

2020 MathWorks 中国汽车年会

交通路口车辆控制及场景仿真

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MathWorks中国区高级应用工程师



典型的交通路口测试场景

CAICV 中国智能网联汽车产业创新联盟
 NTCAS 全国汽标委智能网联汽车分技术委员会
 联合发布

2	交通信号灯识别及响应*	机动车信号灯识别及响应
		方向指示信号灯识别及响应
10	交叉路口通行*	直行车辆冲突通行
		右转车辆冲突通行
		左转车辆冲突通行

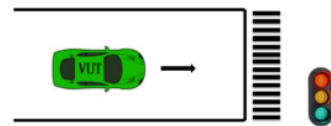


图 6.5 机动车信号灯识别及响应测试场景示意图

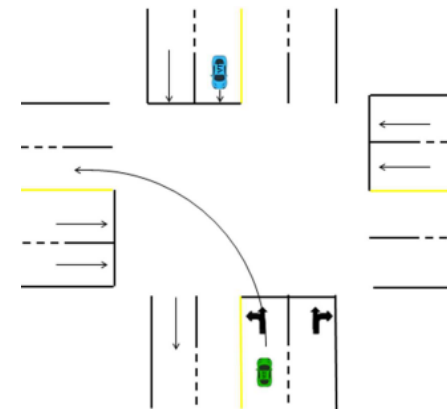
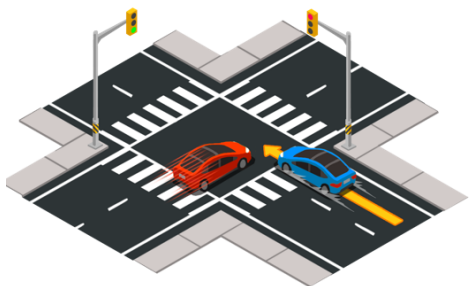


图 6.25 左转车辆冲突通行测试场景示意图



Traffic Scenario 07: Crossing traffic running a red light at an intersection

- **Definition:** Ego-vehicle is going straight at an intersection but a crossing vehicle runs a red light, forcing the ego-vehicle to perform a collision avoidance maneuver.



Traffic Scenario 08: Unprotected left turn at intersection with oncoming traffic

- **Definition:** Ego-vehicle is performing an unprotected left turn at an intersection, yielding to oncoming traffic.

