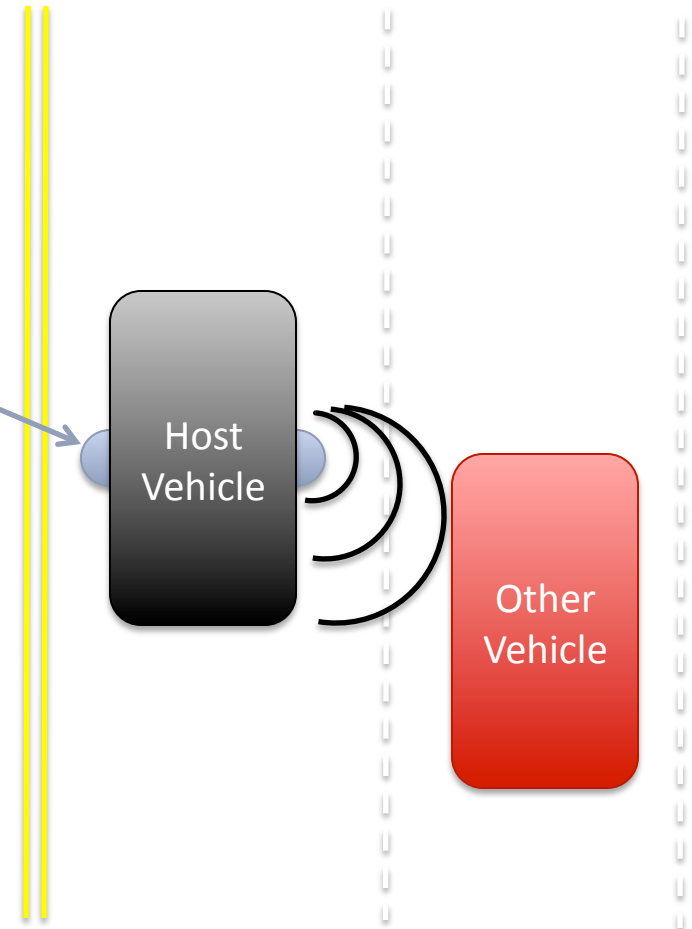
- Ideally, the system will be implemented in all automobiles on the road.

