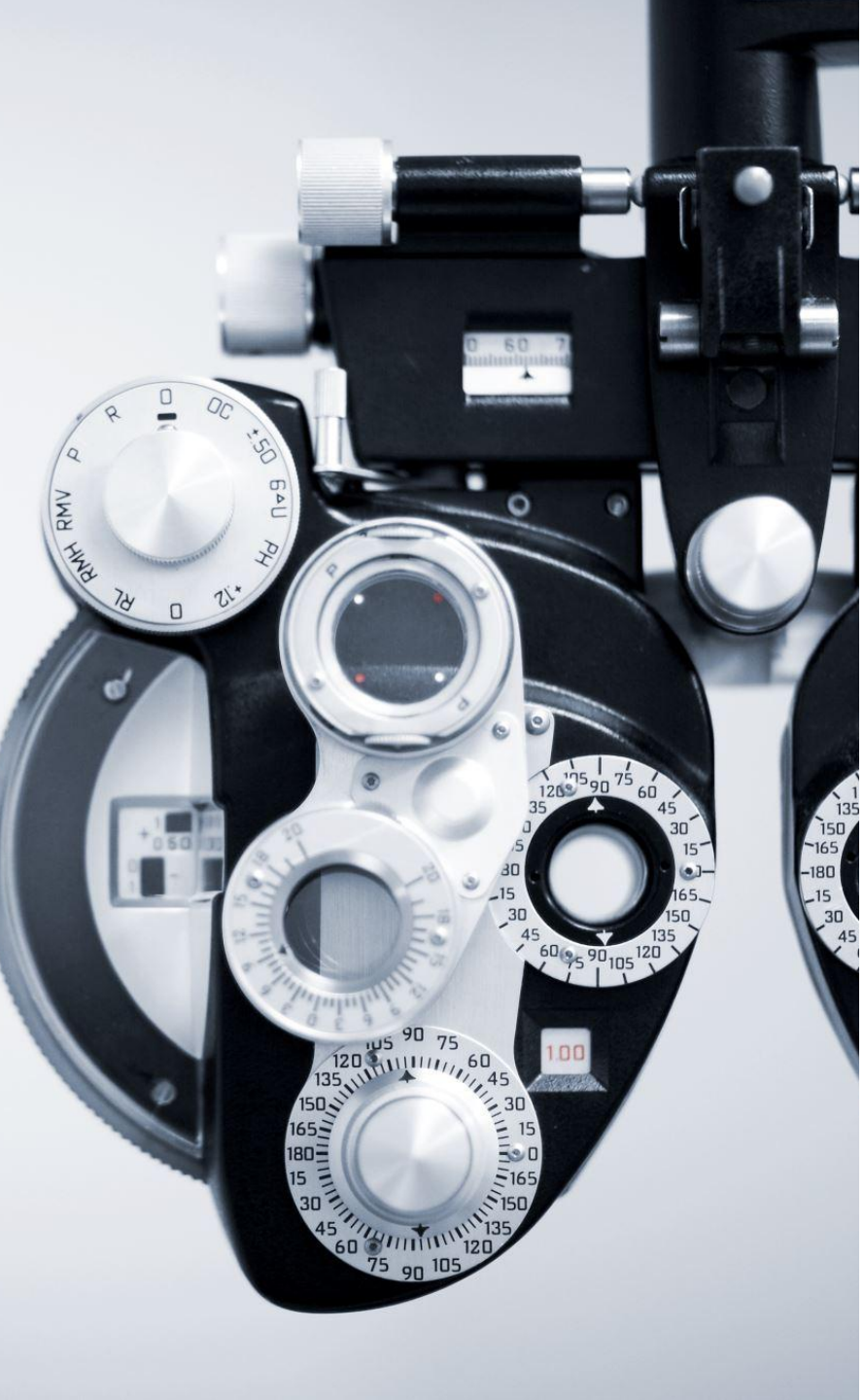

AUTONOMOUS ANTI-LOCK BRAKING SYSTEM

Group -13

Members:

- Md Mostafizur Rahman
- Md Sayem
- Sayed Galib Hossen Rizvi
- Bodrul Amin Murad
- Md Azadul Islam

AGENDA

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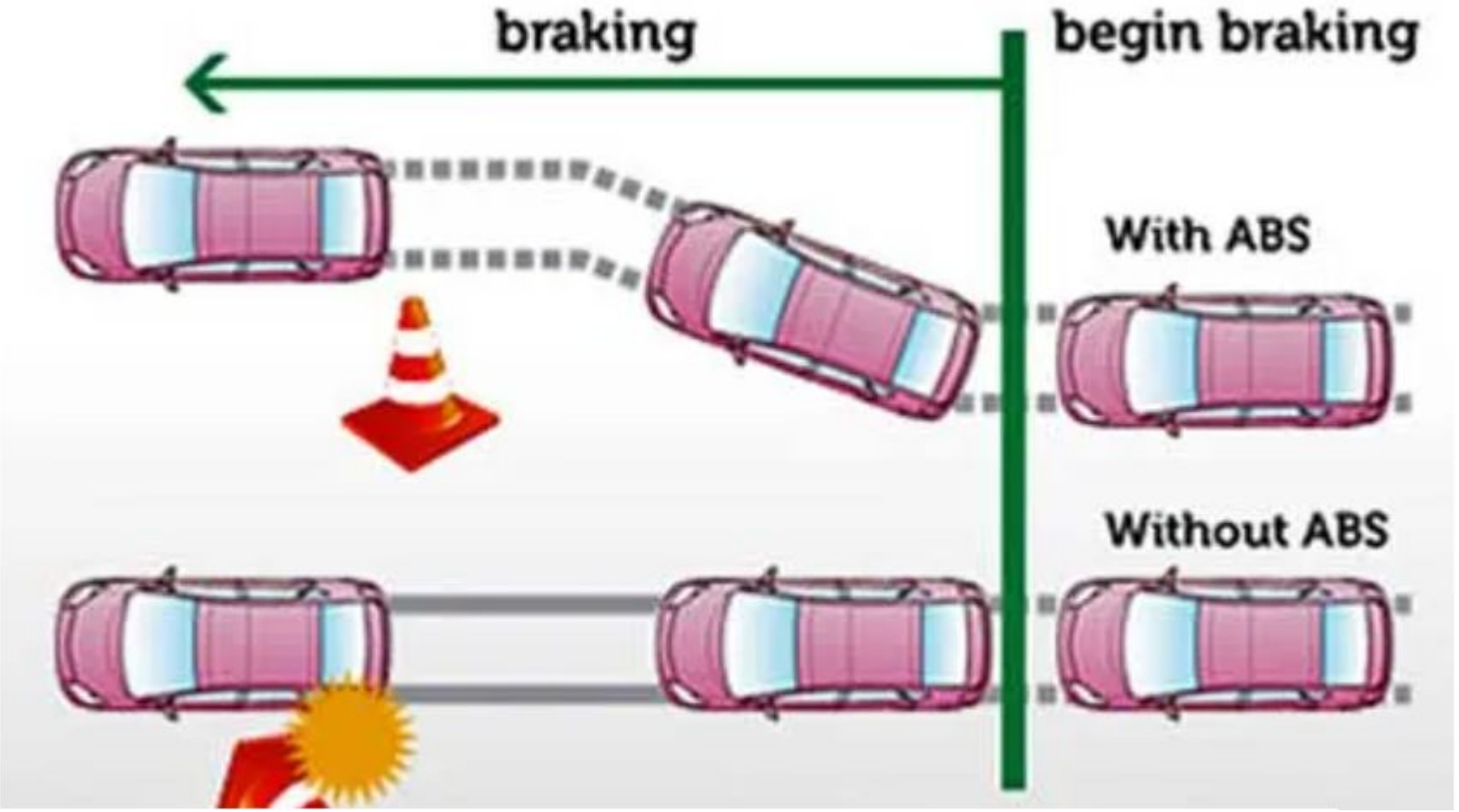
- System Specification
- Behavior and Functionality
- SysML Diagrams
- Requirement Diagram
- Structural Diagrams
- Block Definition Diagram
- Internal Block Diagrams
- Use Case Diagram
- Activity Diagram
- Sequence Diagram
- Parametric Diagram
- State Machine Diagram

