VEÍCULOS AUTÔNOMOS

Como funcionam e quais os desafios desta tecnologia

CONTENTS

Skoods is a self-racing car team, developing competitive engineering for Self-Driving Cars:

- 3D Simulations
- Autonomous Vehicles Algorithms

Mission: Develop self-racing car technology, making the bridge from the race tracks to the streets.

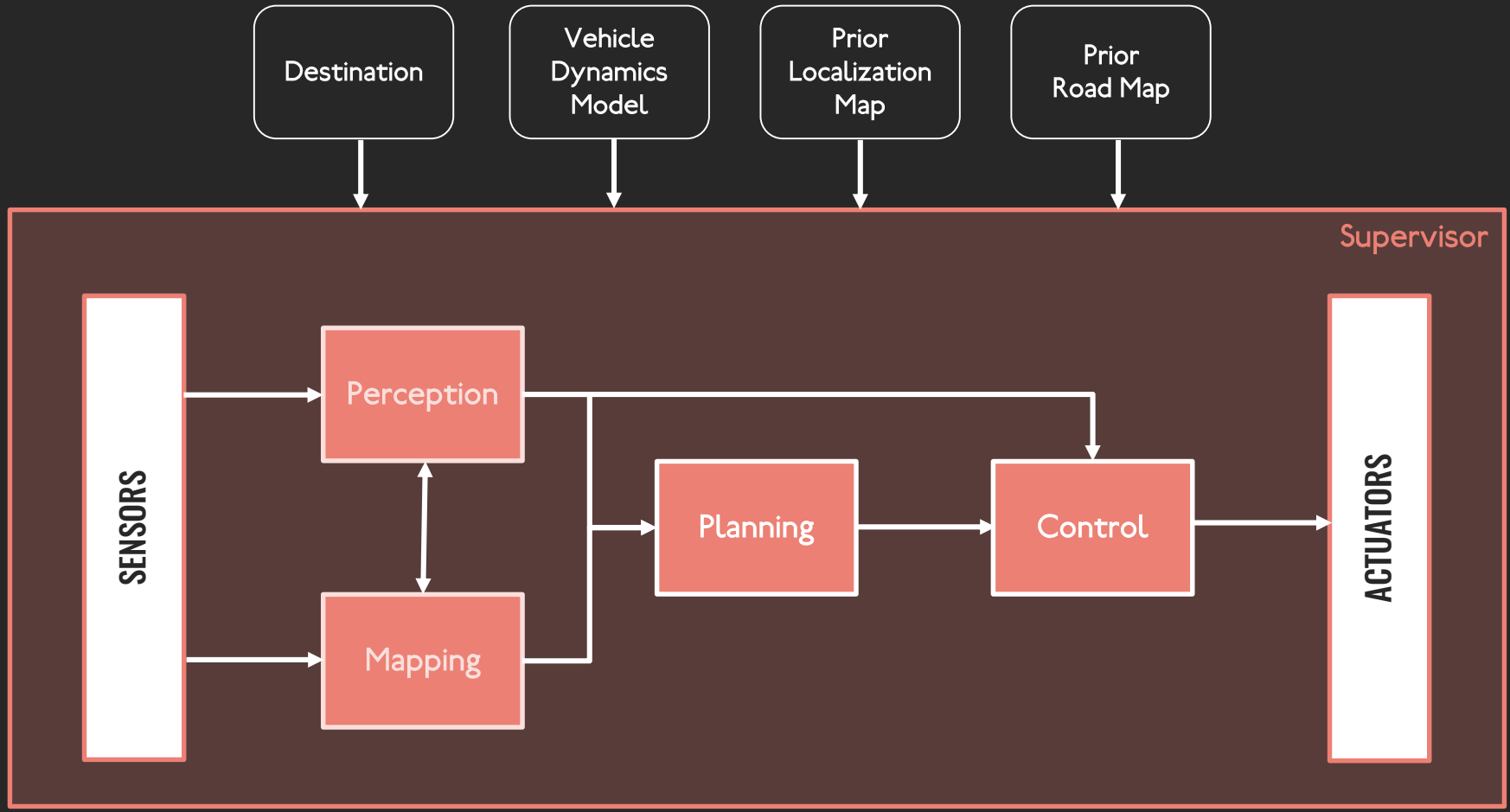
Vision: Self-Racing car technologies development contributes uniquely to everyday applications and will help save millions of lives in the future.

Skoods Open-Source Racing

VIDEO

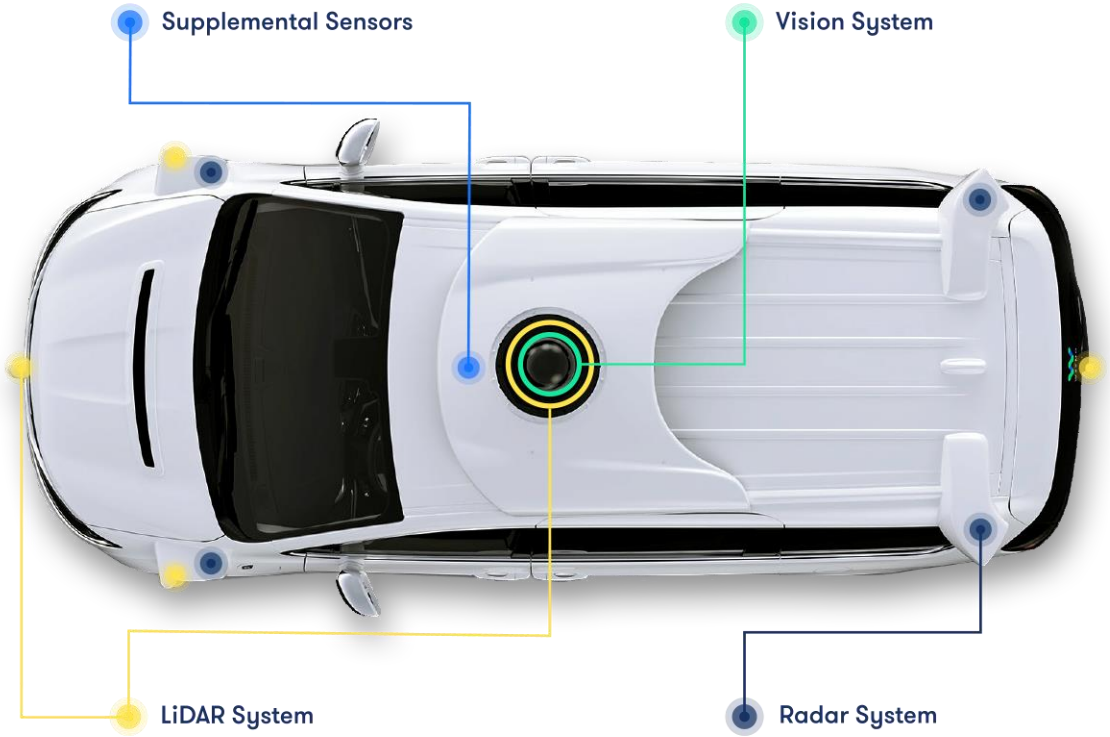
https://youtu.be/llGKBJxa0LA

SOFTWARE AND ALGORITHMS

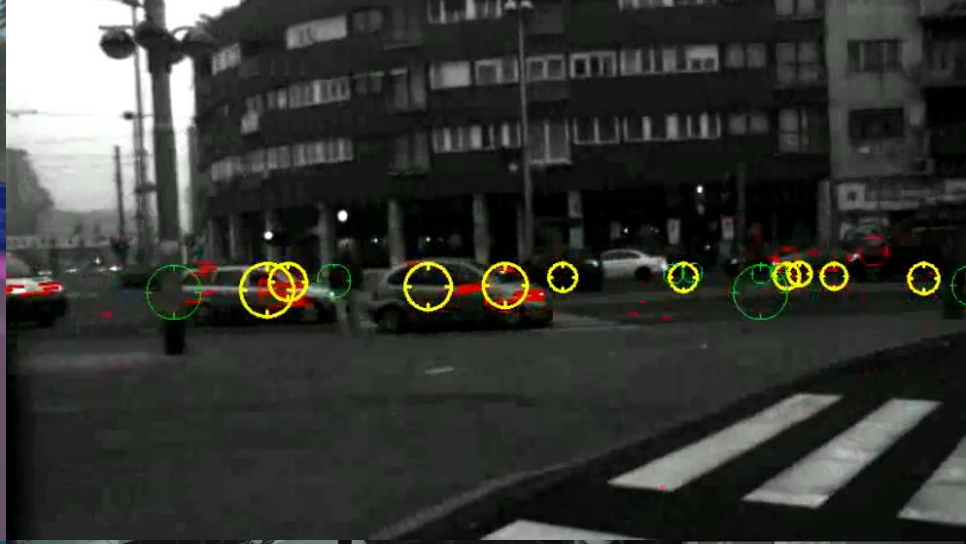

Destination
Vehicle Dynamics Model
Prior Localization Map
Prior Road Map
Supervisor
SENSORS
Perception
Mapping
Planning
Control
ACTUATORS