System Overview

Forward Collision Avoidance System

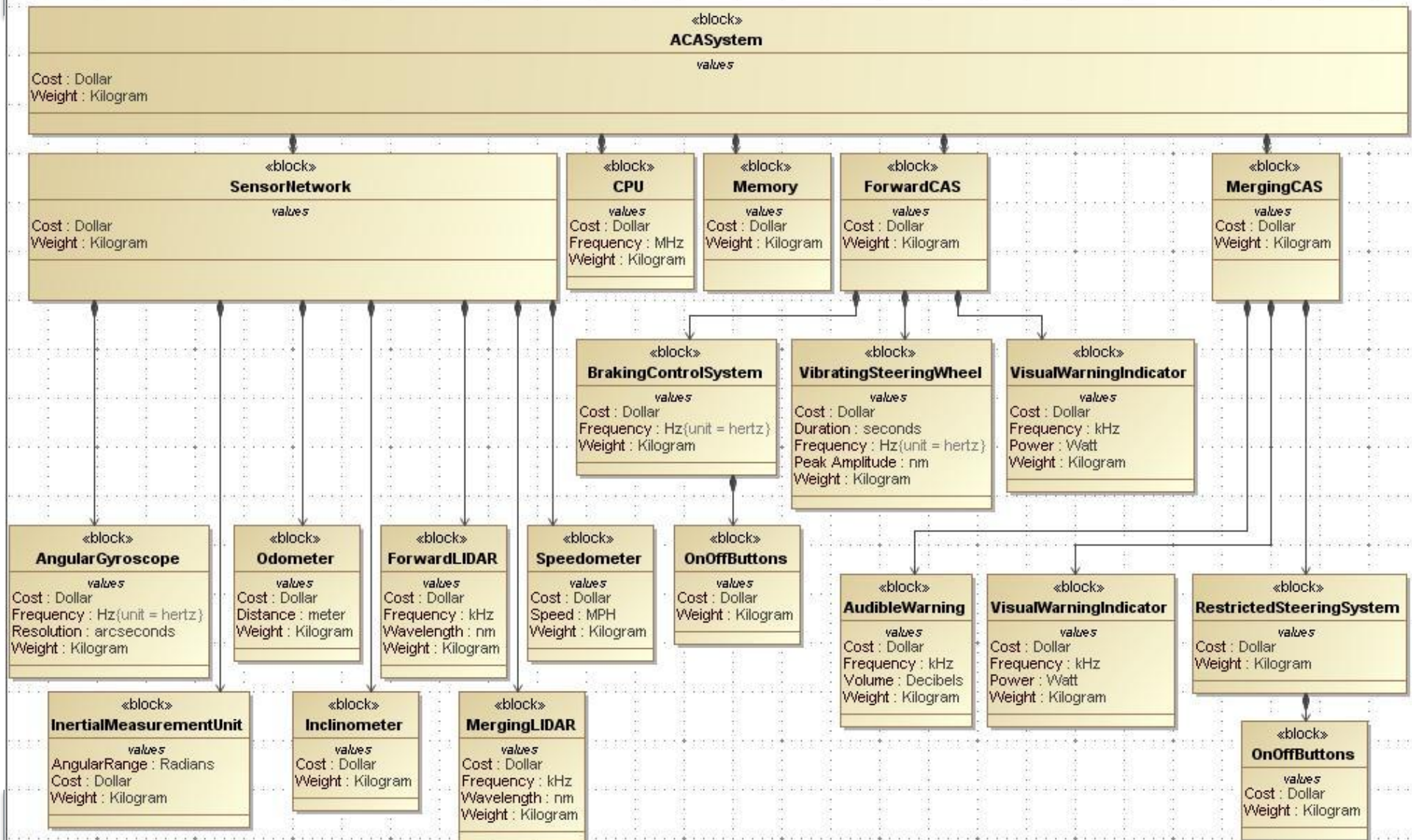


Merging Collision Avoidance System



System Structure

bdd [Package] ACAS[ACASBDD]