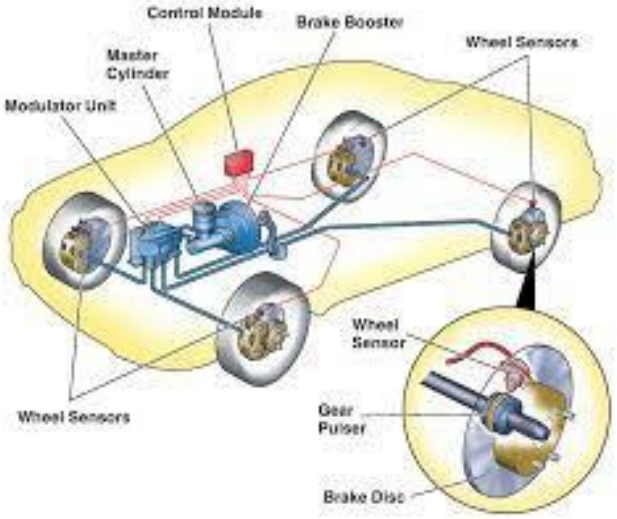
Motivation

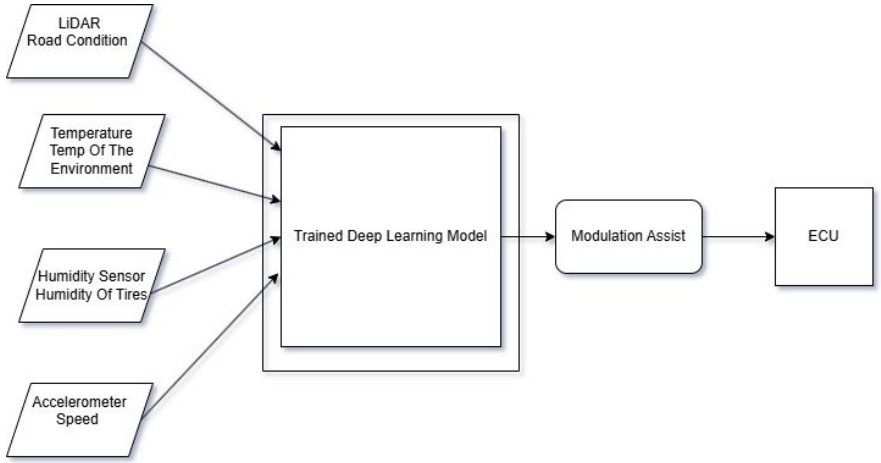
- Anti-Skid
- Wheel-Lock
- Safety



Introduction

A2BS IS AN AI-DRIVEN, ADAPTIVE ABS THAT COMBINES REAL-TIME SENSOR DATA WITH DEEP LEARNING TO OPTIMIZE BRAKING PERFORMANCE ACROSS DIVERSE ENVIRONMENTS, MODELED RIGOROUSLY VIA MBSE/SYSML FOR SAFETY AND RELIABILITY.





System Specifications

HARDWARE COMPONENTS :

Wheel speed sensors – Monitor the rotational speed of each wheel.

Vehicle speed sensor – measures the actual speed of the vehicle.

Brake pressure control unit – applies, holds, or releases hydraulic brake pressure.

Environmental sensors : lidar, temperature, and humidity.

ECU – processes sensor data, executes control logic, and manages ABS state.

SOFTWARE REQUIREMENTS : DEEP LEARNING MODULE

BEHAVIOR AND FUNCTIONALITY

GENERAL SCENARIO :

THE A2BS SYSTEM WILL BE ALWAYS ON IDLE MODE AND WILL BE ACTIVATED WHEN ECU DETECTS BRAKE PRESSURE.

IT MONITORS AND COMPARES WHEEL SPEED AND VEHICLE SPEED IN REAL TIME.

IF THE WHEEL SPEED < CAR SPEED AND CROSSED THE DEFINED THRESHOLD, INDICATING A RISK OF WHEEL LOCK, THE ABS IS ACTIVATED.