Sensors

SKOODS SIMULATION




30.3 FPS




MOTION FLOW
LANE LINES
LANE LINES
ROAD FLOW
IN-PATH OBJECTS
ROAD LIGHTS
OBJECTS
ROAD SIGNS


LEFT REARWARD VEHICLE CAMERA

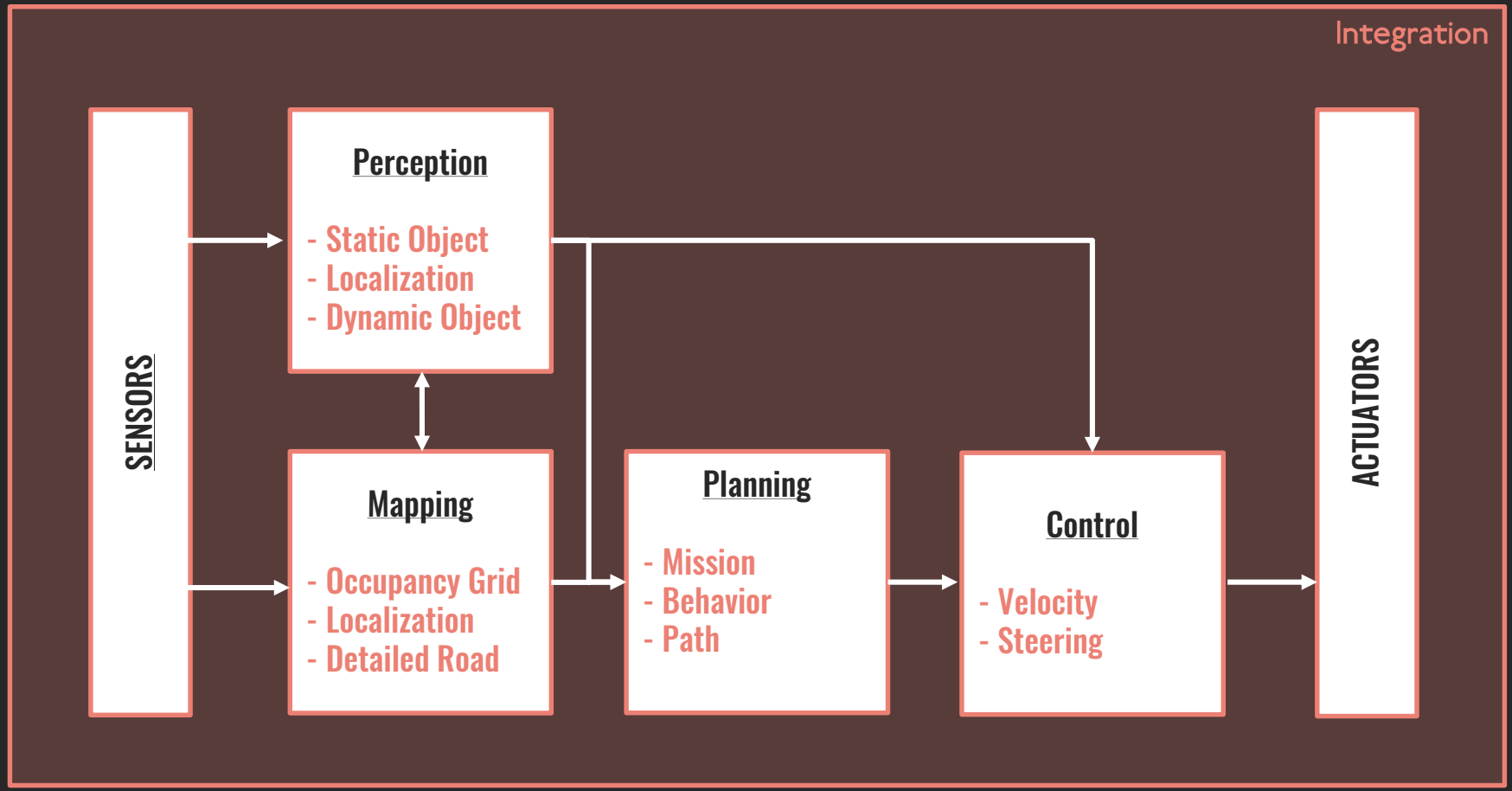

MEDIUM RANGE VEHICLE CAMERA

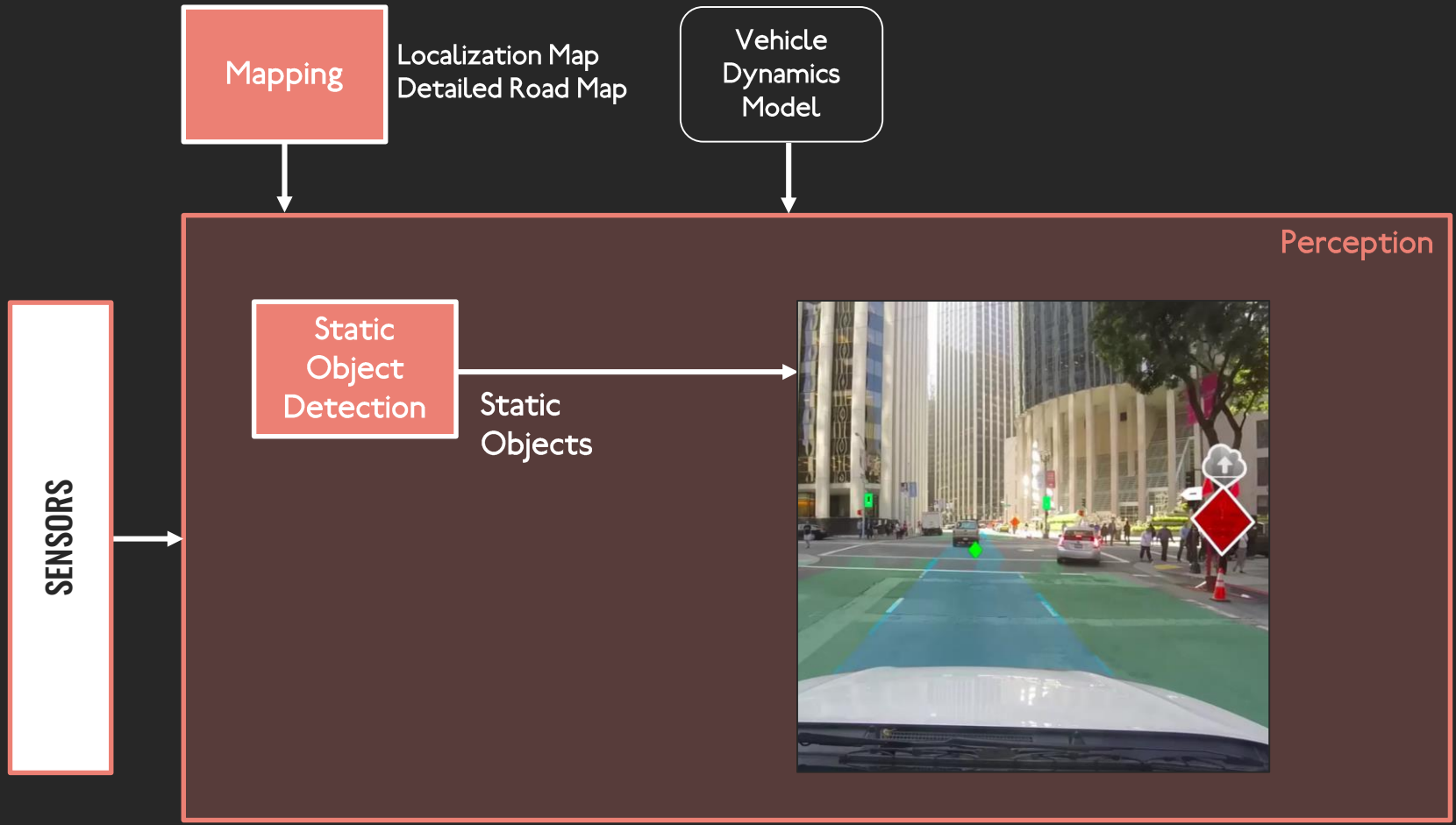

RIGHT REARWARD VEHICLE CAMERA

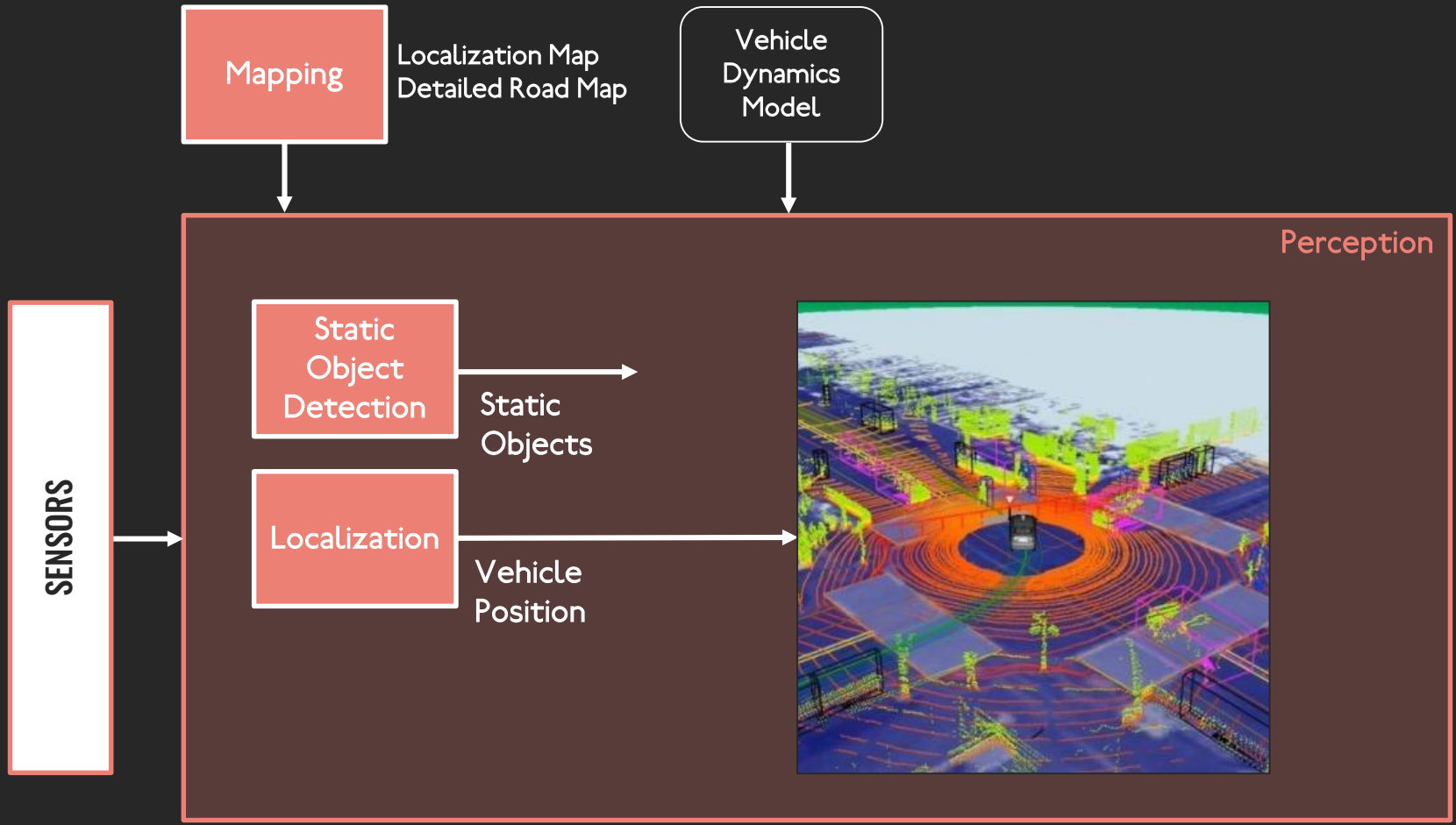
SENSORS

	 CAMERA	+  RADAR	+  LIDAR	+  ULTRASONIC	=  SENSOR FUSION
Detect Traffic Participants	✓	✓	✓	✓	✓
Texture Interpretation (lanes)	✓	✗	✗	✗	✓
Ambient Light Independent	✗	✓	✓	✓	✓
All-weather Operation	✗	✓	✗	✓	✓
Operating Range	mid-far	near-far	mid-far	near	near-far
Angular Resolution	high	medium	high	low	high
Cost	✓	✓	✗	✓	✓
Master of	classification texture	motion measurement	3D mapping	low cost and ranging	
	Typical L2 + L3 Systems		Future?	Replaced?	


In the future, self-driving cars
will only use cameras.


Integration
SENSORS
Perception
- Static Object
- Localization
- Dynamic Object
Mapping
- Occupancy Grid
- Localization
- Detailed Road
Planning
- Mission
- Behavior
- Path
Control
- Velocity
- Steering
ACTUATORS


Mapping
Localization Map
Detailed Road Map
Vehicle Dynamics Model
Perception
SENSORS
Static Object Detection
Static Objects


Mapping
Localization Map
Detailed Road Map
Vehicle
Dynamics
Model
Perception
SENSORS
Static
Object
Detection
Static
Objects
Localization
Vehicle
Position