Use Case Diagram

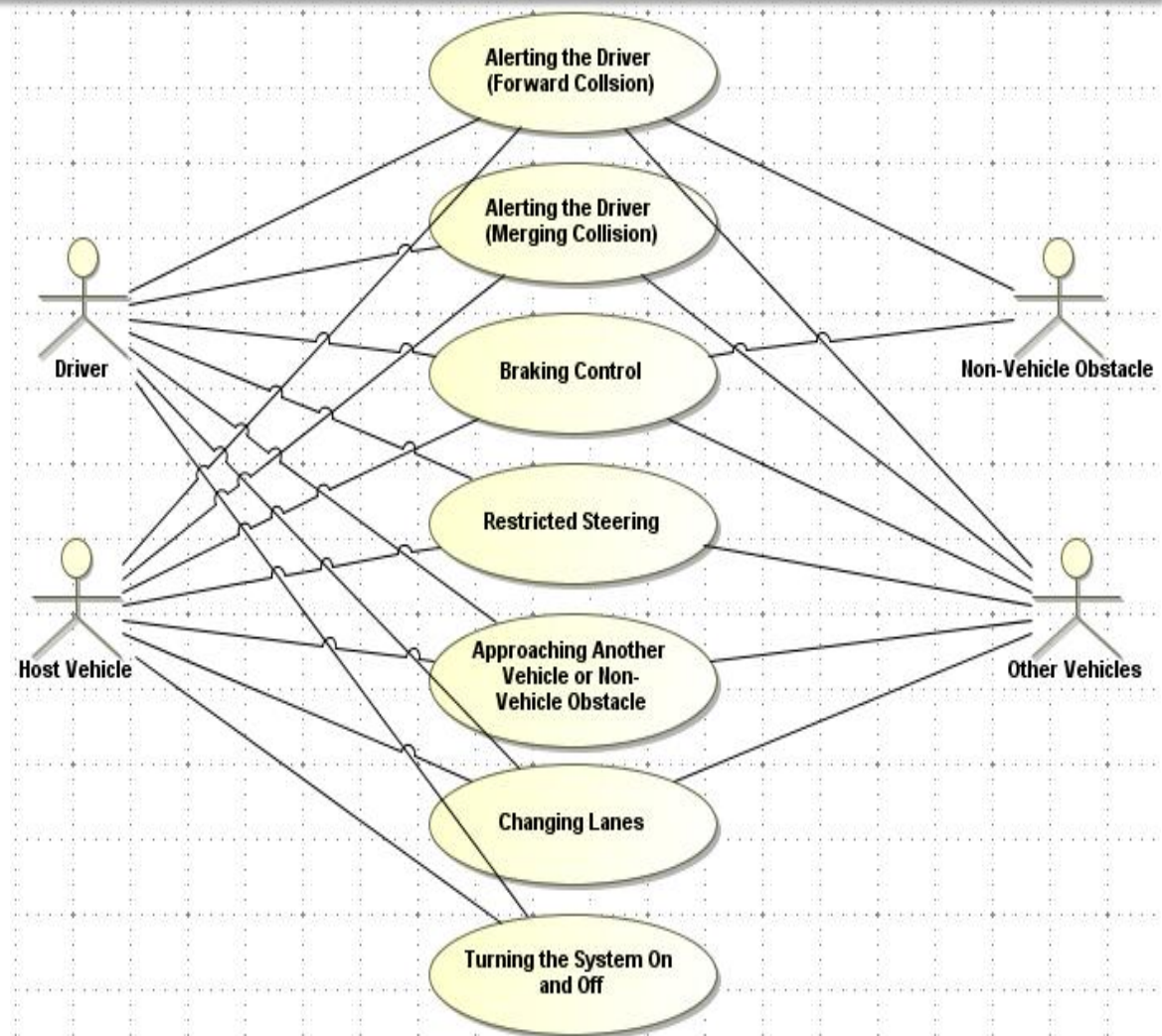
Use Cases

I. System Functionality

- Alerting the Driver (Forward Collision)
- Alerting the Driver (Merging Collision)
- Braking Control
- Restricted Steering

II. Driver Functionality

- Approaching Another Vehicle or Non-Vehicle Obstacle
- Changing Lanes
- Turning the System On and Off



Use Case: Turning the ACAS On and Off

Description:

The driver can turn the Restricted Steering System and the Breaking Control System on/off.

Pre-Conditions:

There is a switch for turning each the Restricted Steering and Breaking Control Systems on/off.