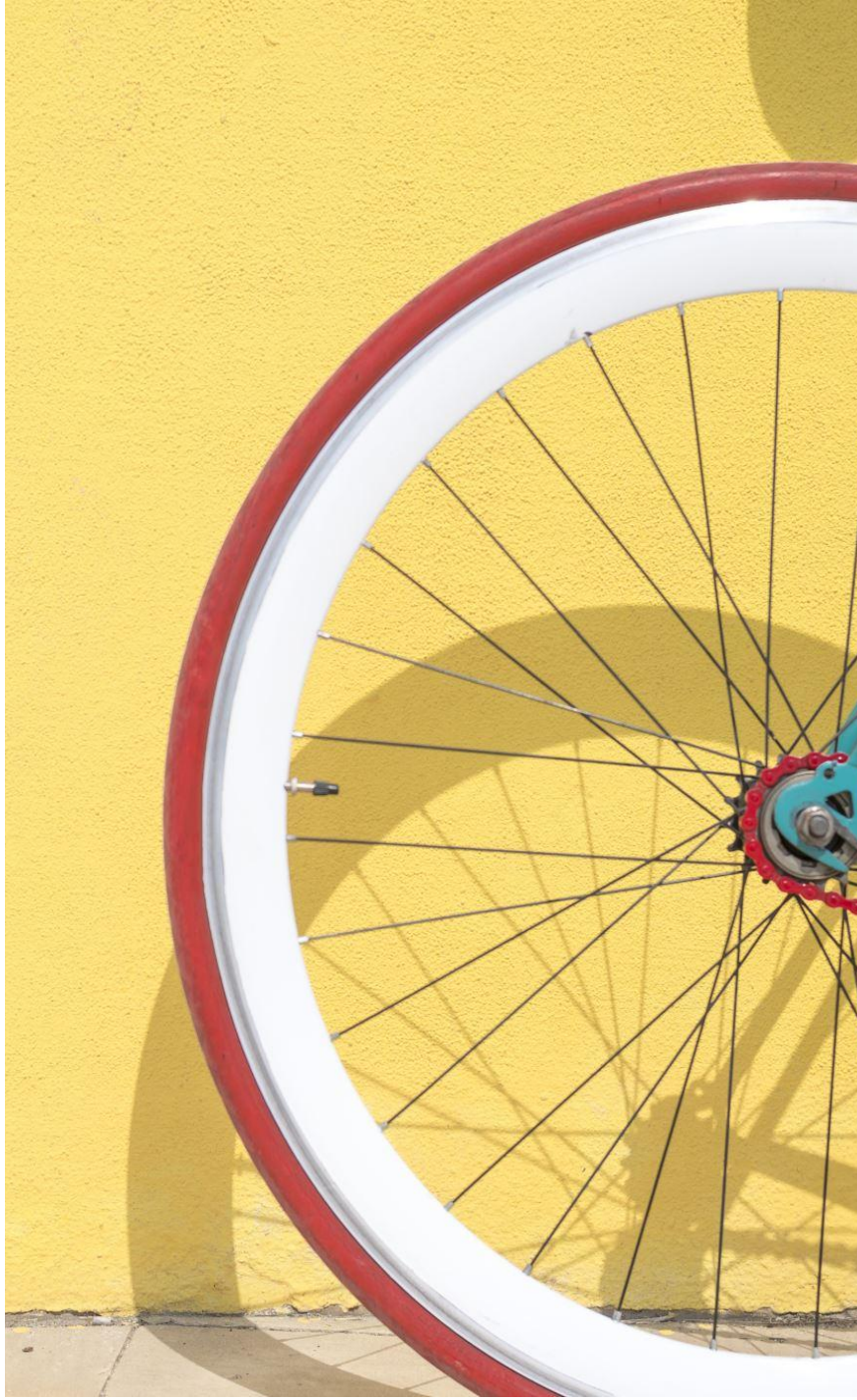
ONCE ACTIVATED, THE SYSTEM MODULATES BRAKE PRESSURE ACCORDING TO SLIPRATIO EVERY 10 MILLISECONDS (OVERRIDE POSSIBLE ACCORDING TO DL ASSIST SIGNAL)

A2BS WILL BE DEACTIVATED IF ‘ WHEEL SPEED < CAR SPEED” IS NO MORE TRUE

AUTONOMOUS SCENARIO :

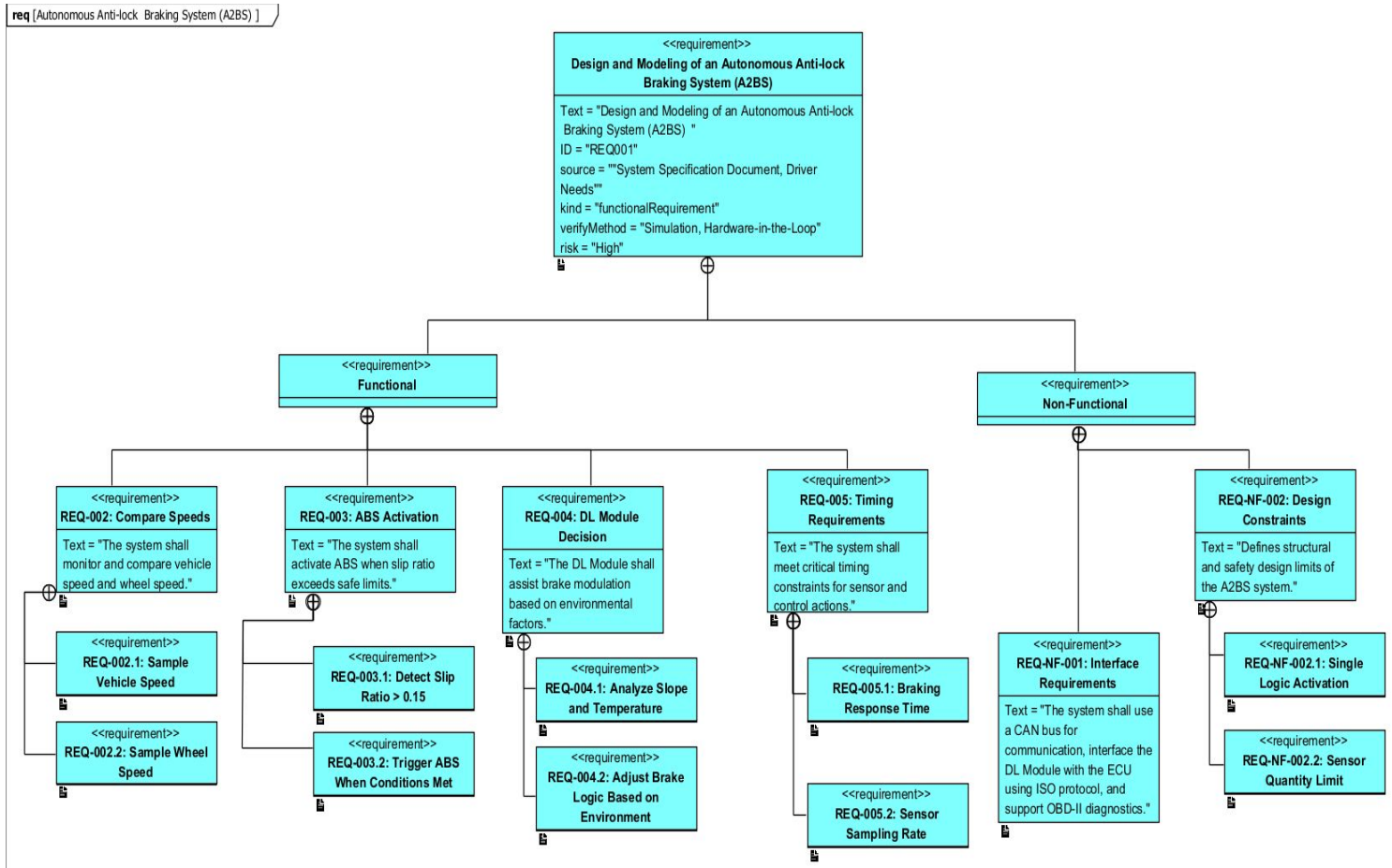
ONCE ACTIVATED, THE DEEP LEARNING MODULE AUTONOMOUSLY ANALYZES REAL-TIME ENVIRONMENTAL DATA AND VEHICLE SPEED AND GENERATE AN ASSIST SIGNAL