Mapping

Localization Map
Detailed Road Map

Vehicle Dynamics Model

Perception

SENSORS

Static Object Detection

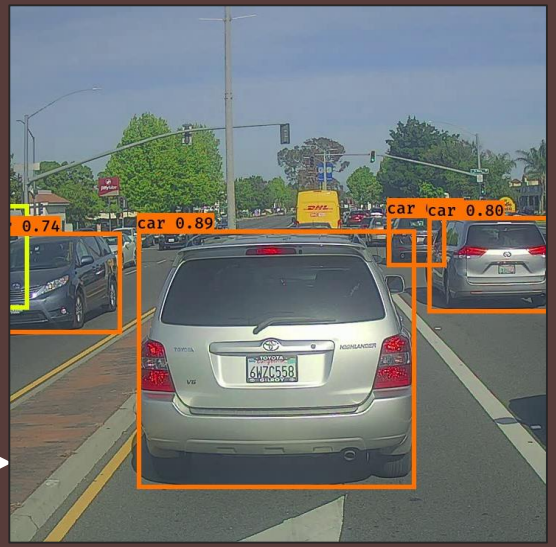
Static Objects

Localization

Vehicle Position

Dynamic Object Detection

Dynamic Objects



Perception

Vehicle Position
Object Tracks
Static Objects

Vehicle Dynamics Model

Prior Localization Map

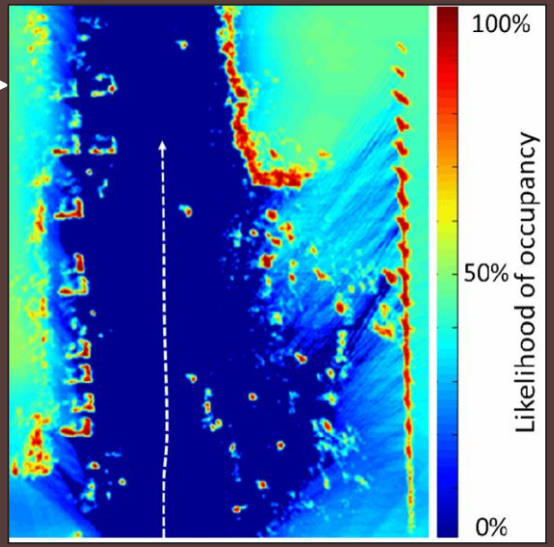
Prior Road Map

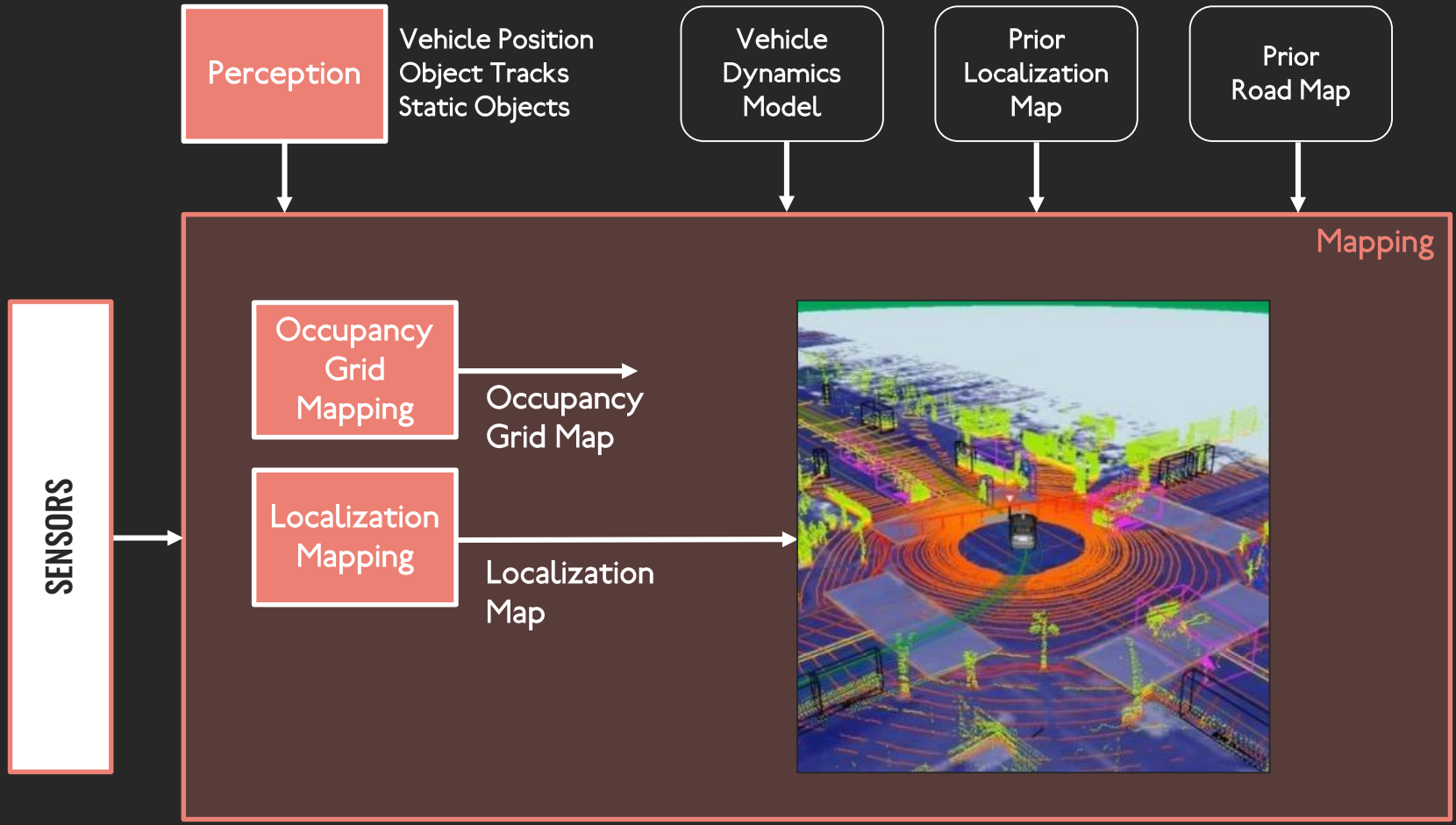
Mapping

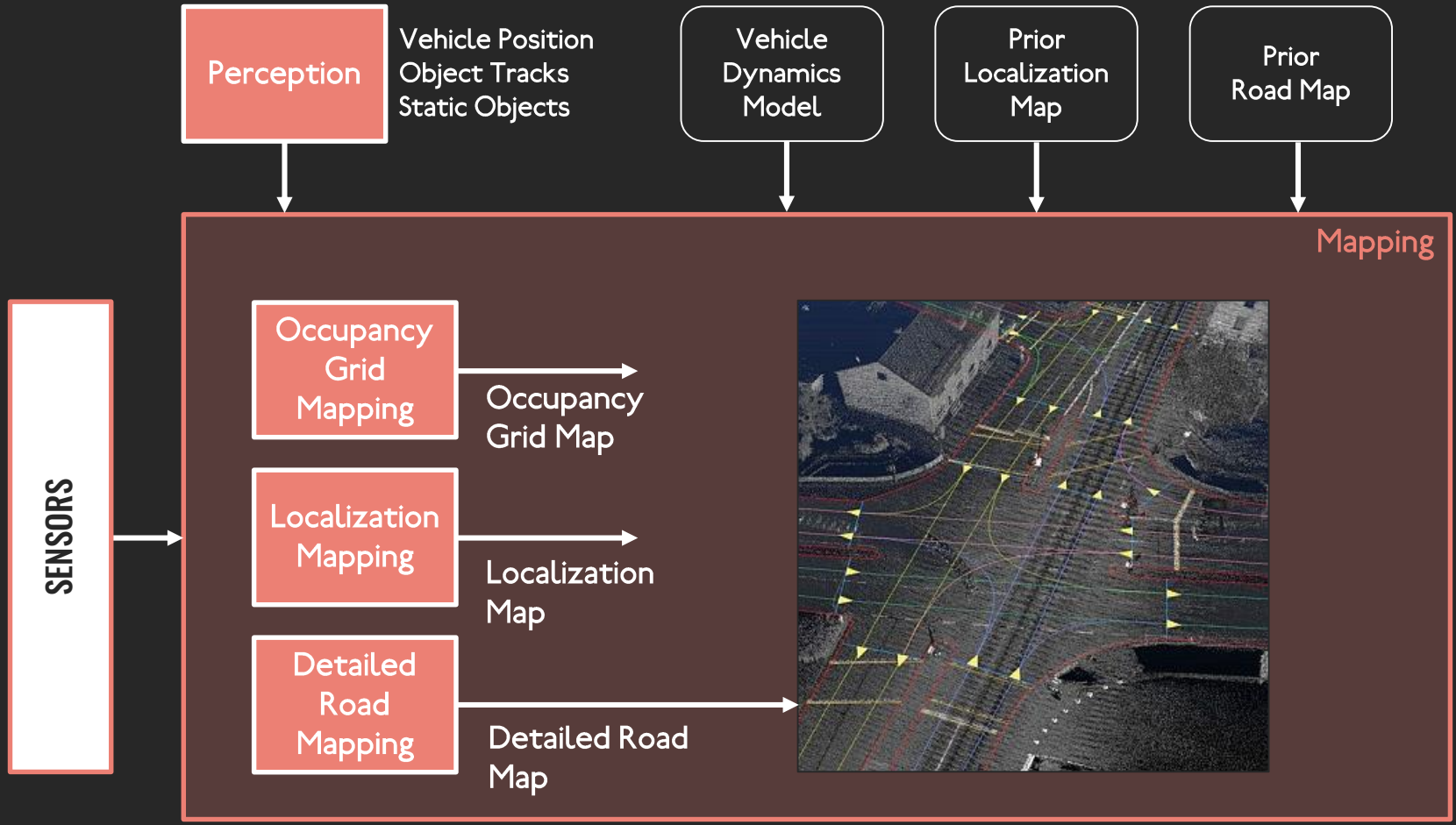
SENSORS

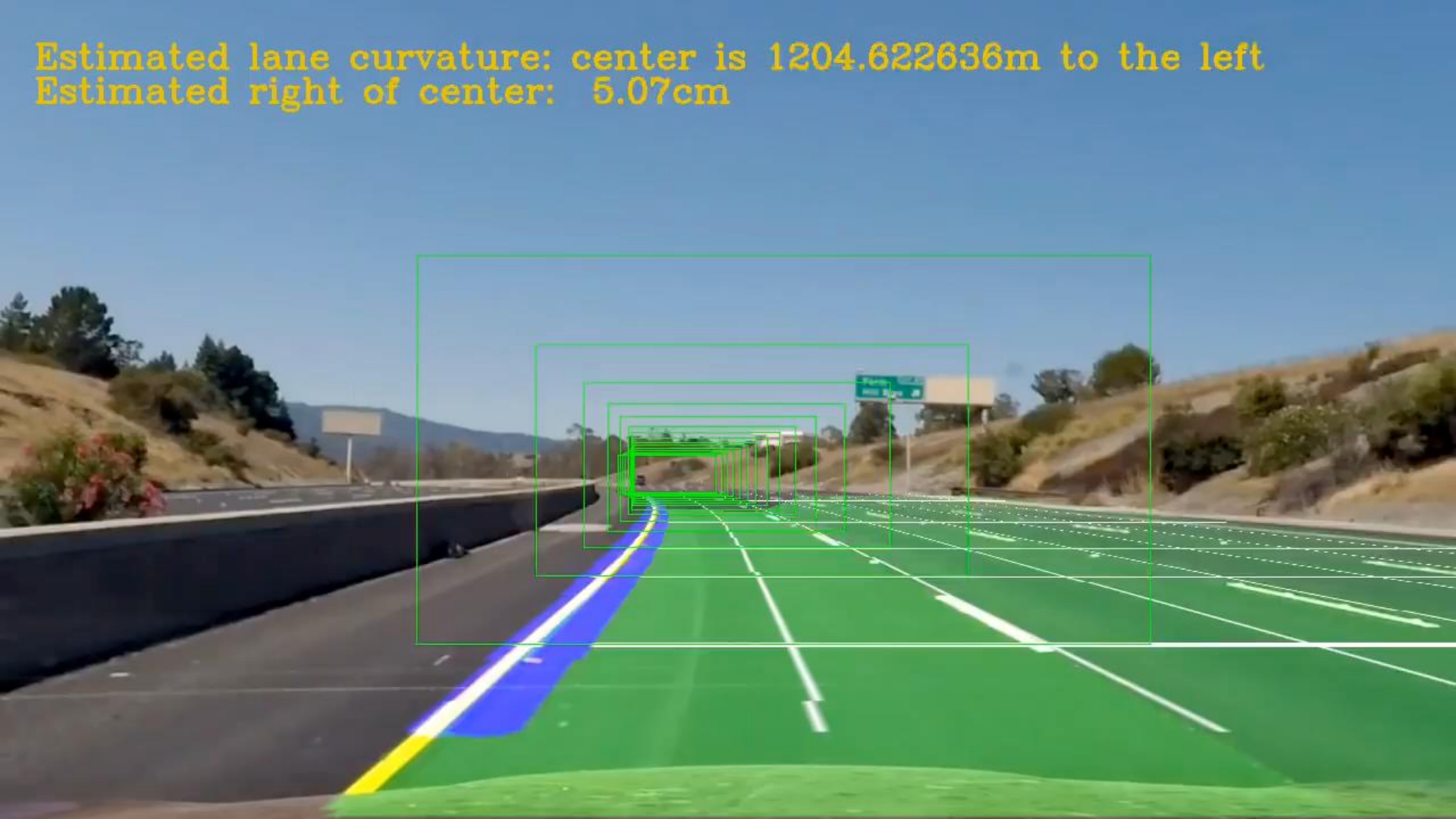
Occupancy Grid Mapping

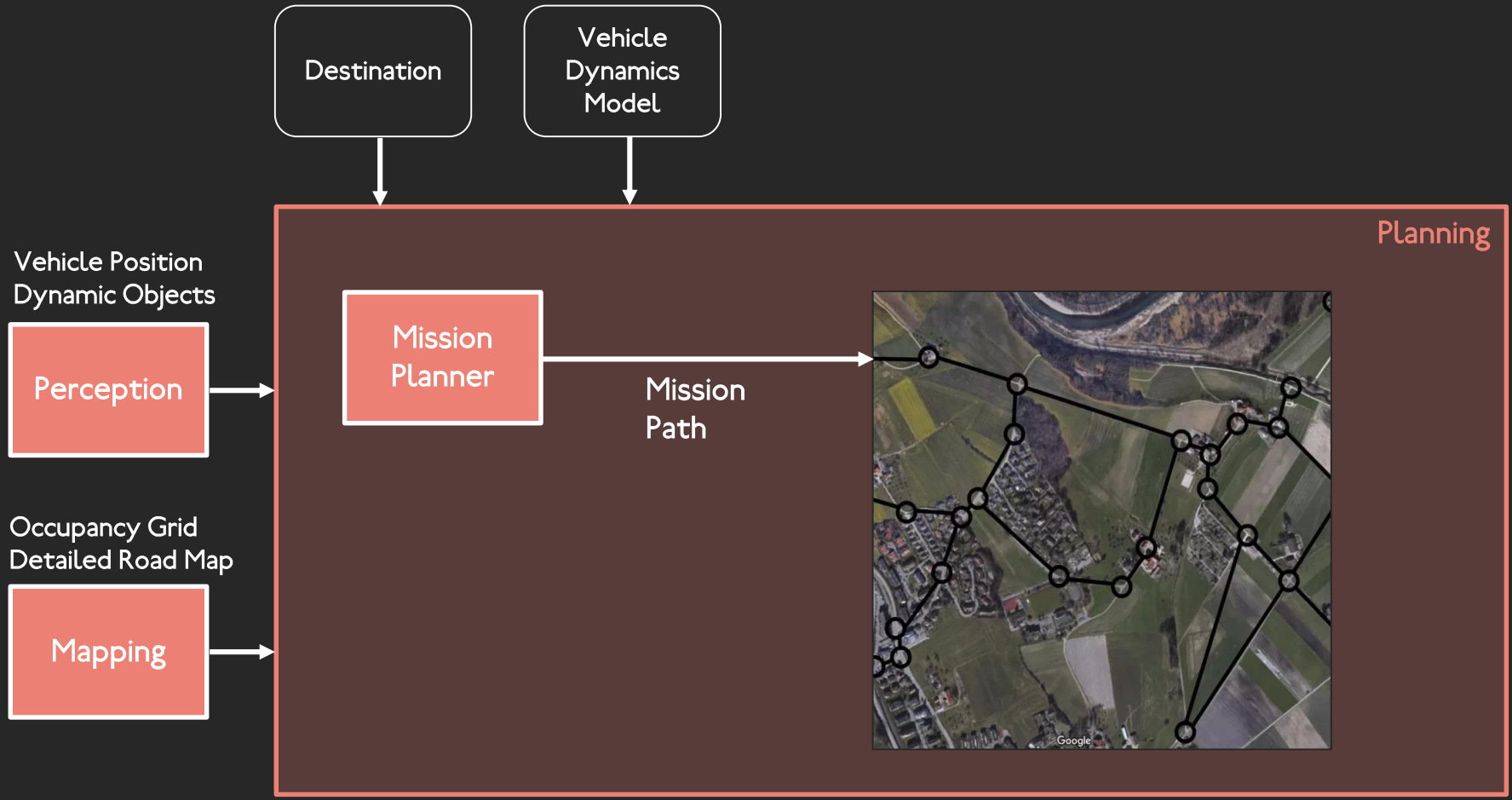
Occupancy Grid Map

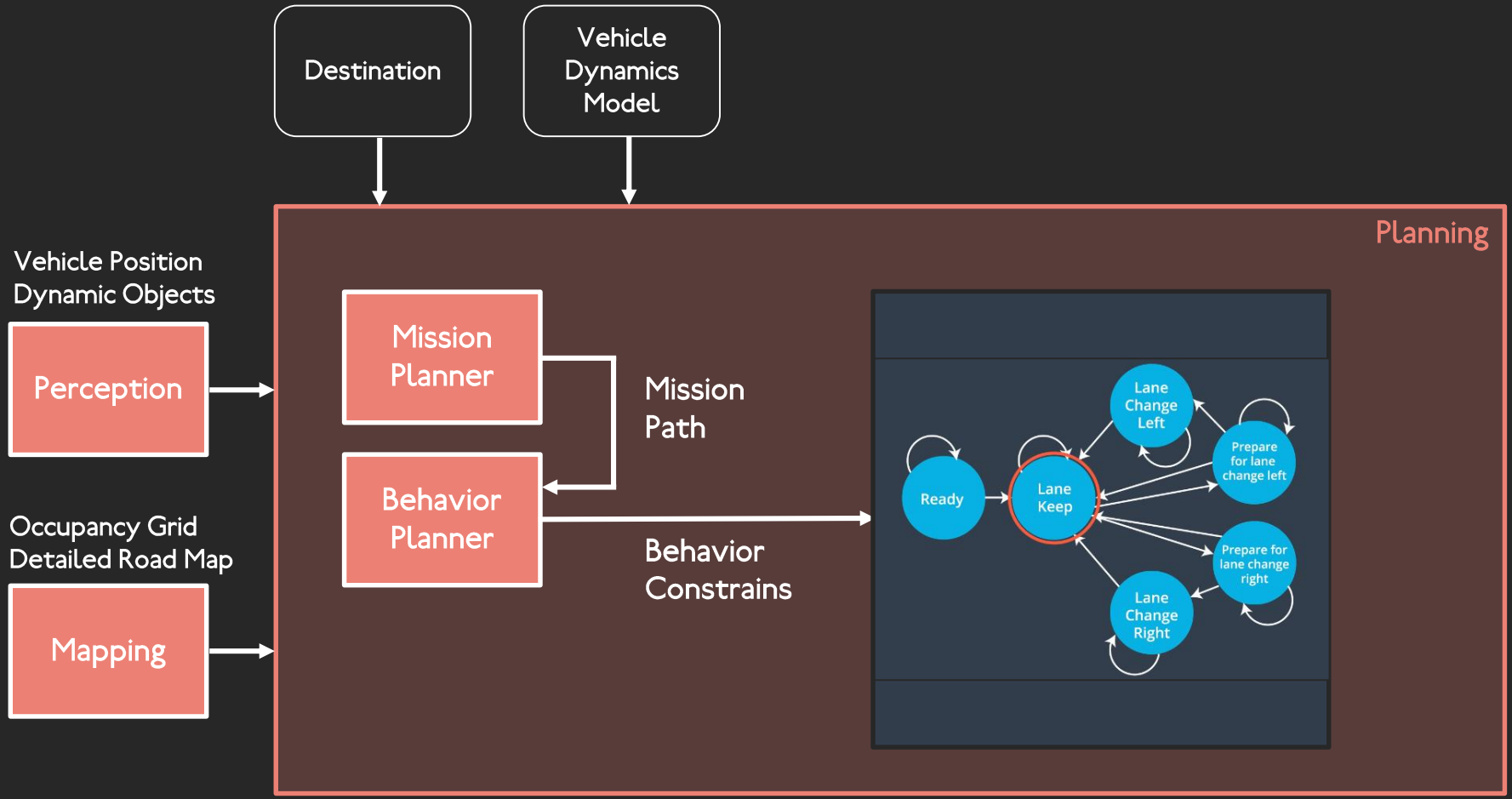


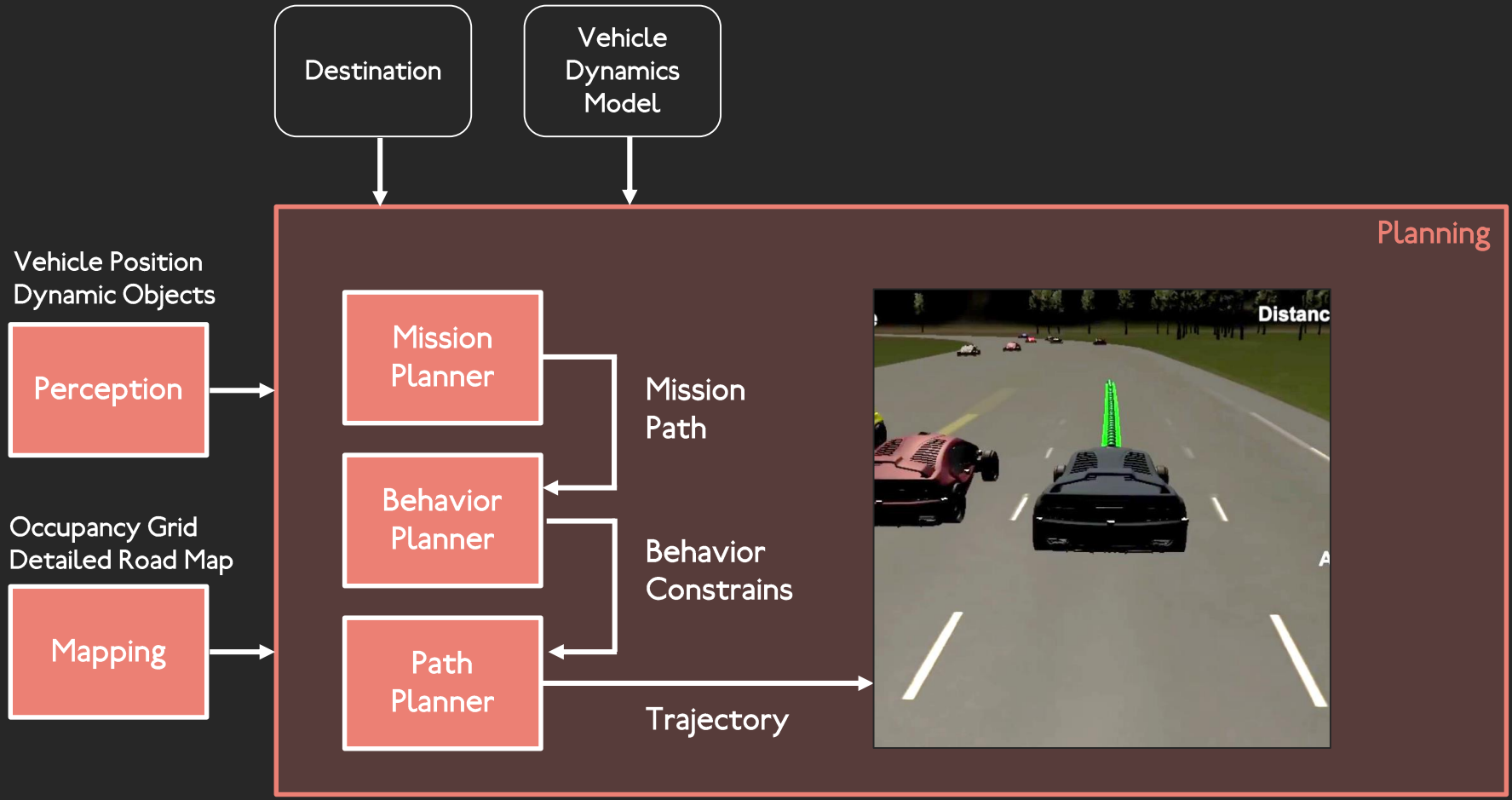

Perception
Vehicle Position
Object Tracks
Static Objects
Vehicle Dynamics Model
Prior Localization Map
Prior Road Map
Mapping
SENSORS
Occupancy Grid Mapping
Occupancy Grid Map
Localization Mapping
Localization Map

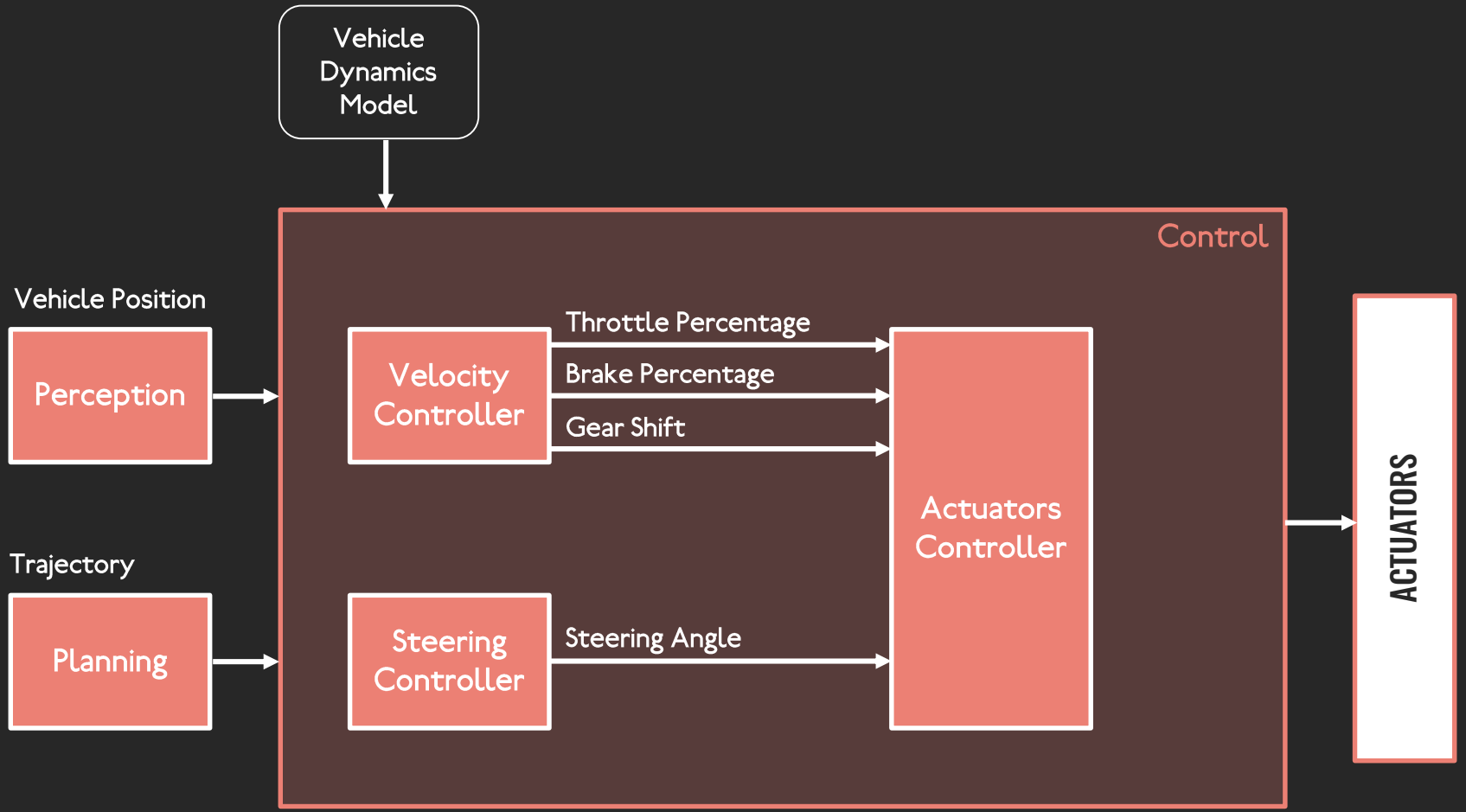

Perception
Vehicle Position
Object Tracks
Static Objects
Vehicle Dynamics Model
Prior Localization Map
Prior Road Map
Mapping
SENSORS
Occupancy Grid Mapping
Occupancy Grid Map
Localization Mapping
Localization Map
Detailed Road Mapping
Detailed Road Map


Estimated lane curvature: center is 1204.622636m to the left
Estimated right of center: 5.07cm


Destination
Vehicle Dynamics Model
Planning
Vehicle Position
Dynamic Objects
Perception
Mission Planner
Mission Path
Occupancy Grid
Detailed Road Map
Mapping
Google