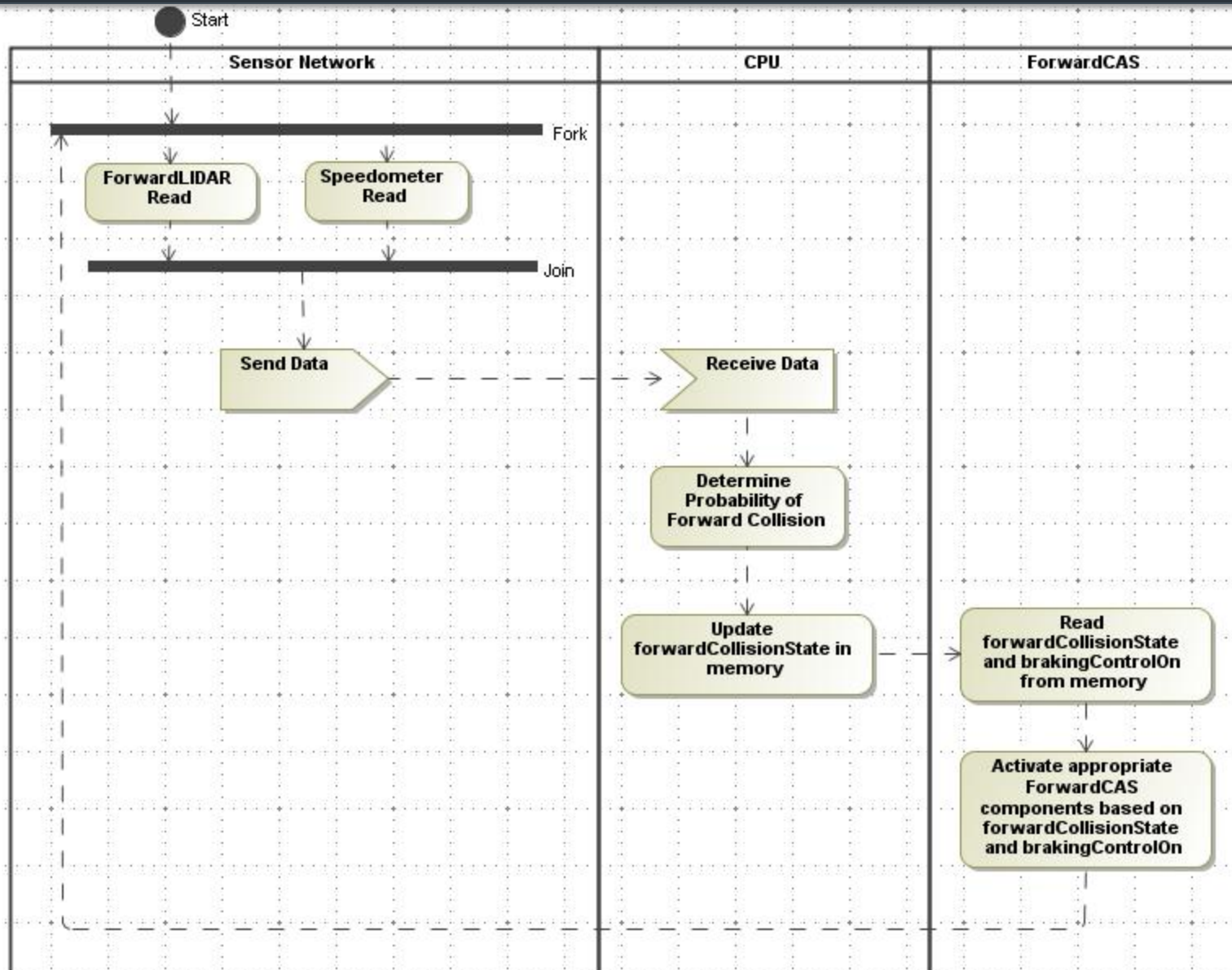
Flow of events:

The driver toggles the on/off switches for the Restricted Steering and Breaking Control Systems.

Post-Conditions:

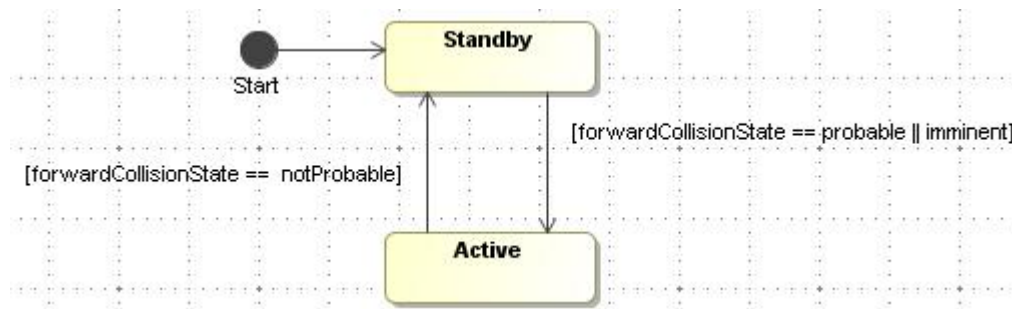
The Restricted Steering and Breaking Control Systems of the ACAS are either on or off based on the driver's preference.