THE MODULATION ASSIST SIGNAL IS SENT TO THE ECU, WHICH EXECUTES THE BRAKE MODULATION CYCLE (RELEASE, HOLD, ATTACK).



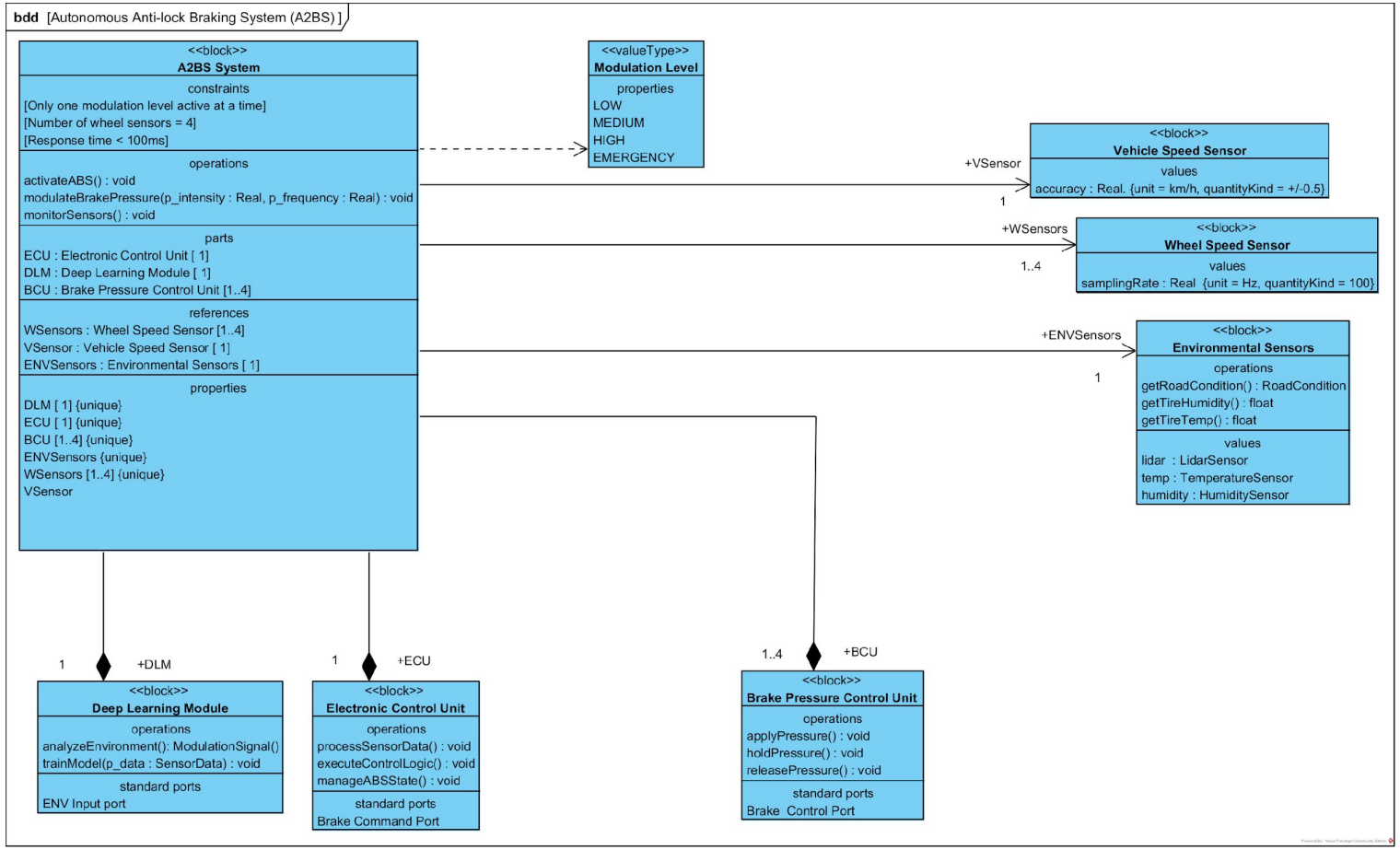
SysML Diagrams

REQUIREMENT DIAGRAM



Murad

Structural Diagrams

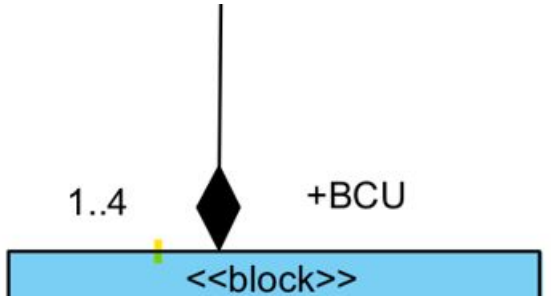


BLOCK DEFINITION DIAGRAM

Structural composition:

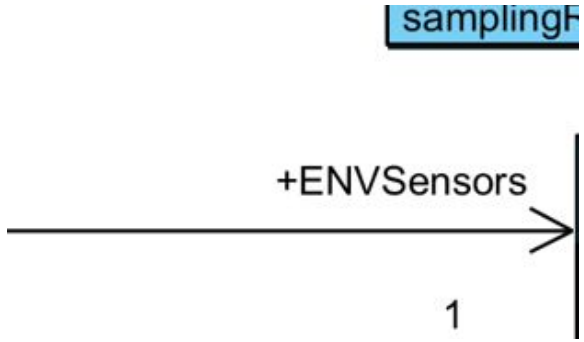
parts (composite aggregation – black diamond):

- ECU (electronic control unit, [1])
- DLM (deep learning module, [1])
- BCU (brake pressure control unit, [1..4])

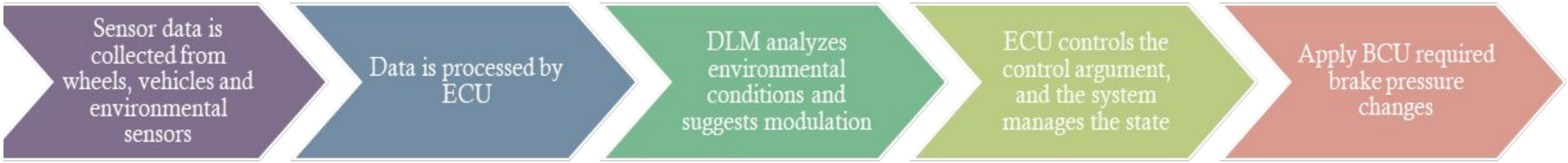


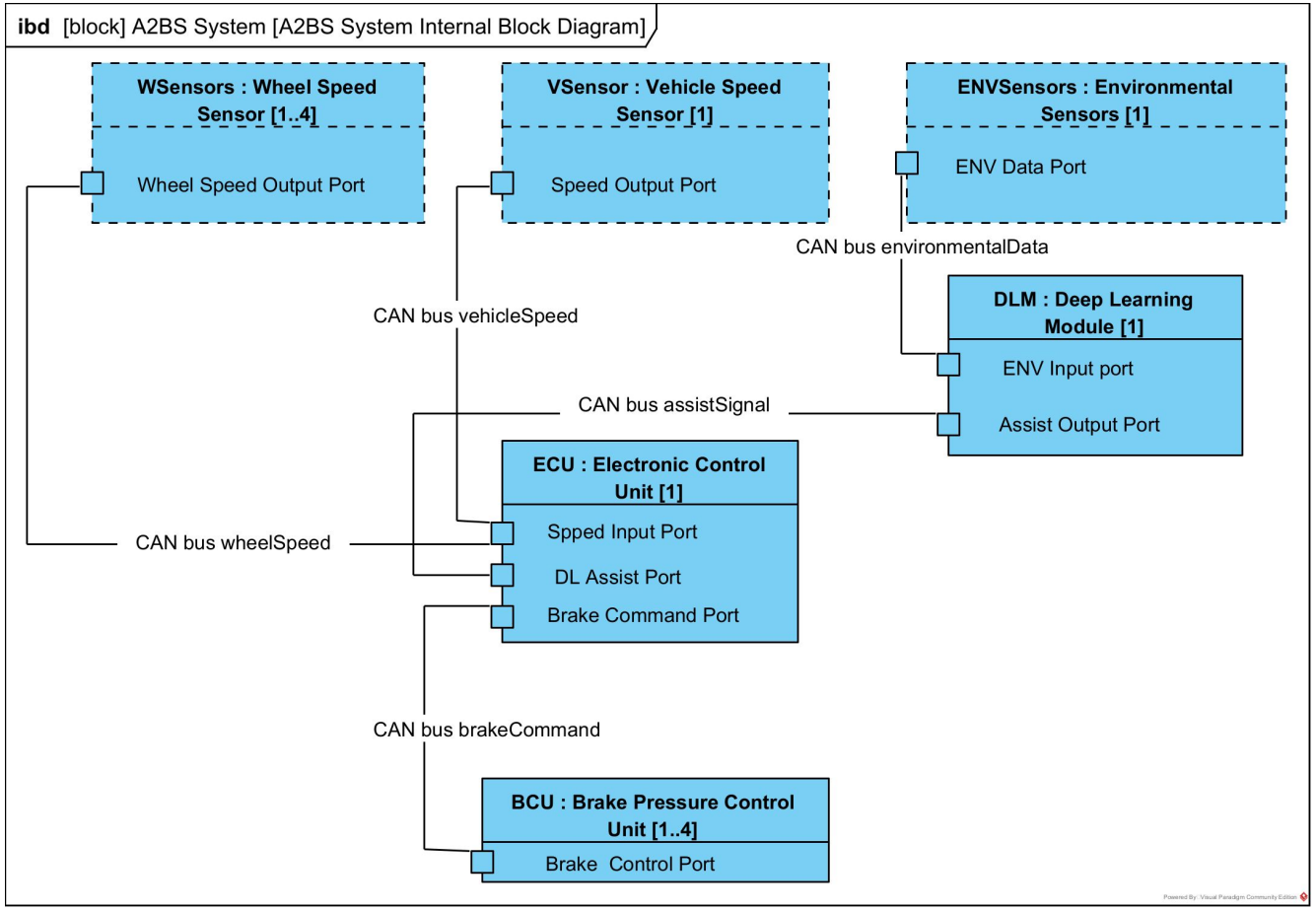
references (associations – no diamond):

- wsensors (wheel speed sensor, [1..4])
- vsensor (vehicle speed sensor, [1])
- envsensors (environmental sensors, [1])



System Workflow





INTERNAL BLOCK DIAGRAM

Sensor and input source:

- **Wheel Speed Sensor (WSensor) [1..4]**
- **Vehicle Speed Sensor (Vsensor) [1]**
- **Environment Sensor (ENVSensor) [1]**

Processing and control units:

- **Electronic Control Unit (ECU) [1]**
- **Deep Learning Module (DLM) [1]**
- **Brake Pressure Control Units (BCU) [1..4]**

Port and communication:

CAN bus connections for:

- Wheel/Vehicle Speed → ECU
- Environmental Data → DLM → Assist Signal → ECU
- Brake Commands → BCU

Functional workflow

Data acquisition:

- The speed of the wheel and the vehicle is occupied and sent to the ECU.
- Environmental conditions (roads, weather) are relayed for DLM.