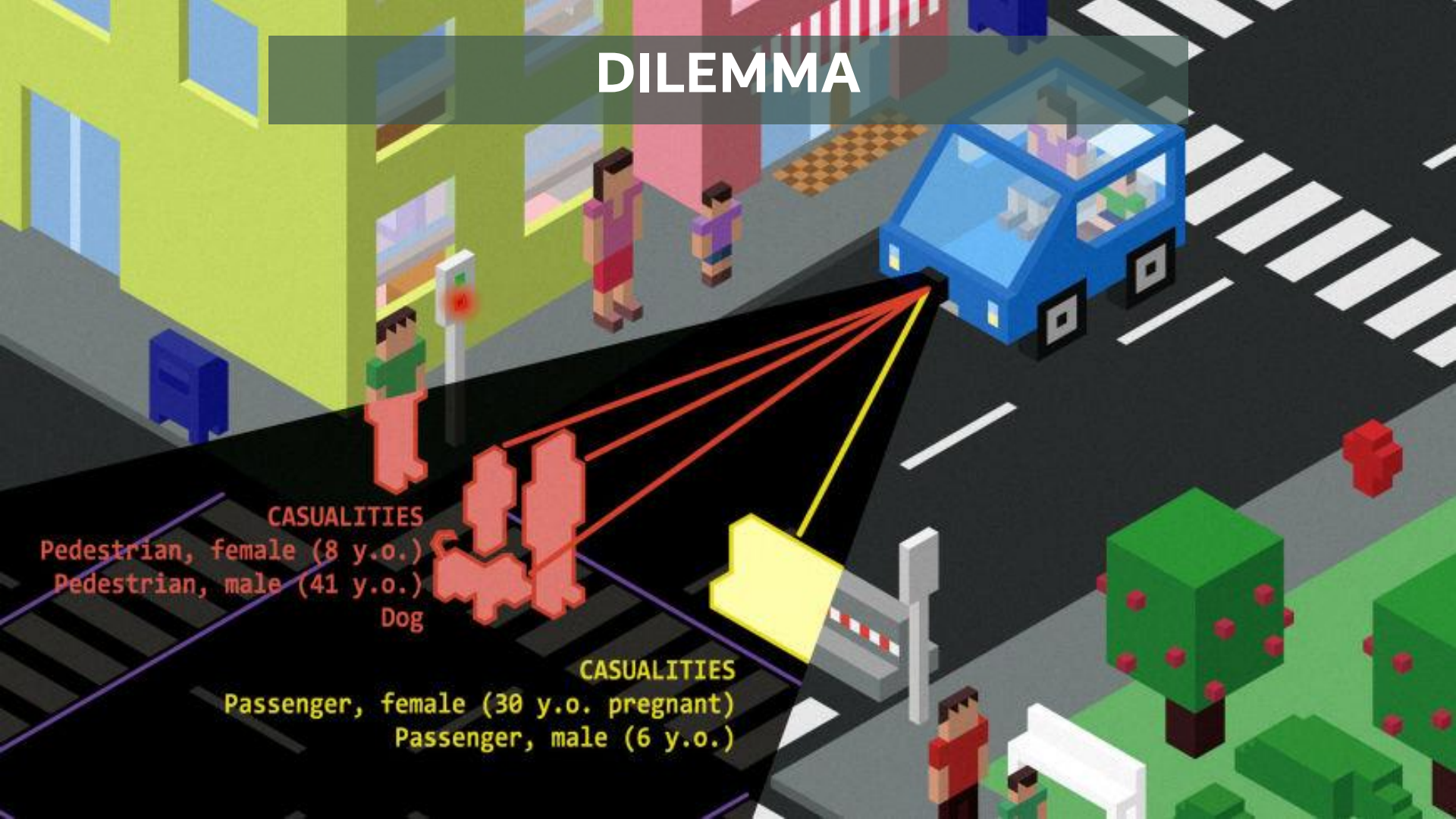

Destination
Vehicle Dynamics Model
Planning
Vehicle Position
Dynamic Objects
Perception
Occupancy Grid
Detailed Road Map
Mapping
Mission Planner
Behavior Planner
Mission Path
Behavior Constrains
Ready
Lane Keep
Lane Change Left
Prepare for lane change left
Prepare for lane change right
Lane Change Right


Destination
Vehicle Dynamics Model
Planning
Vehicle Position
Dynamic Objects
Perception
Occupancy Grid
Detailed Road Map
Mapping
Mission Planner
Behavior Planner
Path Planner
Mission Path
Behavior Constrains
Trajectory
Distanc


Vehicle Dynamics Model
Control
Vehicle Position
Perception
Trajectory
Planning
Velocity Controller
Throttle Percentage
Brake Percentage
Gear Shift
Steering Controller
Steering Angle
Actuators Controller
ACTUATORS


PROBLEMS
AHEAD

DILEMMA


CASUALITIES
Pedestrian, female (8 y.o.)
Pedestrian, male (41 y.o.)
Dog
CASUALITIES
Passenger, female (30 y.o. pregnant)
Passenger, male (6 y.o.)

PROBLEM

Big Data needed

Tesla estimates that

6 BILLION miles will be required

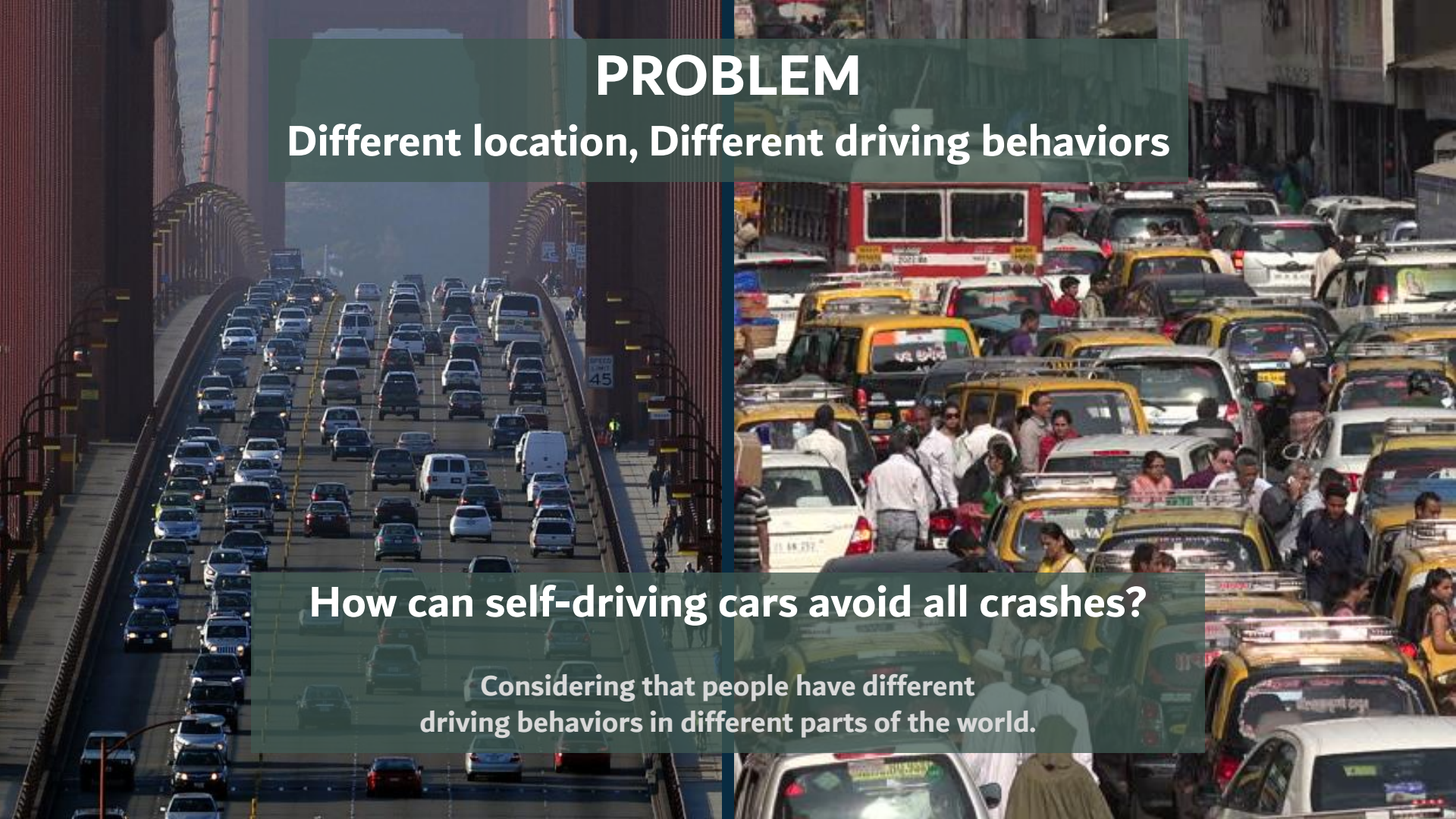
before government regulators will give fully autonomous vehicles the green light.

In Jan ’17 Google had

1.8 MILLION miles

of autonomous and manual driving in their self-driving vehicles.

source: https://autotrader.com, https://datafloq.com



PROBLEM

Different location, Different driving behaviors

How can self-driving cars avoid all crashes?

Considering that people have different
driving behaviors in different parts of the world.

PROBLEM

Diversity of Traffic Signs

How to map all traffic signs of the world?

Considering that people can be very creative sometimes ☺

AUTOMOTIVE DIGITAL TWIN

Benefits

DIGITAL TWIN

SAVE COST, TIME AND RISK

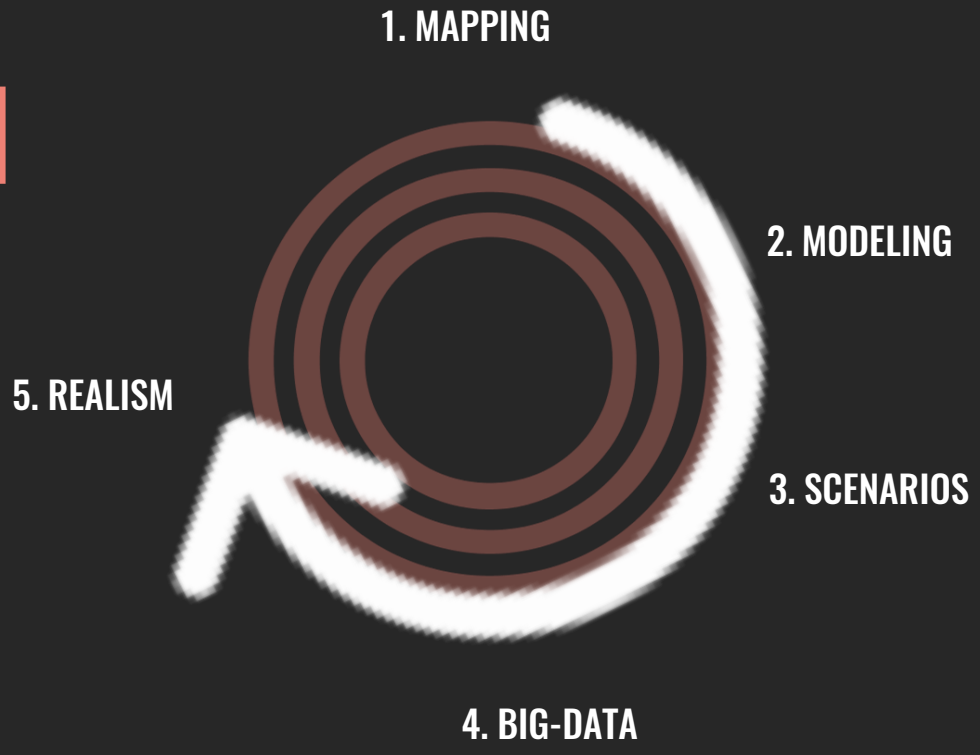
Skoods digital twin allows automakers to test changes earlier in the design cycle than would otherwise be possible when relying on testing real prototypes.

The earlier that you can identify changes, through simulated testing, the less costly those changes are to implement.

Skoods simulation is used for vehicle dynamics and drivetrain engineering: calibrate and test passive chassis designs, steering systems, chassis control systems, drivetrain control systems, traction control, stability control, torque vectoring and engine control systems.

Also to develop, test and validate autonomous vehicles, ADAS systems and sensor models.

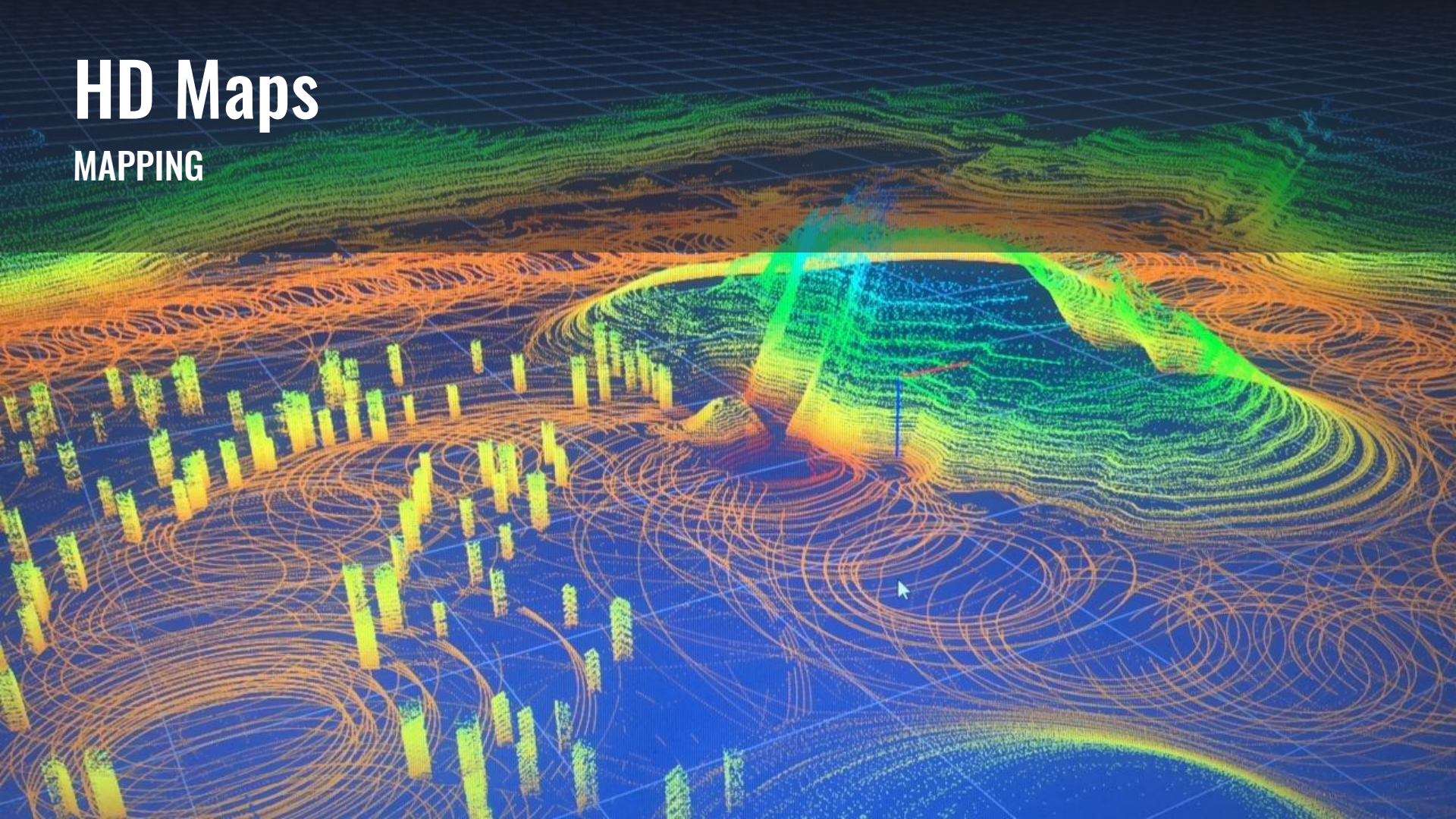
AUTOMOTIVE DIGITAL TWIN



MAPPING

HD Maps

MAPPING



LIDAR | Light Detection And Ranging

MAPPING

- Height: 74 mm, Diameter: 80 mm (3.14 in)
- Mass: 396 g (14 oz)
- Channels: 16
- Field of View Vertical: +16.6° to -16.6° (33.2°)
- Field of View Horizontal: 360°
- Range: 120m (80%), 40m (10%)
- Laser Class: Class 1 Eye-Safe
- Precision/Accuracy: 3 cm average
- Sampling Rate: 327,680 points/sec
- Rotation Rate: 10–20 Hz