ForwardCAS Activity Diagram

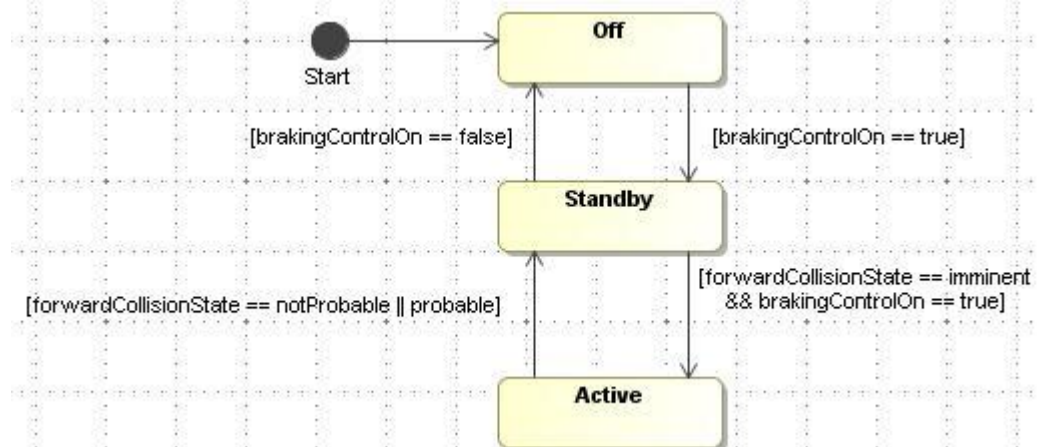


ForwardCAS State Machine Diagrams

Visual Warning Indicator



Braking Control System & Vibrating Steering Wheel



Use Case: Alerting the Driver (Forward Collision)

Description:

The ACAS alerts the driver when the sensors detect that the host vehicle is on a collision path with another vehicle or non-vehicle obstacle.

Pre-Conditions:

There is another vehicle or non-vehicle obstacle in the direct path of the host vehicle.

Flow of events:

1. The driver is driving the vehicle forward.
2. The ACAS continuously gathers data about the host vehicle and objects in the host vehicle's path, e.g. the velocity of the host vehicle, the distance from other vehicles and objects, the velocity of other vehicles and objects.
3. From this data, the ACAS determines that the host vehicle is in one of the following states:
 - State 1: Forward collision is not probable (normal driving)
Any alerts are deactivated
 - State 2: Forward collision is probable if no action is taken
The ACAS activates a visual alert
 - State 3: Forward collision is imminent
The activates a visual alert and vibrates the steering wheel

Post-Conditions:

The driver is alerted of a probable or imminent forward collision.

Use Case: Braking Control

Description:

The ACAS prevents the host vehicle from colliding with other vehicles and non-vehicle obstacles in its direct path.

Pre-Conditions:

- The Braking Control System is turned on.
- There is another vehicle or non-vehicle obstacle in the direct path of the host vehicle.