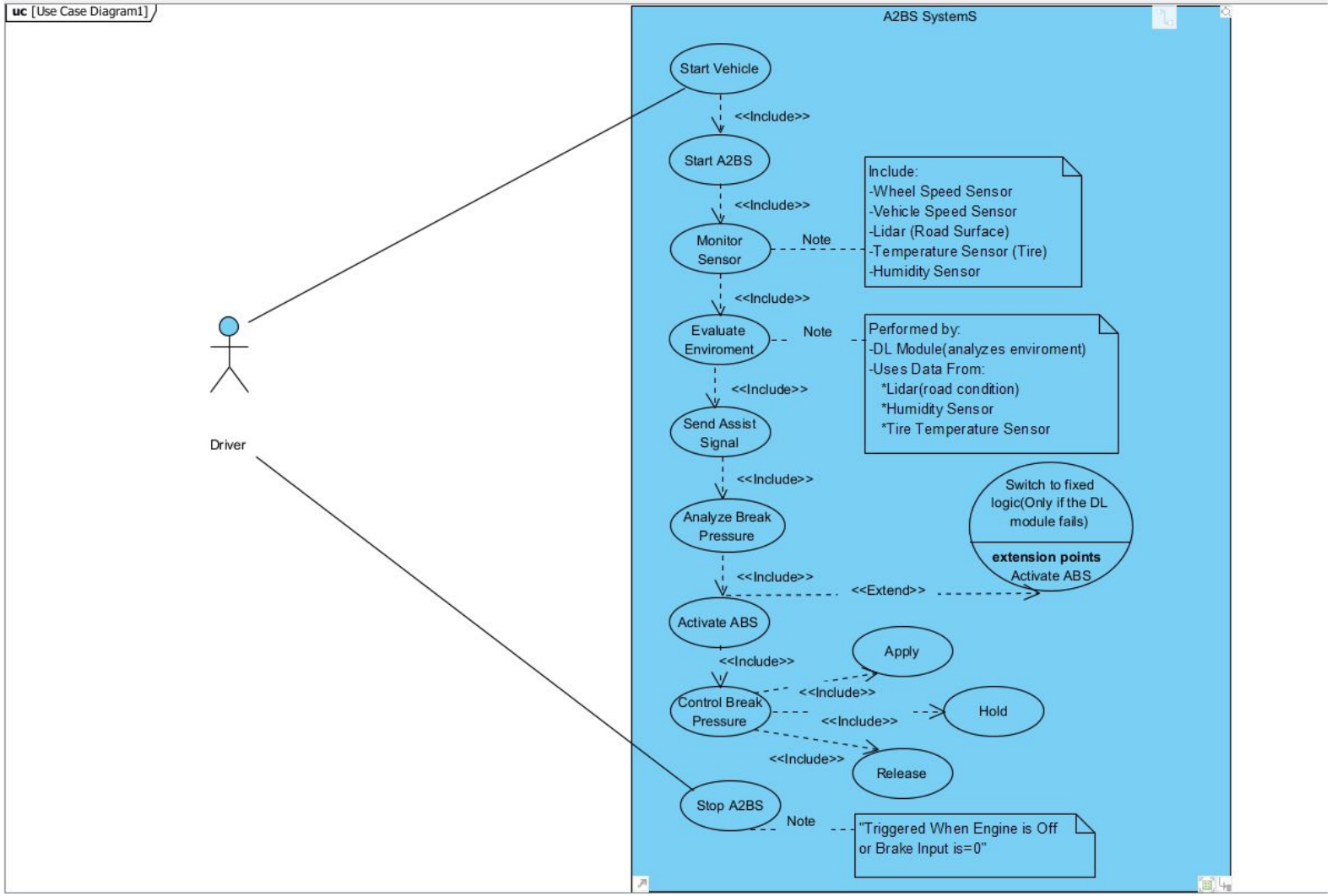
Decision-Making:

- ECU wheel processes speed data to detect lock-up risk.
- DLM analyzes the condition of the road and suggests optimal braking strategy.

Break execution:

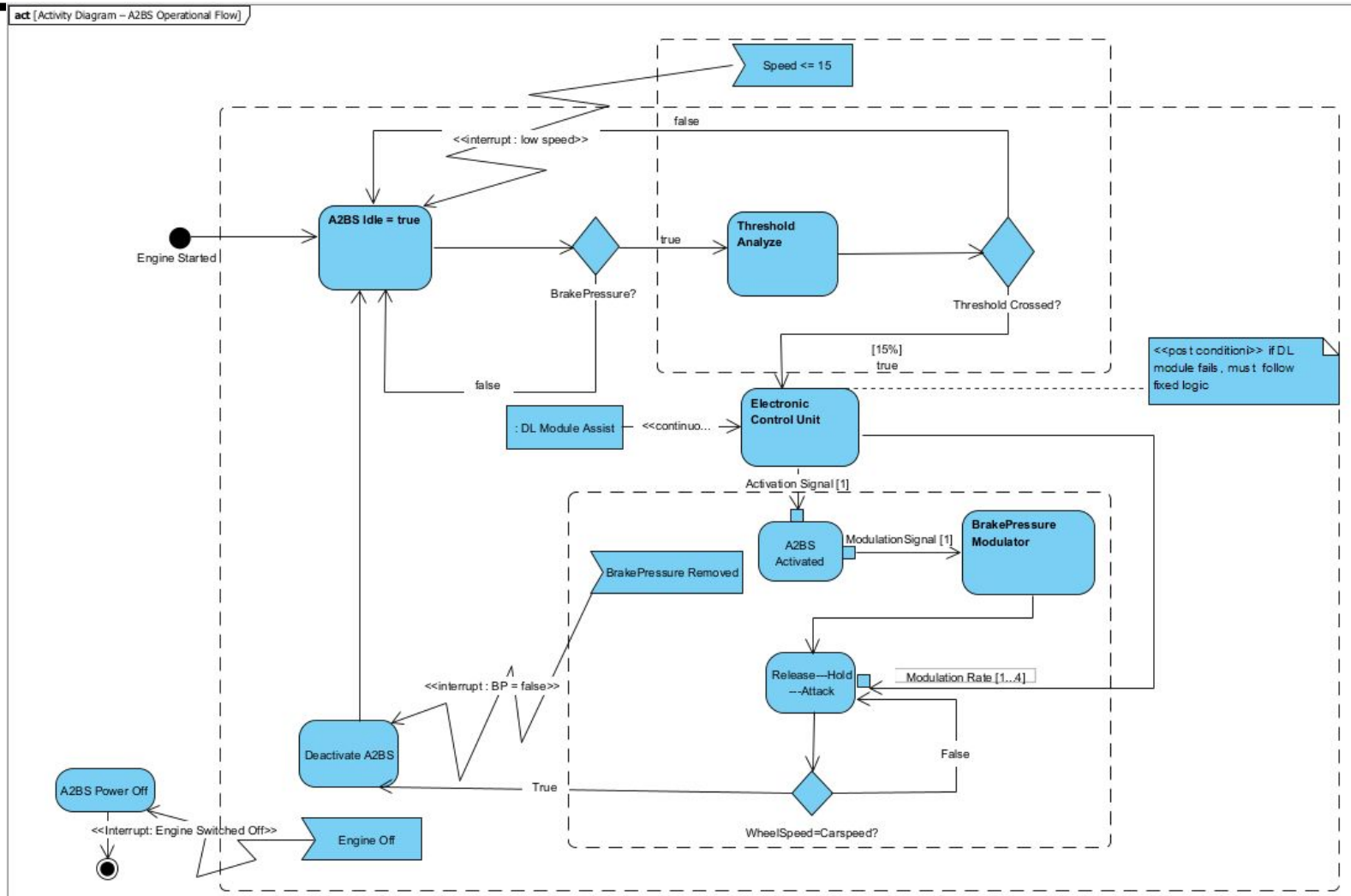
- ECU sends a brake modulation command to BCU.
- BCUs adjust pressure to prevent skidding while maintaining control.