Road Map

MAPPING

3D Reconstruction

MAPPING

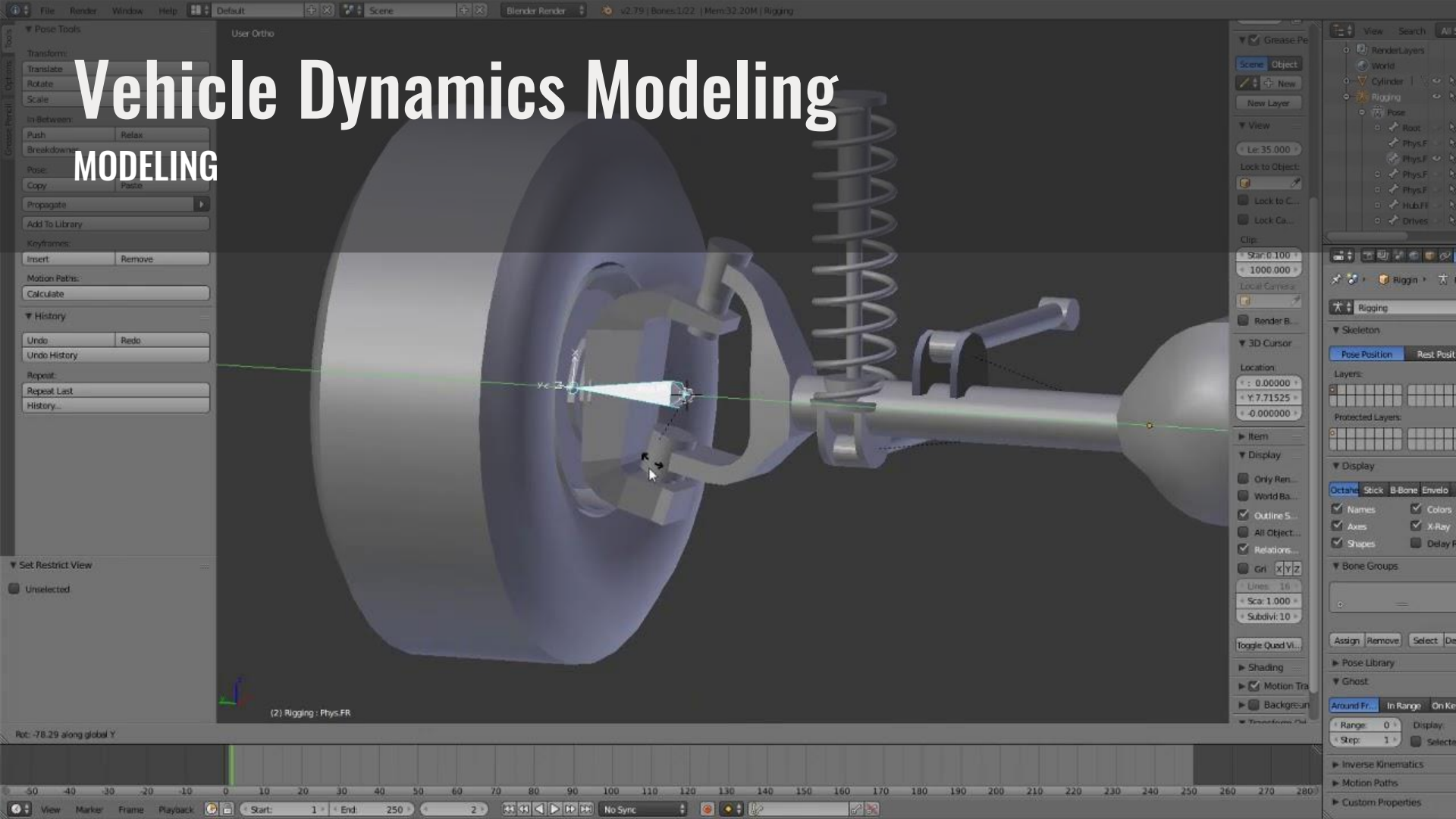
MODELING

Ego Vehicle Design

MODELING

Vehicle Dynamics Modeling

MODELING



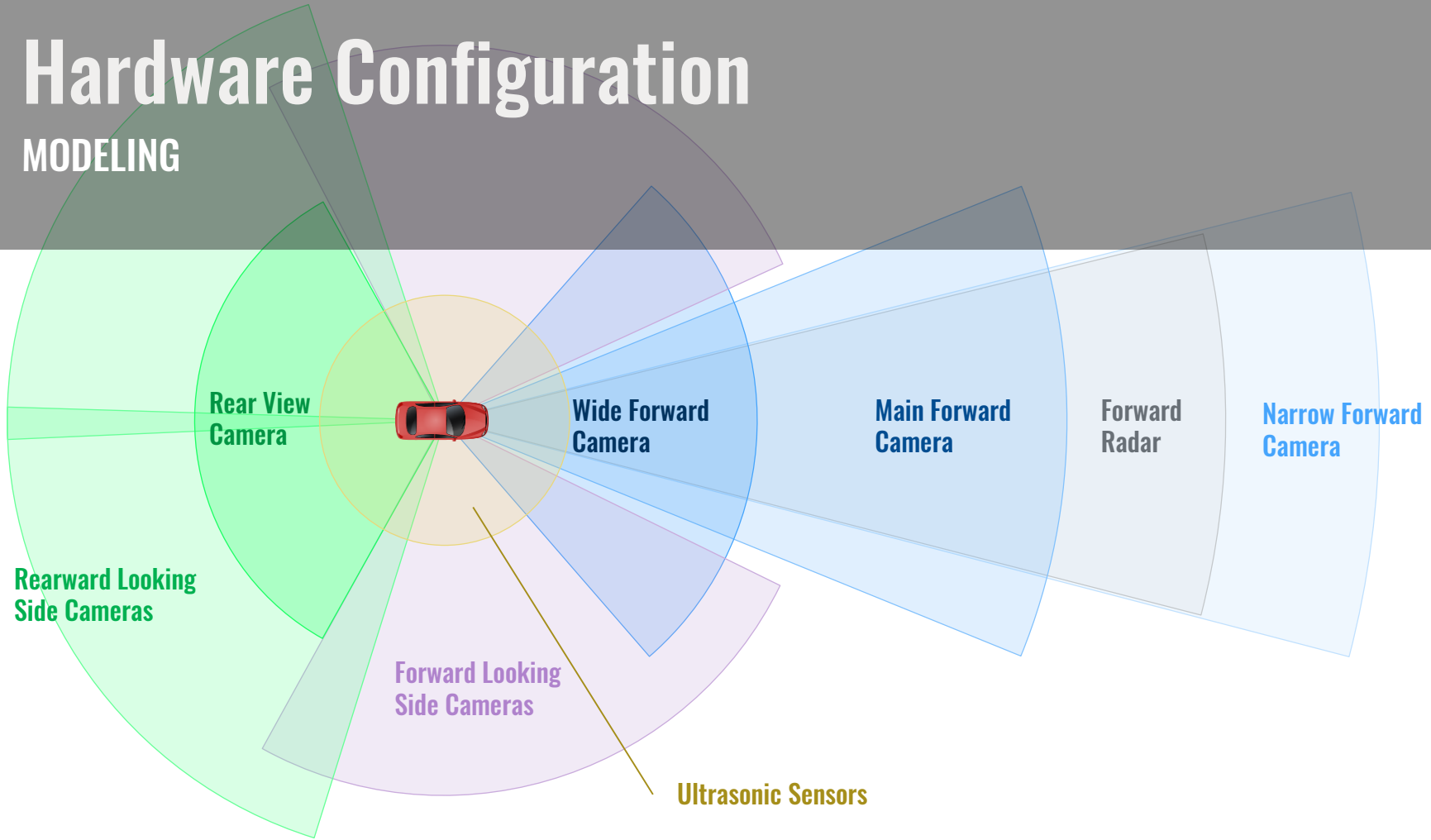
Sensors Virtualization

MODELING

SENSORS
GPS | Global Positioning System
Cameras
RADAR | Radio Detection And Ranging
SONAR | Sound Navigation and Ranging
LIDAR | Light Detection And Ranging
IMU | Inertial Measurement Unit
Wheel Odometry