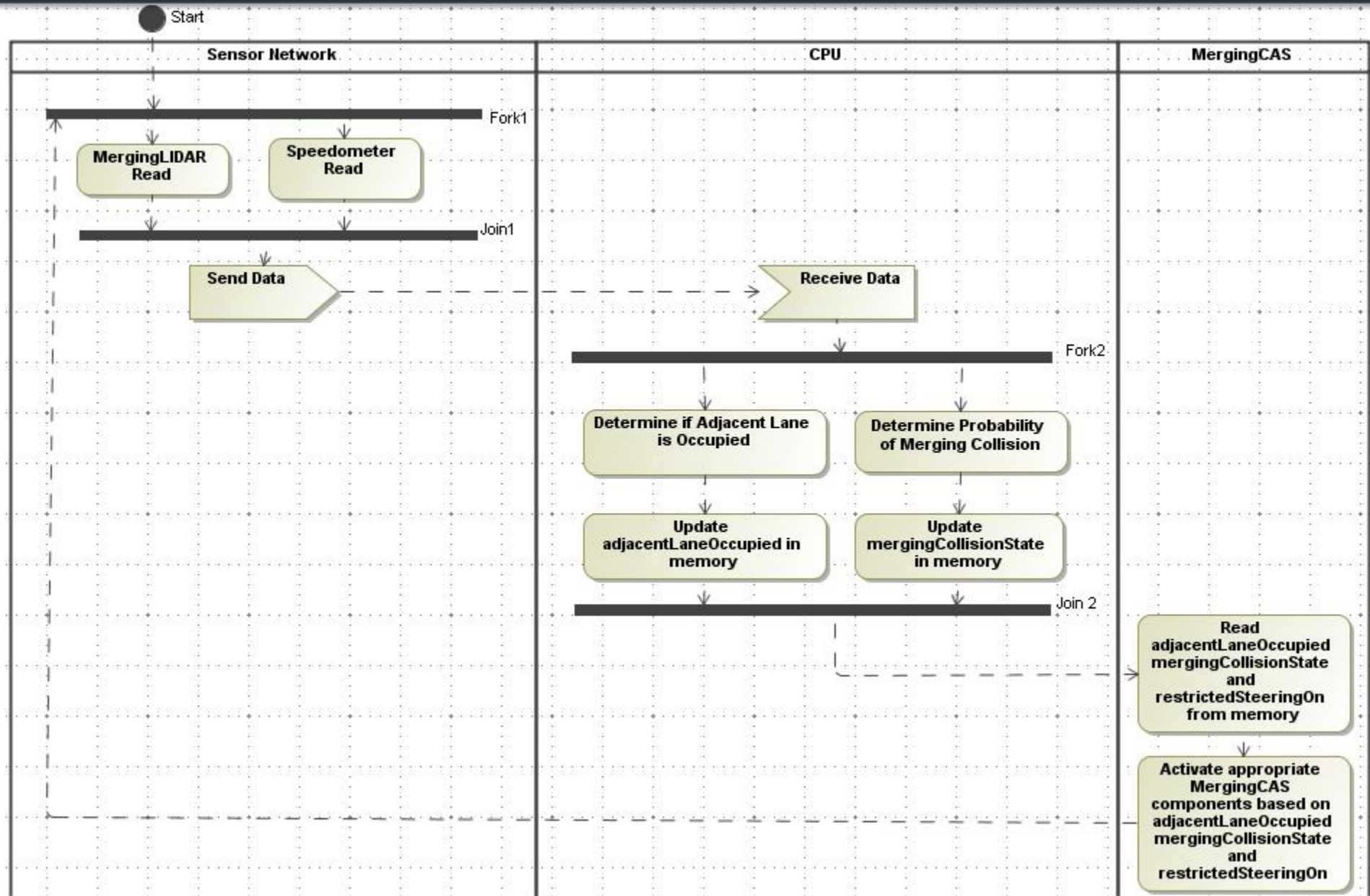
Flow of events:

1. The host vehicle is approaching another vehicle or non-vehicle obstacle.
2. The driver does not activate the brakes, or activates the brakes not hard and/or quickly enough.
3. The ACAS determines that a collision is imminent.
4. The Braking Control System activates the brakes.
5. The ACAS determines that a collision is no longer imminent.
6. The Braking Control System deactivates.

Post-Conditions:

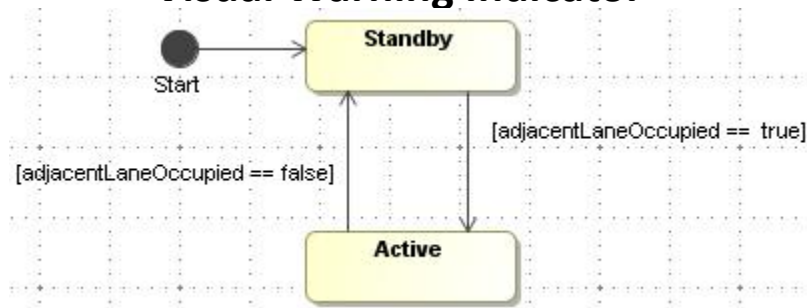
- Forward collision is not imminent.
- The driver has full control of the vehicle.