Behavioral Models

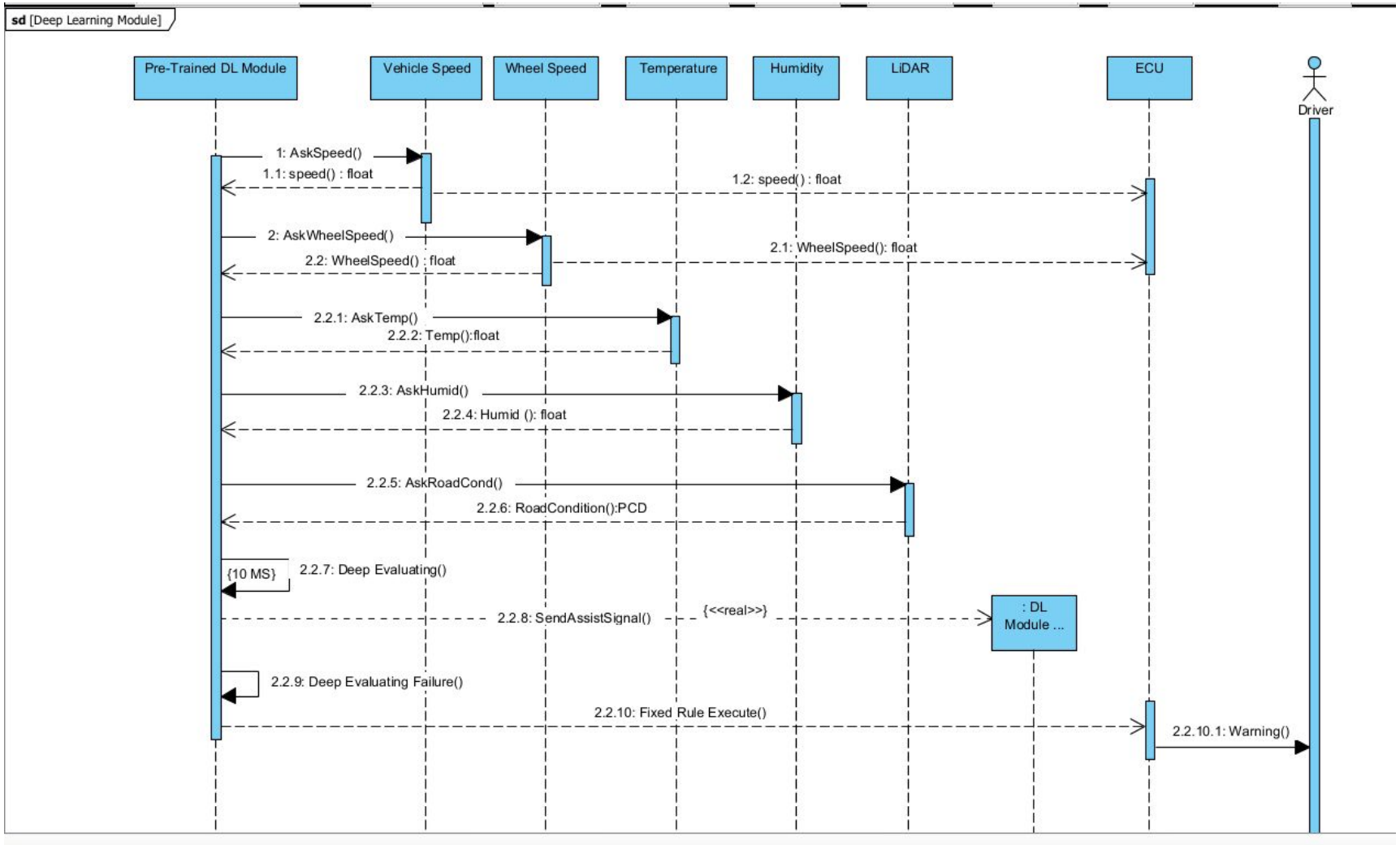


USE CASE DIAGRAM

ACTIVITY DIAGRAM (Operational FLow)



Sequence Diagram (DL Module)