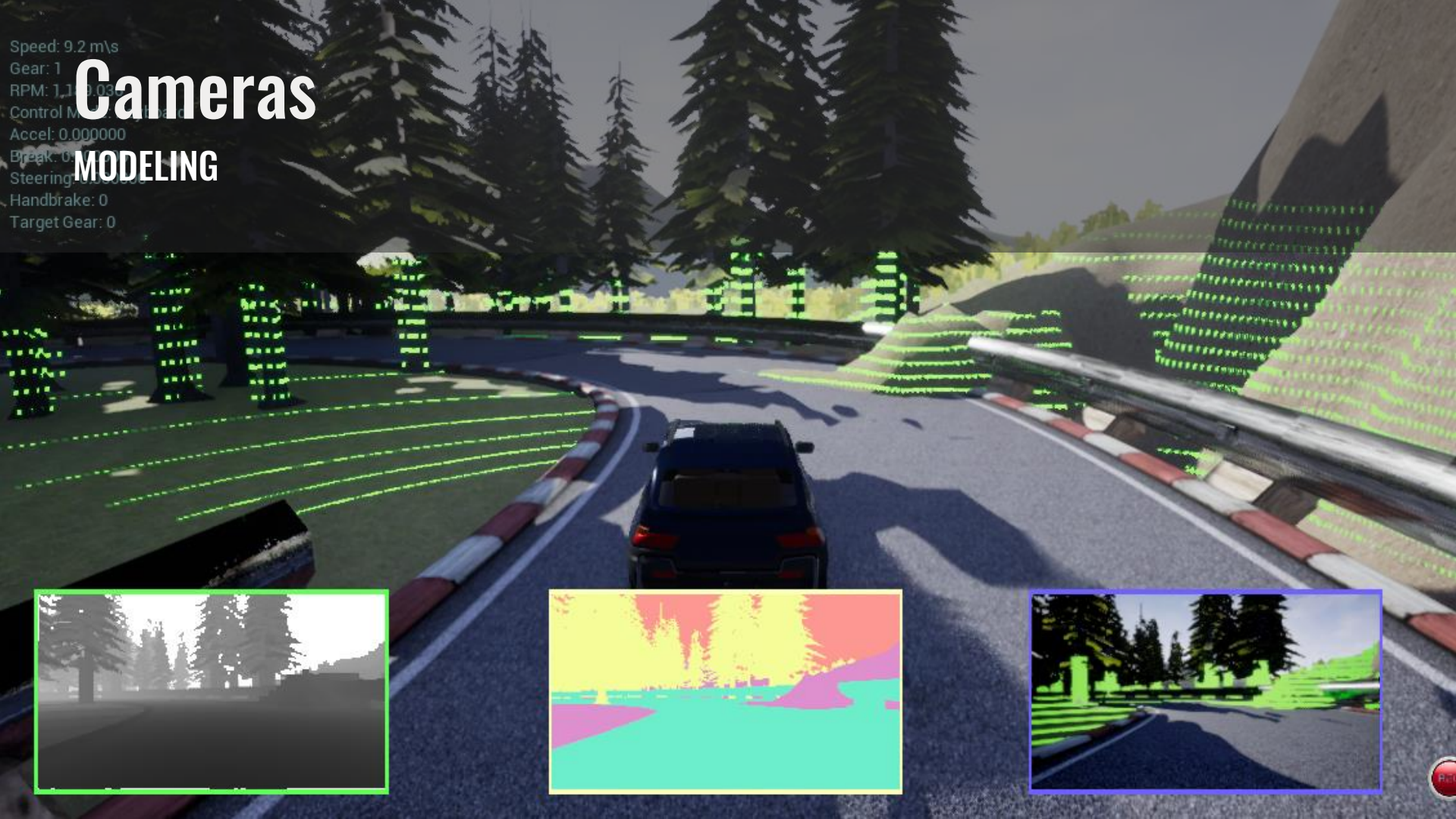
Hardware Configuration

MODELING



Cameras

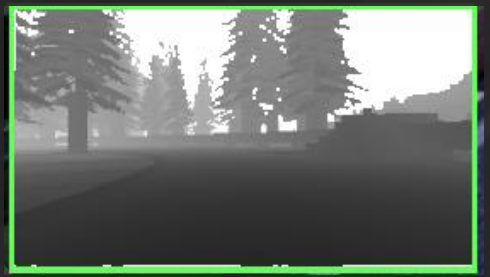
MODELING



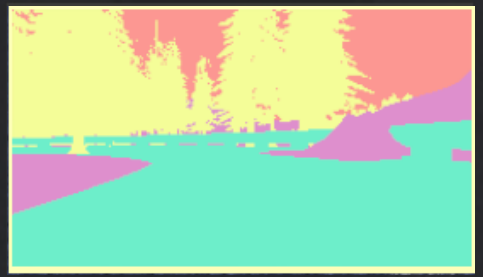
Cameras

MODELING

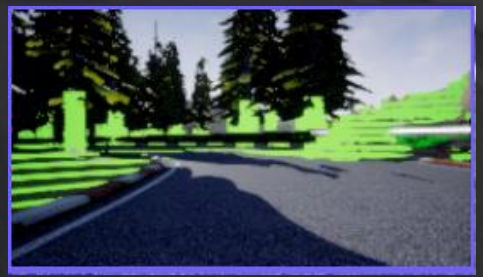
Depth

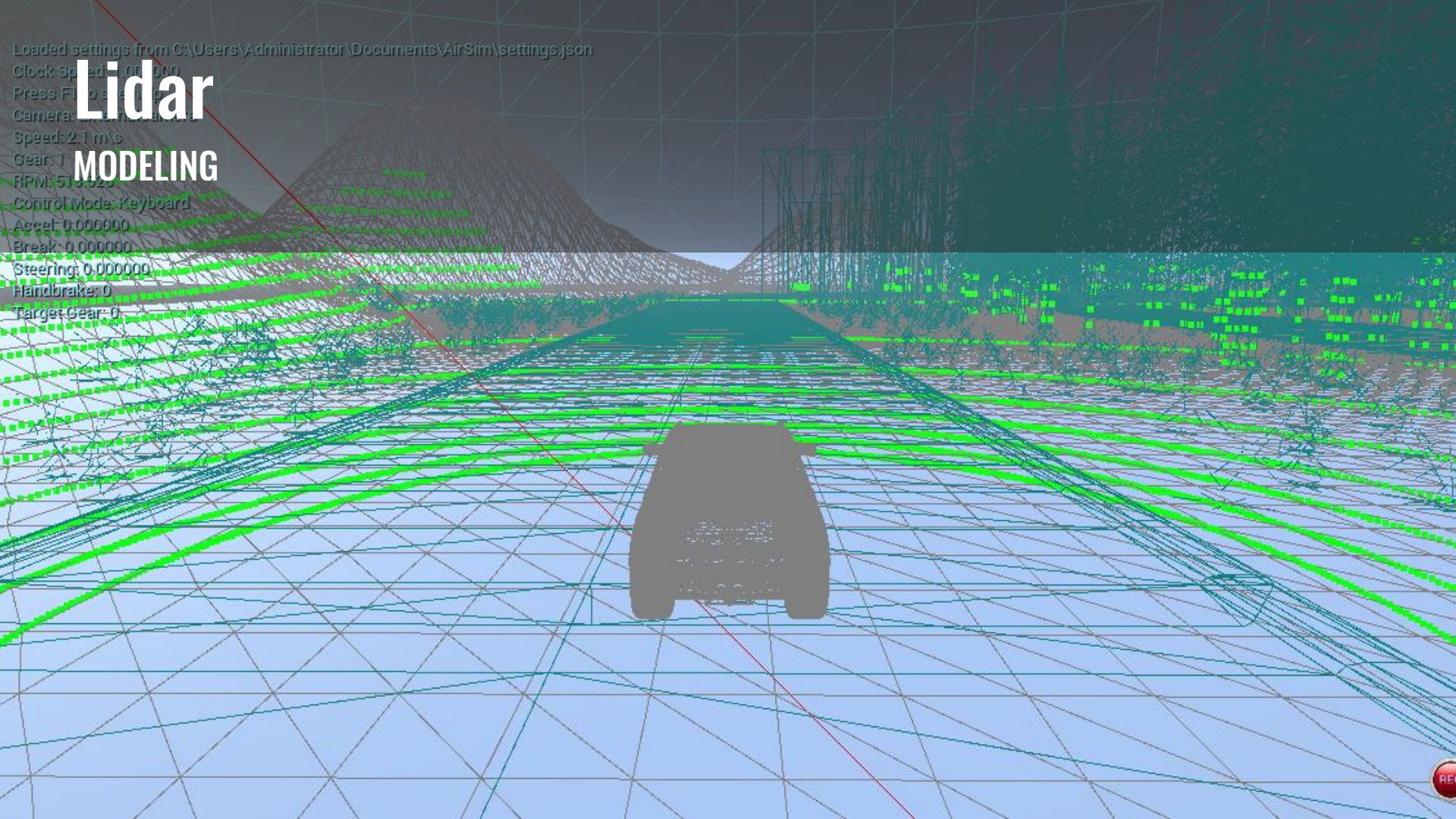


Segmentation



Camera





Lidar

MODELING

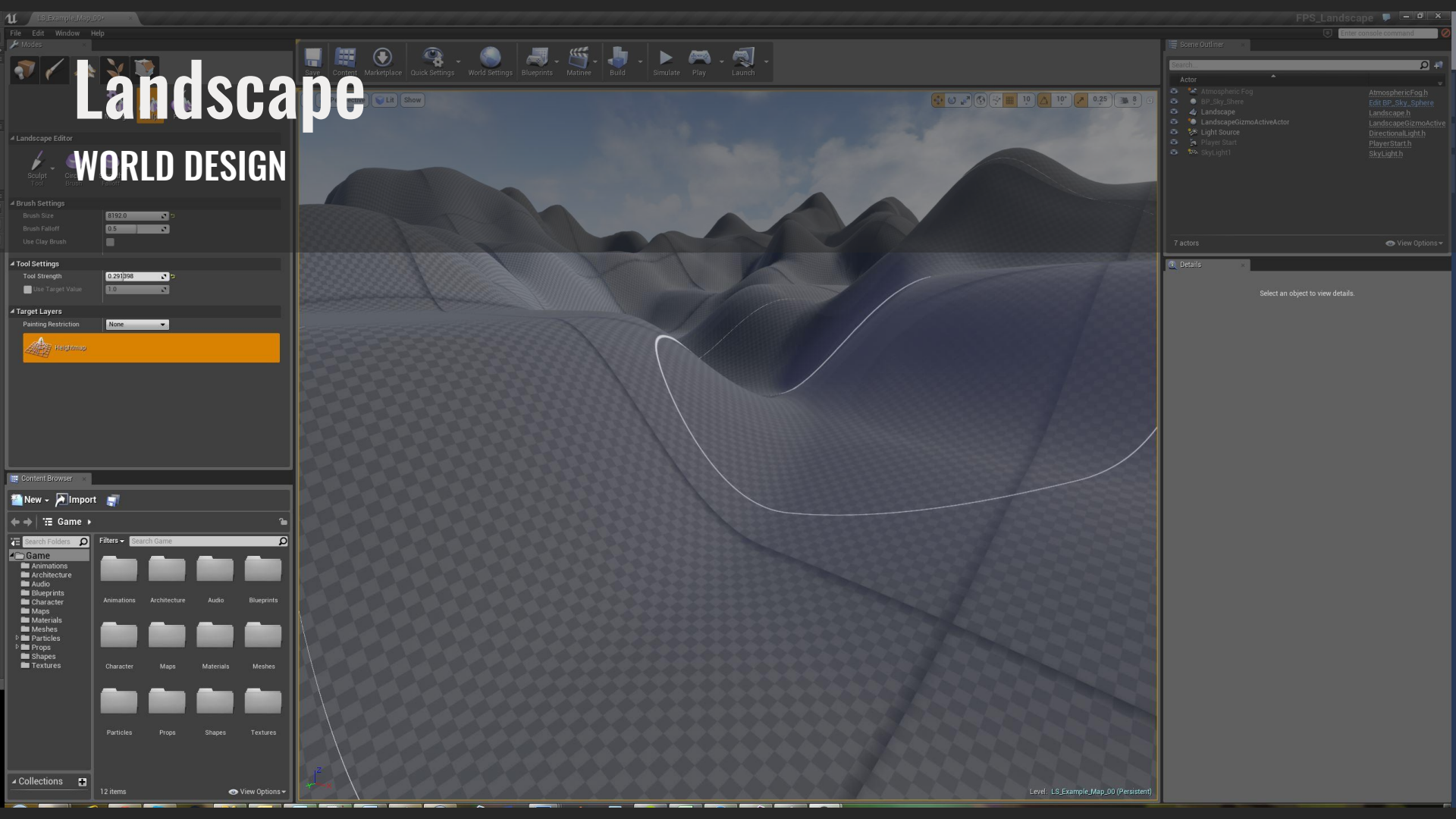
Actuators Virtualization

MODELING

WORLD DESIGN

Real-Time Rendering Simulation

WORLD DESIGN


Landscape
WORLD DESIGN

Light and Sky

WORLD DESIGN

Road Conditions

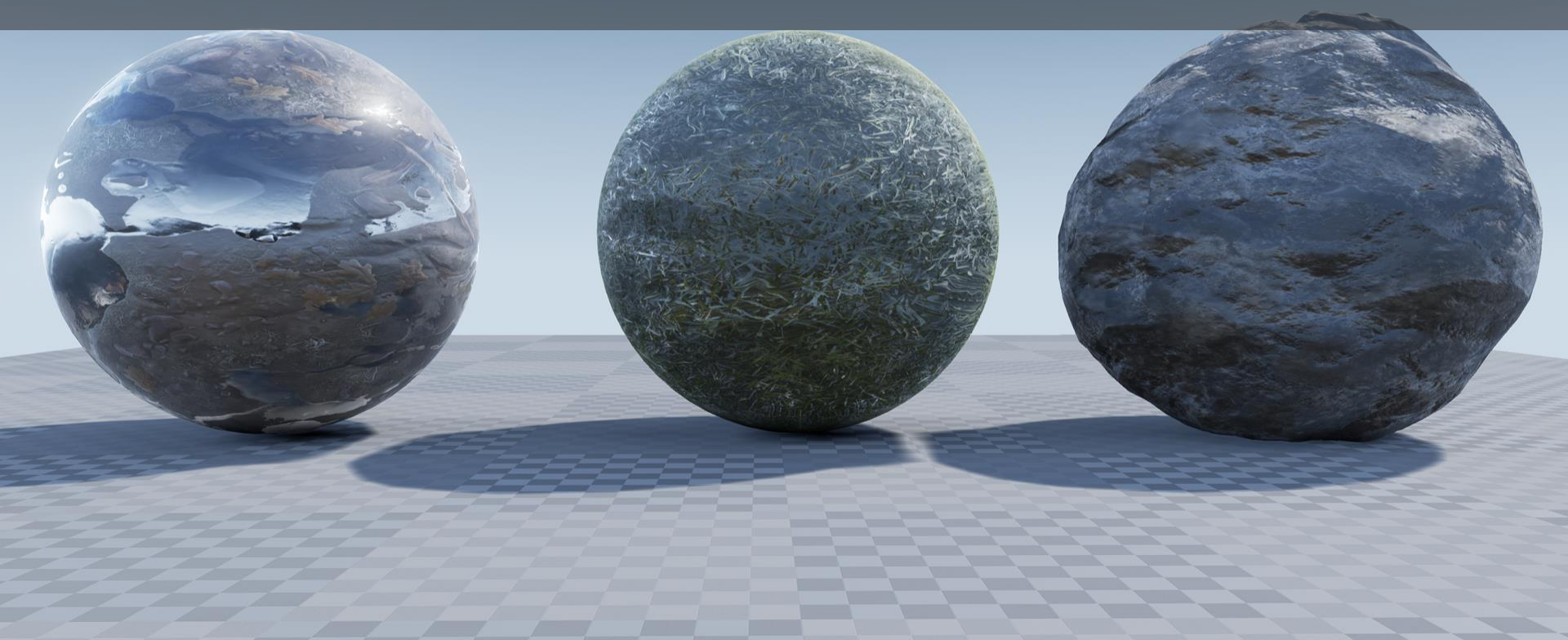
WORLD DESIGN

Assets and Build

WORLD DESIGN

Material, Textures and Friction

WORLD DESIGN



Traffic Signs

WORLD DESIGN

Traffic Signs

WORLD DESIGN

Assets

WORLD DESIGN

SCENARIOS

Variety

SCENARIOS

Weather Conditions

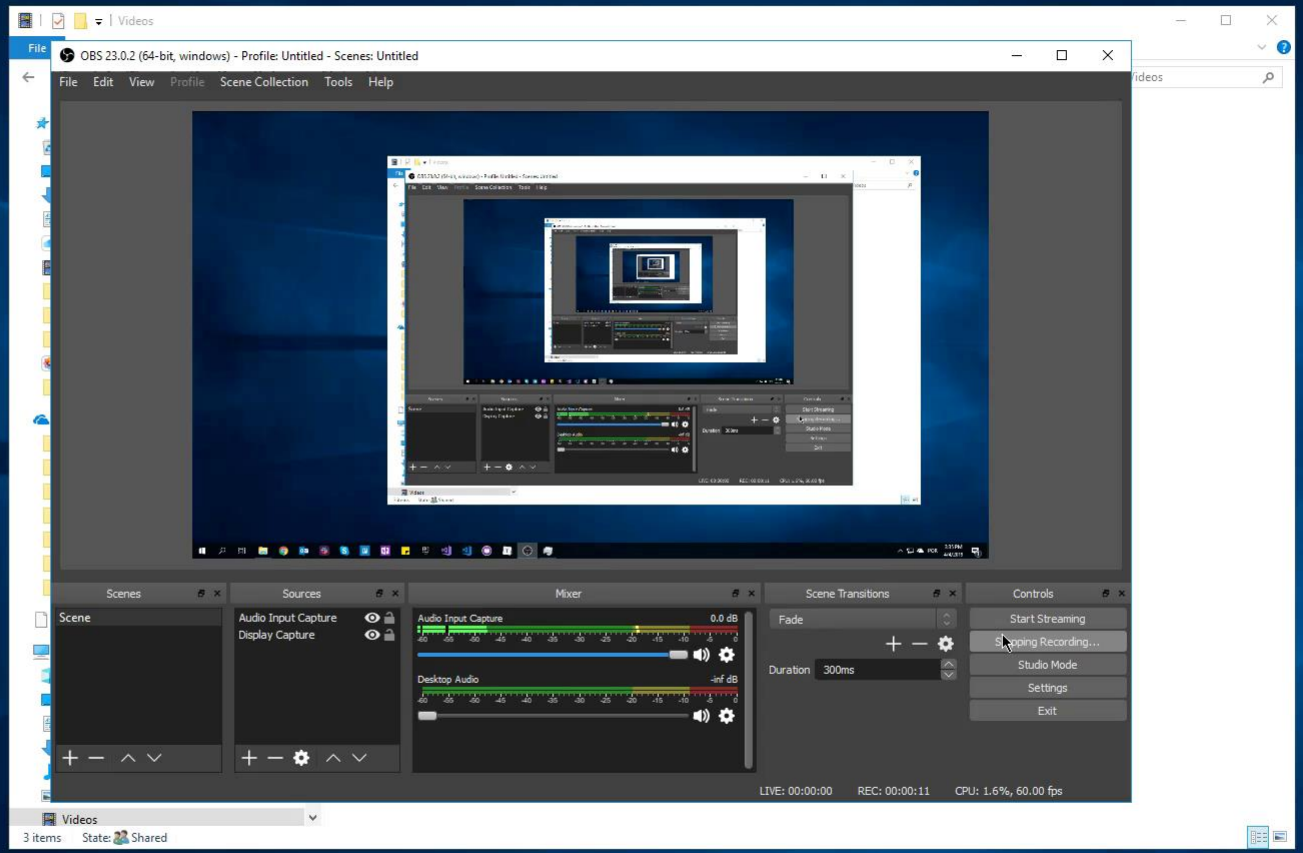
SCENARIOS


Ангар

Dynamic Actors and Environment

SCENARIOS

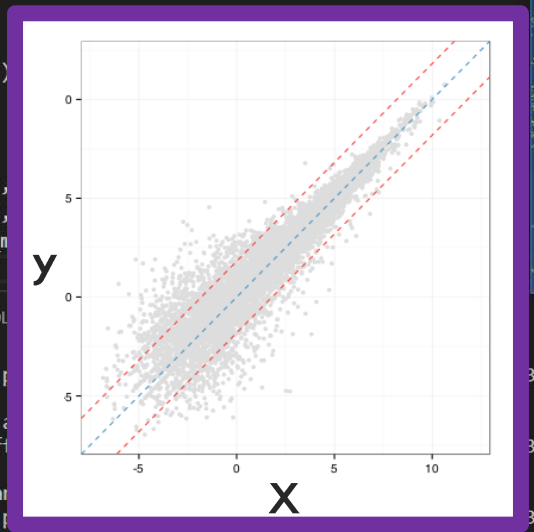

Speed: 6.2 m\s
Gear: 1
RPM: 3,884.384
Control Mode: Keyboard
Accel: 0.721569
Break: 0.000000
Steering: 0.000000
Handbrake: 0
Target Gear: 0
REC

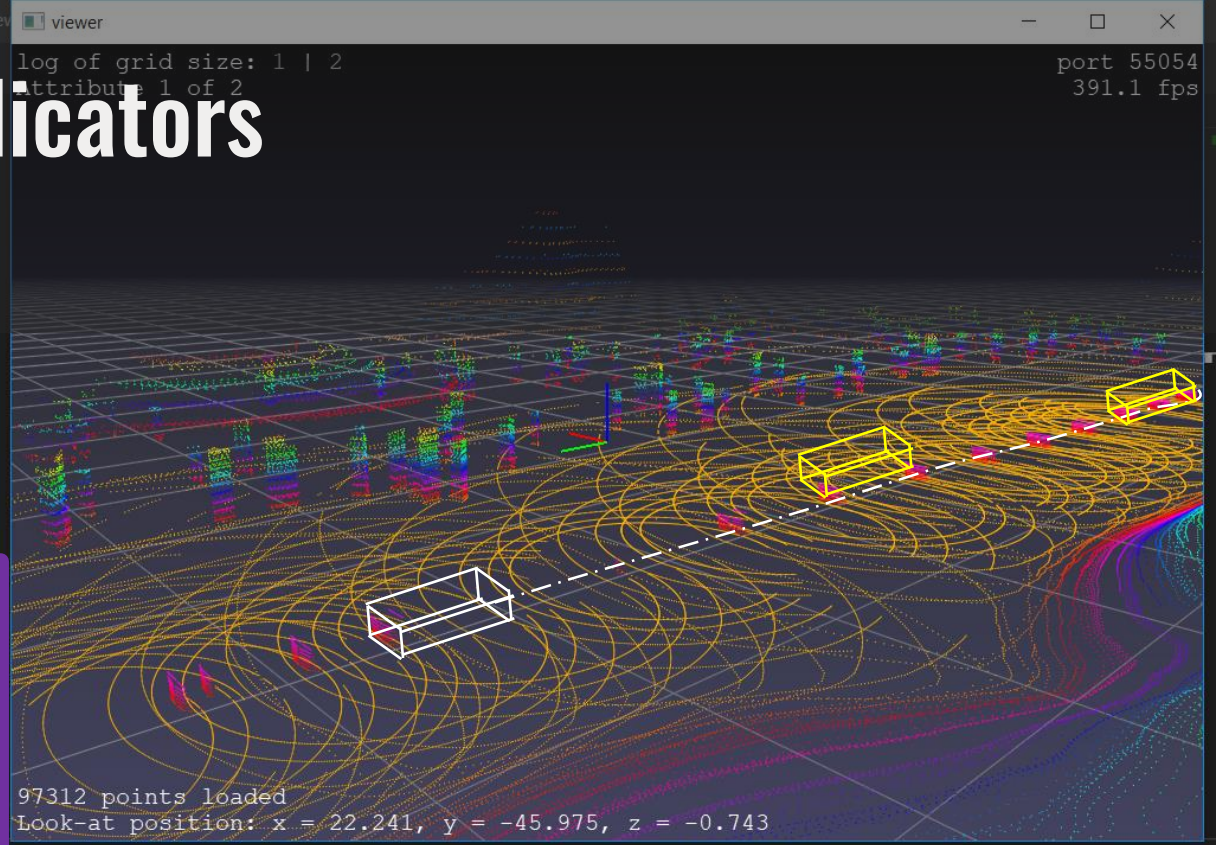

Videos
File
OBS 23.0.2 (64-bit, windows) - Profile: Untitled - Scenes: Untitled
File Edit View Profile Scene Collection Tools Help
Scenes
Scene
Sources
Audio Input Capture
Display Capture
Mixer
Audio Input Capture 0.0 dB
Desktop Audio -inf dB
Scene Transitions
Fade
Duration 300ms
Controls
Start Streaming
Stopping Recording...
Studio Mode
Settings
Exit
LIVE: 00:00:00 REC: 00:00:11 CPU: 1.6%, 60.00 fps
Videos
3 items State: Shared

BIG-DATA

Performance Indicators

BIG-DATA

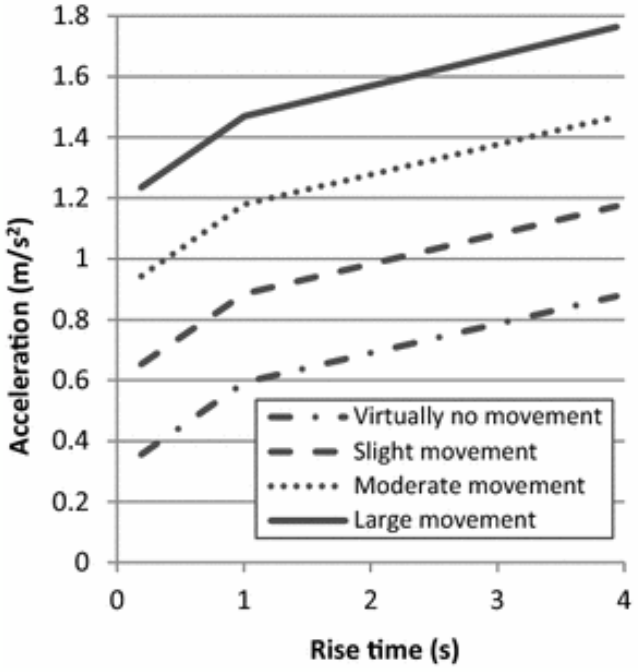


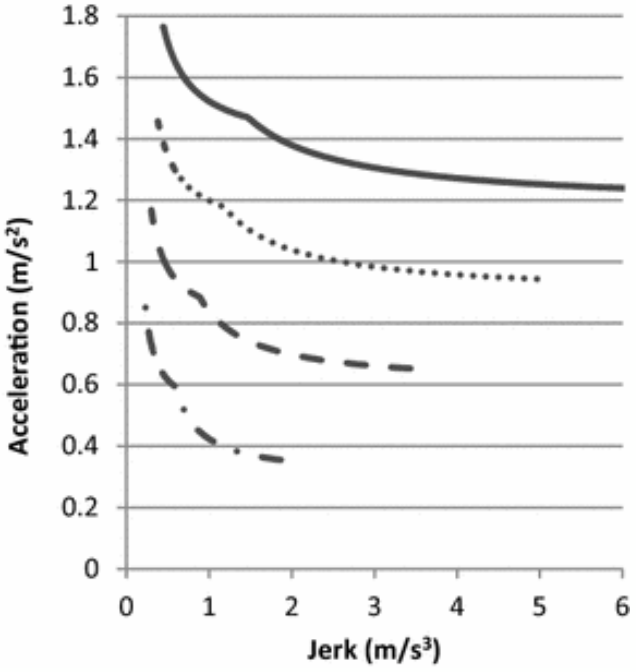



```
    rgb_z.append(rgb_map[i])
IndexError: list index out of range

(Skoods_noGPU) C:\Users\Guilherme Bortolaso\Desktop\Skoods_Code>python zscale_carlidar.py

(Skoods_noGPU) C:\Users\Guilherme Bortolaso\Desktop\Skoods_Code>python zscale_carlidar.py
```