MergingCAS Activity Diagram

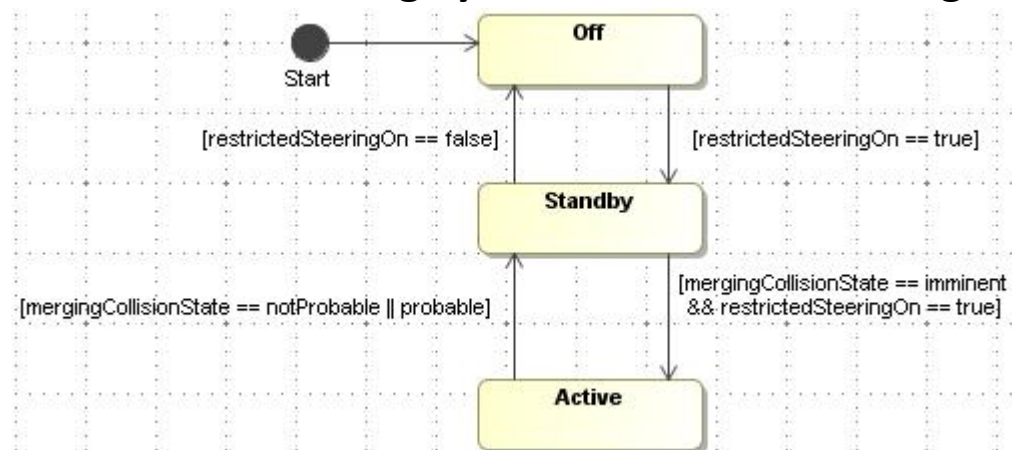


MergingCAS State Machine Diagrams

Visual Warning Indicator



Restricted Steering System & Audible Warning



Use Case: Alerting the Driver (Merging Collision)

Description:

The ACAS alerts the driver when the sensors detect a vehicle in the adjacent lane and when a merging collision is imminent.

Pre-Conditions:

There is a vehicle in the adjacent lane.

Flow of events:

1. The ACAS system determines if a vehicle is occupying the lane adjacent to the host vehicle.
2. If there is a vehicle occupying the adjacent lane,
 1. The ACAS activates a visual alert.
 2. The ACAS determines if the host vehicle is in one of the following states.
 - State 1: Merging collision is not probable
 - State 2: Merging collision is probable if no action is taken
 - State 3: Forward collision is imminentThe ACAS activates an audible warning.
3. The ACAS deactivates the visual alert when there is no vehicle occupying the adjacent lane.

Post-Conditions:

- The driver is warned of a vehicle in the adjacent lane.
- The driver is warned of an imminent merging collision.

Use Case: Restricted Steering

Description:

The ACAS prevents the host vehicle from colliding into an adjacent vehicle.

Pre-Conditions:

- The Restricted Steering System is turned on.
- There is a vehicle in the adjacent lane.

Flow of Events:

1. The driver turns the steering wheel in the direction of the occupied adjacent lane.
2. The ACAS determines that a collision is imminent.
3. The Restricted Steering System steers the car in the opposite direction.
4. The ACAS determines that a collision is no longer imminent.
5. The Restricted Steering System deactivates.

Post-Conditions:

- Merging collision is no longer imminent.
- The driver has full control of the vehicle.

Requirements and Traceability

Component	Use case	Requirement	Structure/Behavior	Description
Performance Requirements	N/A	1.1	Behavior	The ACAS must work at all vehicle speeds
	N/A	1.2	Behavior	The ACAS must work in all weather conditions.
	N/A	1.3	Behavior	The ACAS must work in all light conditions.
	N/A	1.4	Behavior	The ACAS must be capable of working in real time.
	N/A	1.5	Behavior	The ACAS must work in all traffic conditions.
Safety Requirements	N/A	2.1	Behavior	The ACAS must not frighten, disorient, or distract drivers.
	N/A	2.2	Structure	The ACAS must not cause an accident while trying to avoid a collision.
Sensor Network and CPU Requirements	N/A	3.1	Structure/Behavior	The sensor network and CPU must process large amounts of data at high speeds.
ForwardCAS Requirements	1.a	4.1	Structure	The Visual Warning Indicator must be highly visible.
	3.a	4.2	Behavior	The braking control system should not activate when cars/ objects are moving toward the host vehicle.
	3.b	4.3	Structure	The braking control system must be compatible with vehicle's braking system.
	7.b	4.4	Structure	There must be a user friendly way to turn on/off the Breaking Control System.
MergingCAS Requirements	1.a	5.1	Structure	The Visual Warning Indicator must be highly visible.
	1.b	5.2	Structure	The Audible Warning must be highly audible.
	4.a	5.3	Structure	The restricted steering system must be compatible with the vehicle's steering system.
	7.a	5.4	Structure	There must be a user friendly way to turn on/off the Restricted Steering System.