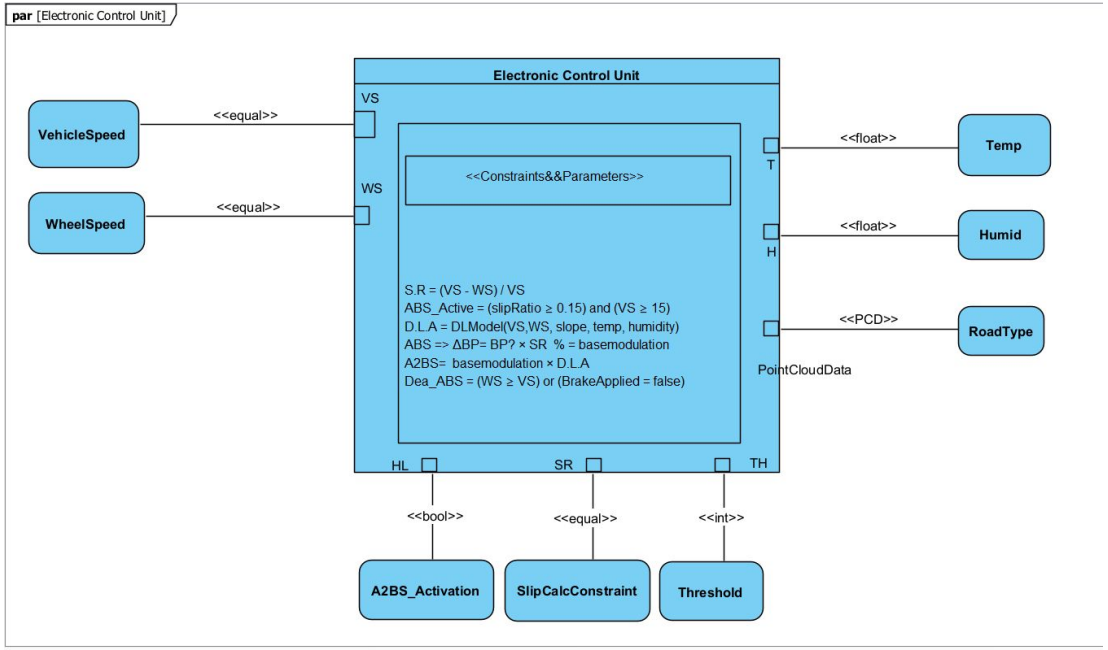


Sayem

Parametric Diagram

S.R	BP?	MR	Meaning
0.2	30	6%	Normal
0.2	50	10%	Aggressive
0.1	30	3%	no

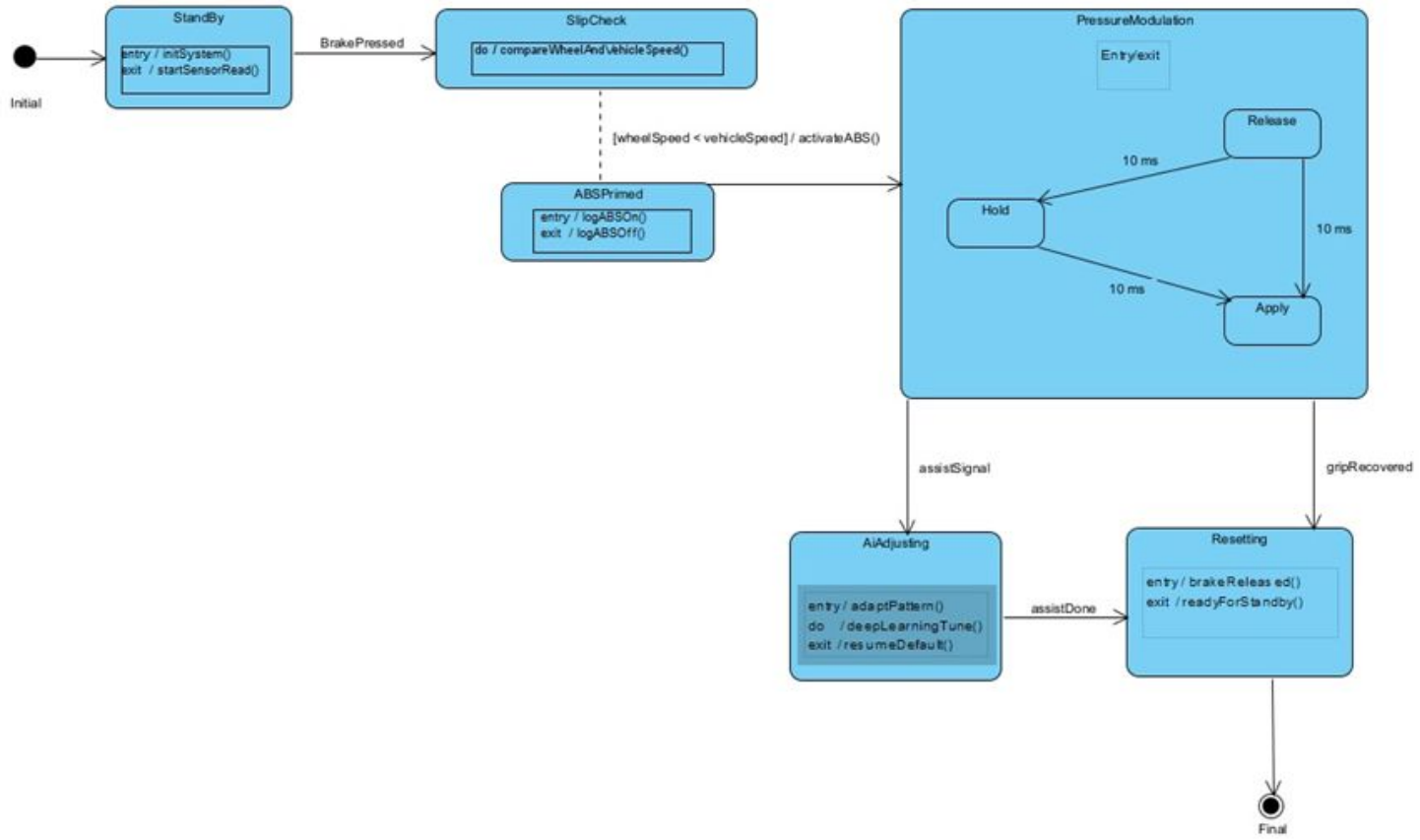
Example: Fixed Logic MR



Fixed MR	(DLA)	F.M.R	Aspects
6%	1.0	6%	normal
6%	0.8	4.8%	uphill
6%	1.2	7.2%	downhill

Final MR (DL Override)

STATE MACHINE DIAGRAM



Simulation

Conclusion

- An autonomous anti-lock braking system (A2BS) was designed and modeling using Sysml in the visual paradigm.
- The fixed ABS integrated a deep learning module to intelligently adjust the brake pressure beyond the logic.
- Facing challenges in selecting a suitable modeling tool and managing teamwork effectively.
- Got valuable skills in the deep understanding of system design and modern braking technologies.

References

1. Visual Paradigm
2. Images:

   https://www.motor-works.com/blog/inside-the-tech--anti-lock-braking-system--abs-

3. https://www.aasprint.com.au/what-is-the-difference-between-abs-vs-non-abs/