Comfort Driving

BIG-DATA





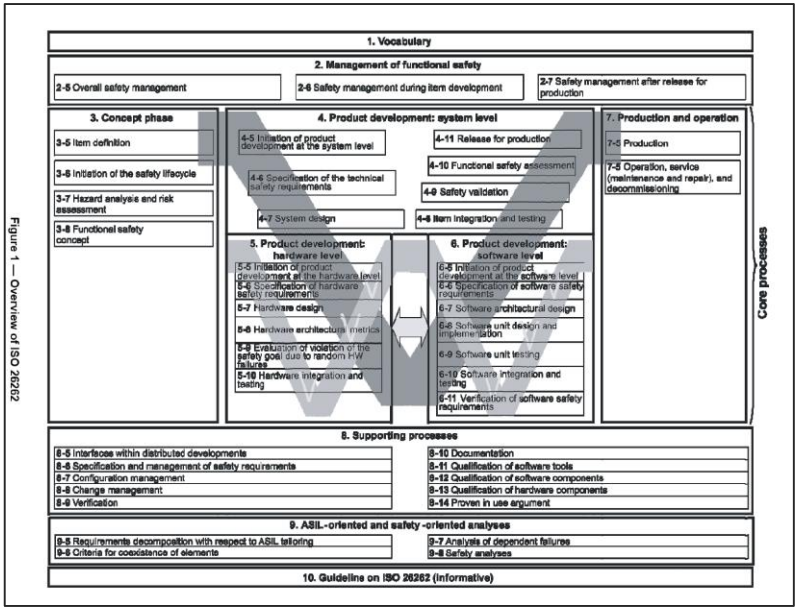
Functional Safety

BIG-DATA

Functional Safety Analysis
- Identify Hazards
- Measuring Risks
- Using System Engineering to Lower Risk

ISO 26262: Hardware and Product Development Cycle
- Item Definition
- Situational Analysis and Identification of Hazards
- Classification ASIL
- Safety Goals
- Functional Safety Concept
- Technical Safety Concept
- Functional Safety at the Software and Hardware Levels

Diagnostic Test Interval and Fault Reaction Time Measurements



VIRTUAL REALITY

Oculus VR

VIRTUAL REALITY


BRIGHT IDEA

Application

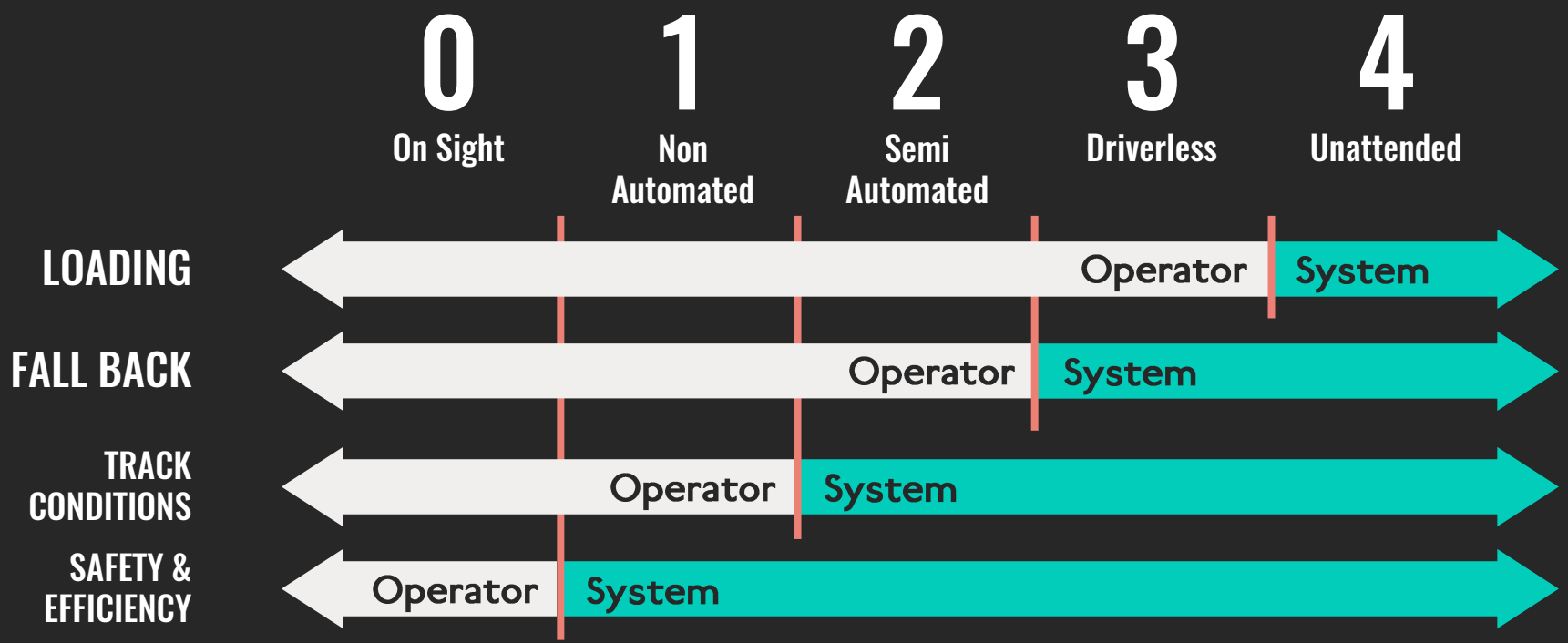
Application

Application

Application

RAILWAY CASE

TRAINS: 4 GRADES OF AUTOMATION

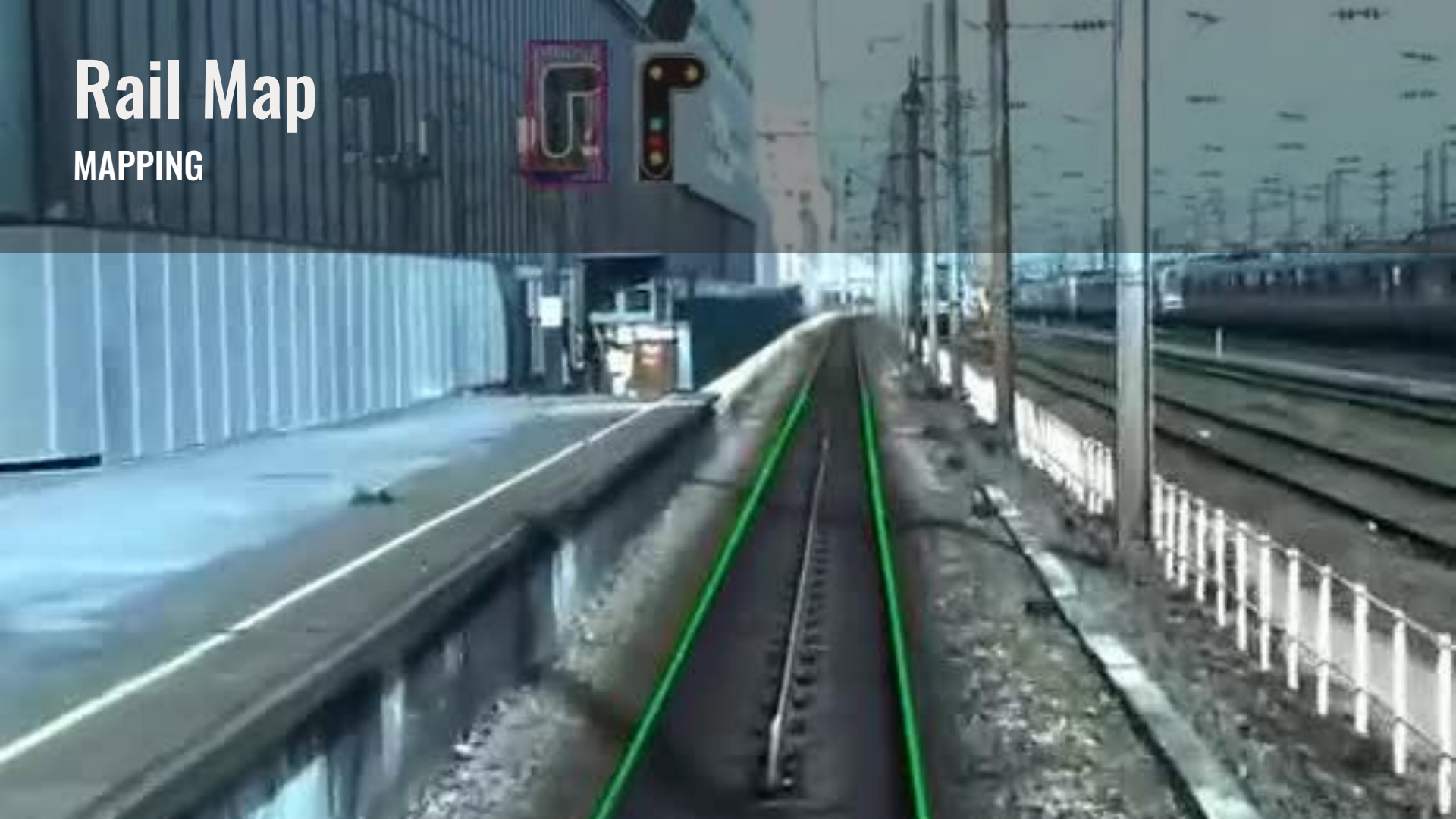


3D Reconstruction

MAPPING

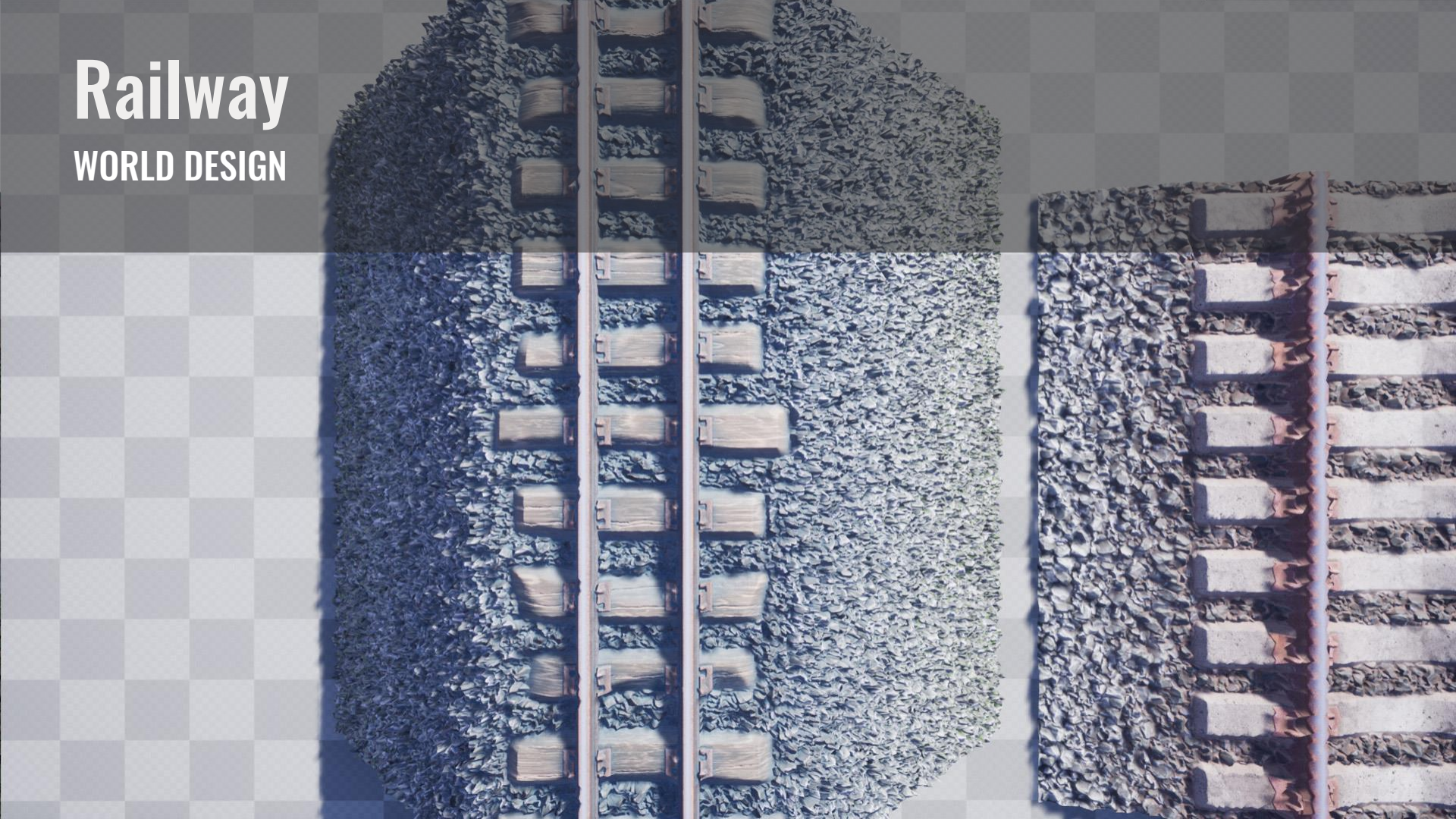
Rail Map

MAPPING



Railway

WORLD DESIGN

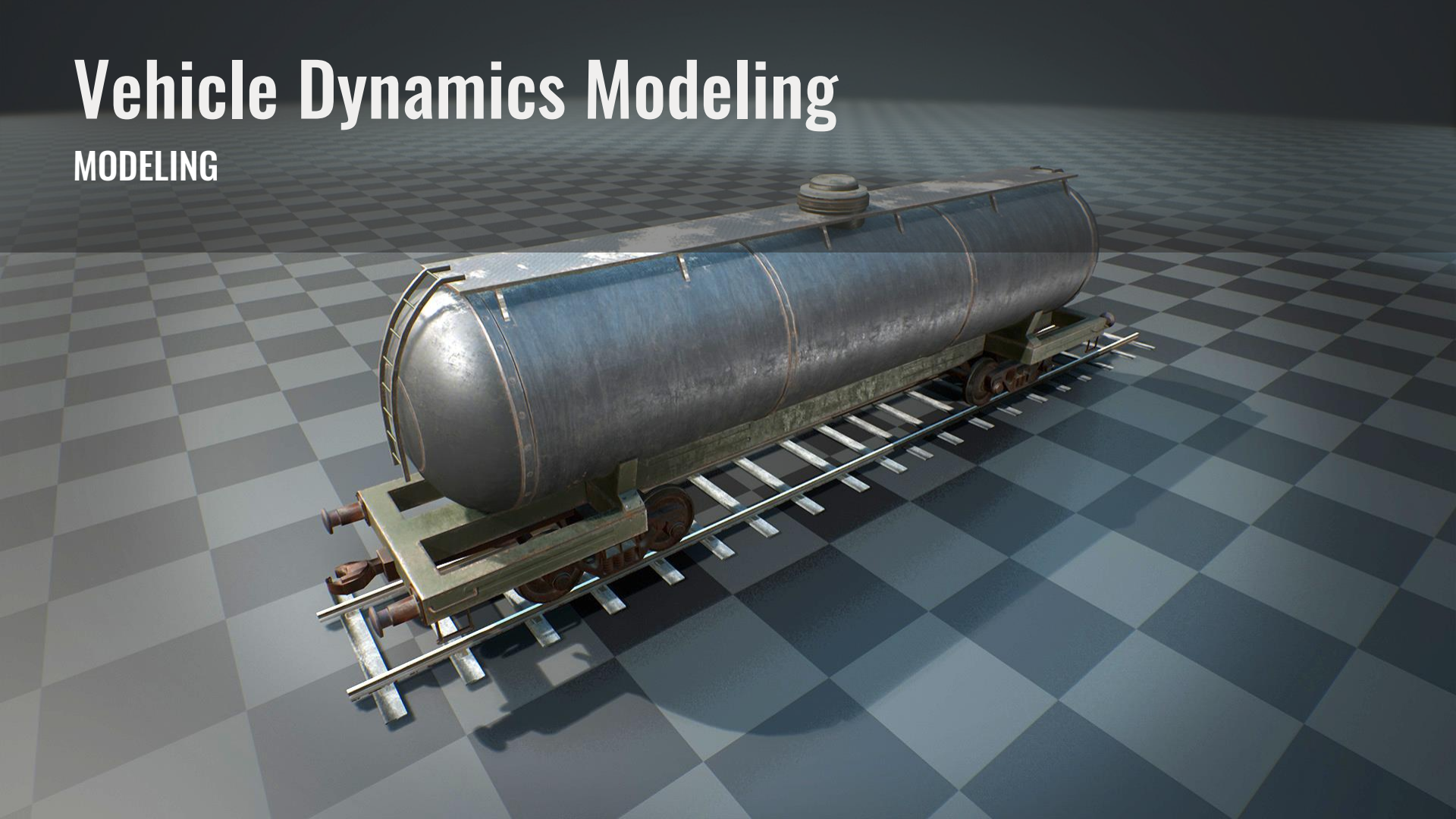


Ego Vehicle Design

MODELING

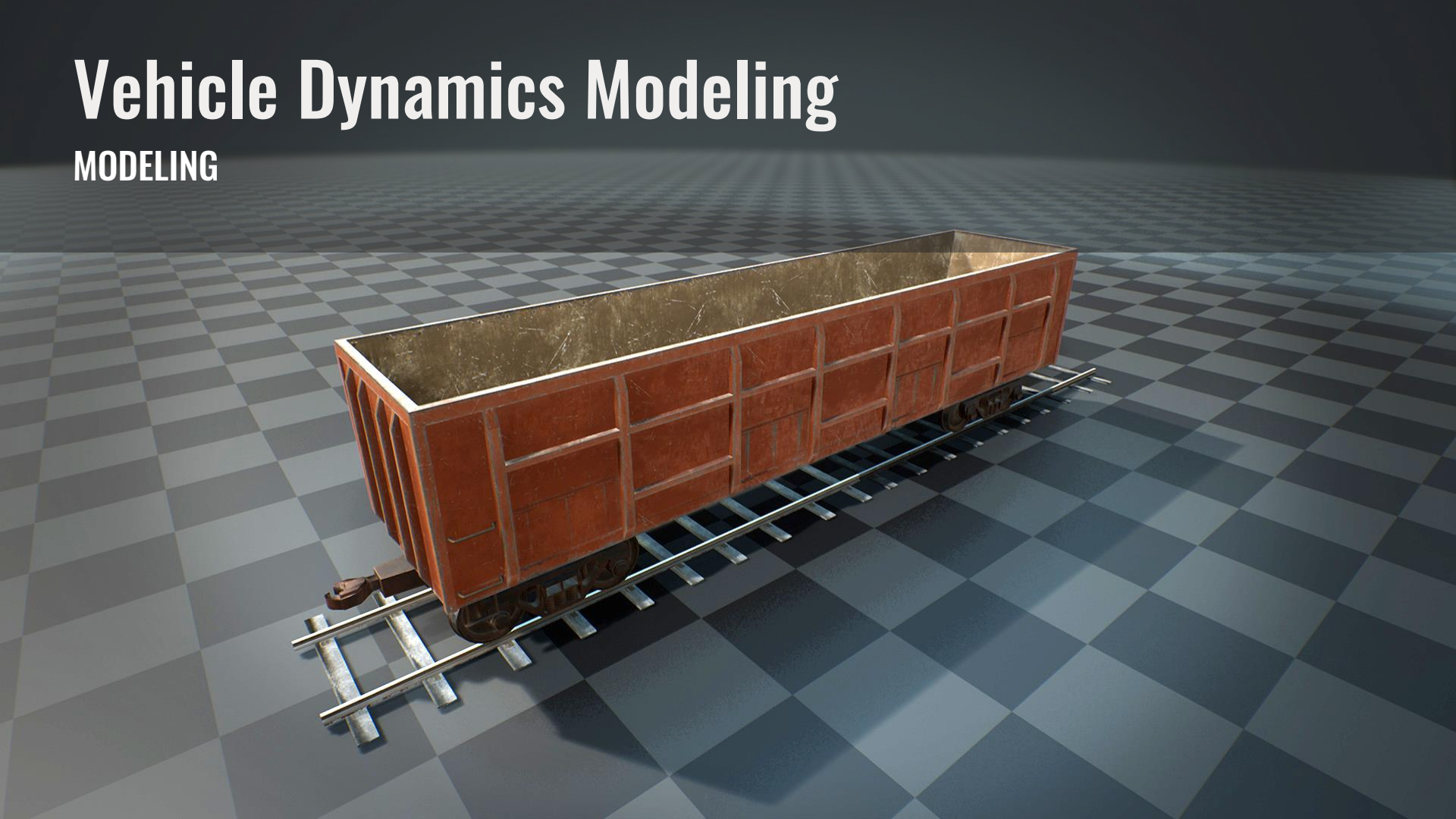
Vehicle Dynamics Modeling

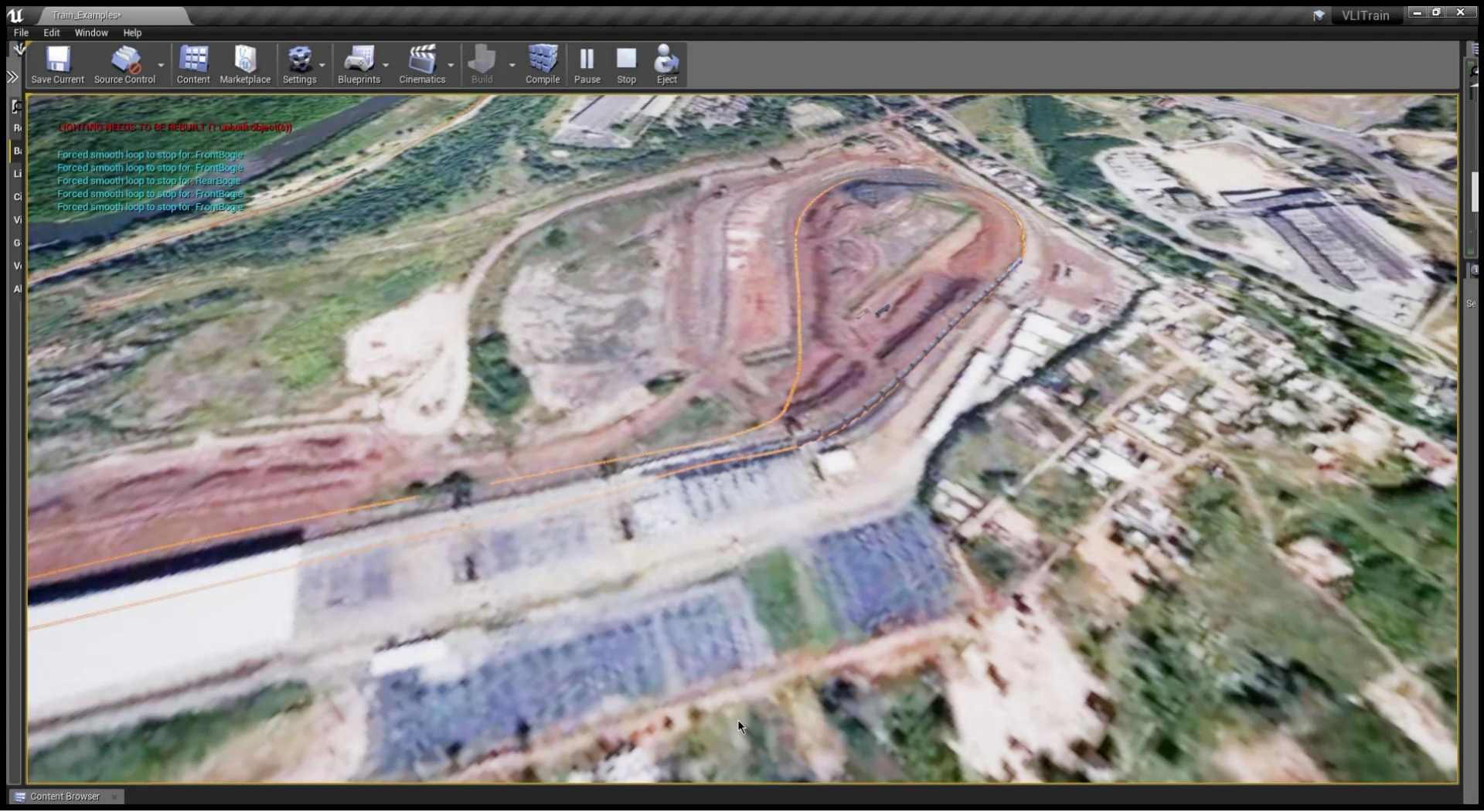
MODELING



Vehicle Dynamics Modeling

MODELING




Train_Examples*
VLITrain
File
Edit
Window
Help
Save Current
Source Control
Content
Marketplace
Settings
Blueprints
Cinematics
Build
Compile
Pause
Stop
Eject
LIGHTING NEEDS TO BE REBUILT (1 unbuilt object(s))
Forced smooth loop to stop for: FrontBogie
Forced smooth loop to stop for: FrontBogie
Forced smooth loop to stop for: RearBogie
Forced smooth loop to stop for: FrontBogie
Forced smooth loop to stop for: FrontBogie
Content Browser

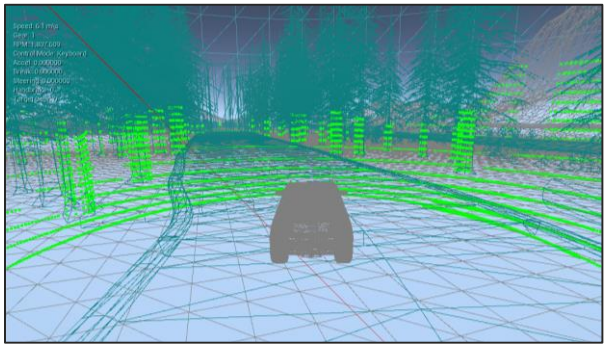
PORTFOLIO

Portfolio

ABOUT US

Carla Self-Driving Car

Implementation of core functionality of the autonomous vehicle system, including traffic light detection, control, and waypoint following.



Alpha Version Virtual Track

It's a typical closed circuit track with a few challenges, like obstacles, shadows, different backgrounds, weather conditions, and tight curve

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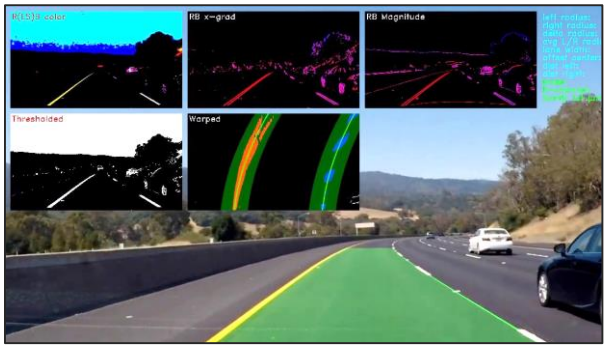

Advanced Lane Line Finding

Development of a software pipeline to identify the lane boundaries in a video from a front-facing camera on a car, including camera calibration and other computer vision techniques. Returns the position of the car relative to the lane and the curvature of the path.

Vehicles Detection and Tracking

Implementation of the software pipeline to identify vehicles in a video from a front-facing camera on a car, using advanced computer vision techniques, feature extraction and machine learning (SVM).

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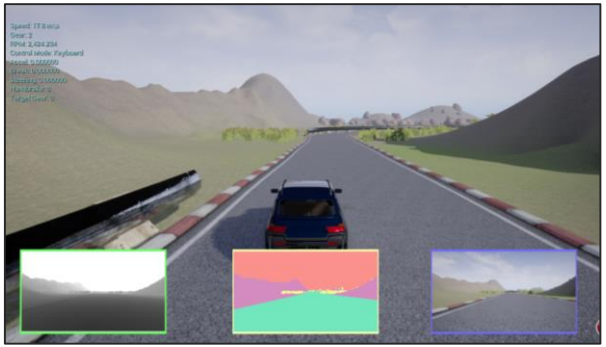
Deep Learning for Traffic Sign Classification

Development of a deep neural networks and convolutional neural networks to classify traffic signs from the German Traffic Sign Dataset.



End to End Deep Learning Behavioral Cloning

Creation of a Deep Learning model using convolutional neural networks to drive a car without any pre-processing or deterministic and probabilistic algorithm.

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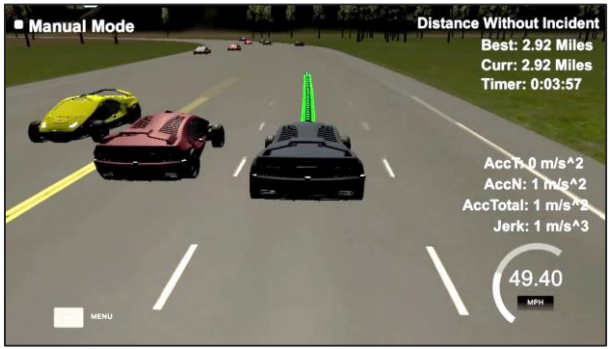
Deep Learning: Semantic Segmentation

Labeling the pixels of a road in images using a Fully Convolutional Network (FCN)



Path Planning

Design of a path planner that is able to create smooth, safe paths for the car to follow along a 3 lane highway with traffic, keep the vehicle inside its lane, avoid hitting other cars, and pass slower moving traffic, all by using localization, sensor fusion, and map data.

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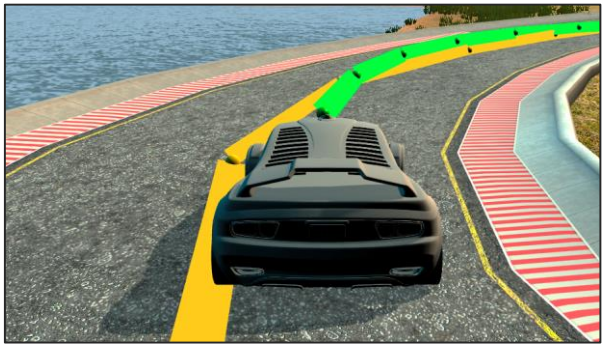

MPC + PID Controller

Implementation of a Model Predictive Control and a PID control to drive the car around the track, simulating a 100 millisecond latency between actuations commands on top of the connection latency.

Open-Source: Road Driving Big-Data

Recording and open-source distribution of 100GB of driving data, including 750,000 frames, GPS, IMU and speed metadata.

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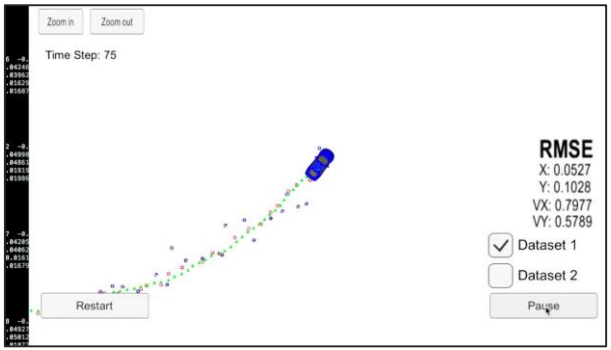
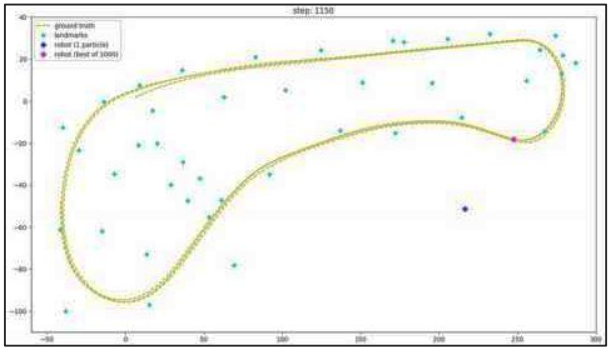


Sensor Fusion: Extended and Unscented Kalman Filters

Implementation of Sensor Fusion algorithms with simulated lidar and radar measurements detecting and tracking the position and velocity of a bicycle that travels around the vehicle.



Localization: Particle Filter

Implementation of a particle filter in C++, given a map, GPS information, observation and wheel odometry data.

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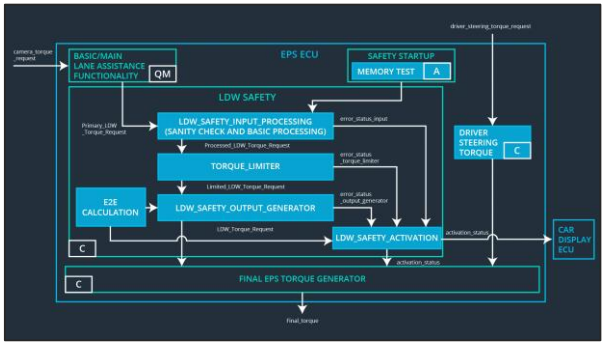

Functional Safety: Lane Assistance System

Construction part of a safety case for a lane departure warning feature: hazard analysis, risk assessment, functional and technical safety concepts, and hardware requirements.

Technology Transfer: Infosys India

Leading the class and teaching self-driving cars technology to 100 engineers, helping to build a self-driving Golf Cart, at the Infosys Campus, Mysore / India.


Car of the Future
#Concept

SKOODS

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