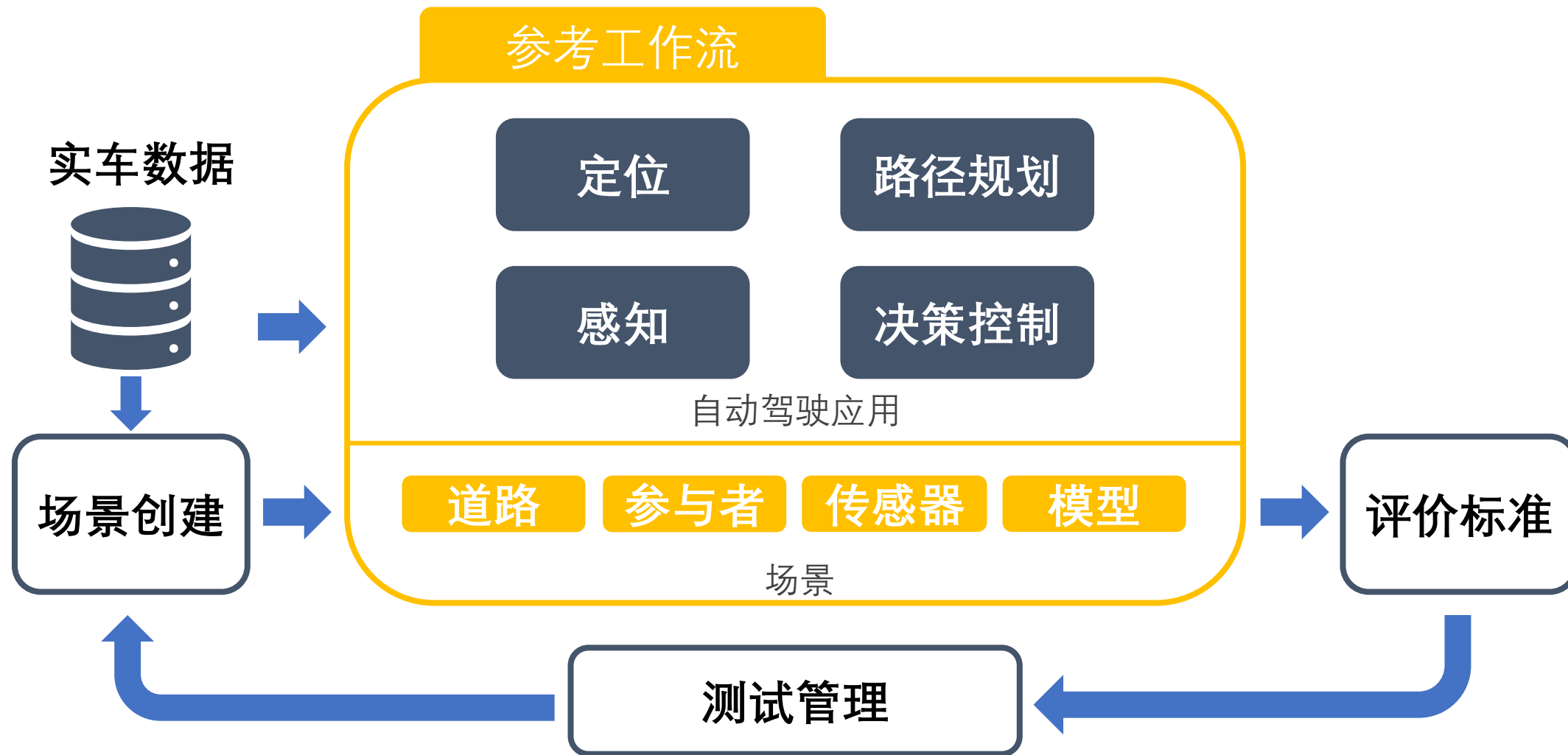


Traffic Scenario 09: Right turn at an intersection with crossing traffic

- **Definition:** Ego-vehicle is performing a right turn at an intersection, yielding to crossing traffic.

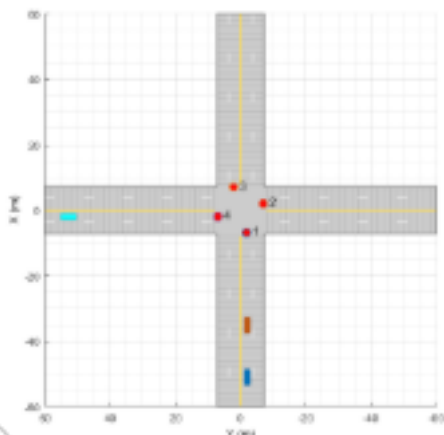


基于MATLAB/Simulink仿真流程



交通路口车辆控制及场景仿真

Cuboid

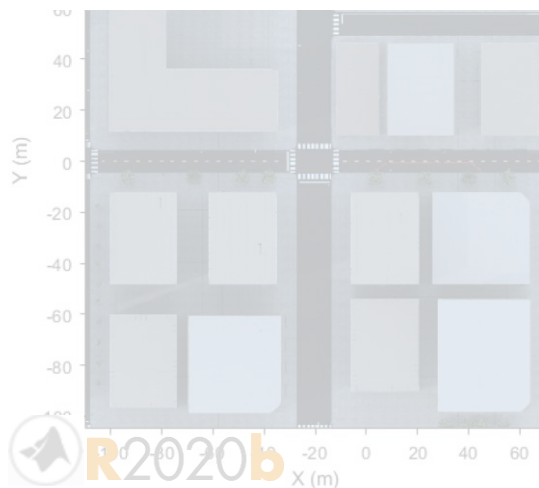


Traffic Light Negotiation

Automated Driving Toolbox™

- 创建交通路口场景
- 设计交通信号灯
- 创建交通路口路径规划
- 设计交通路口决策功能

UE4 3D



Traffic Light Negotiation with Unreal Engine Visualization

Automated Driving Toolbox™

- 在Simulink中配置 3D场景
- 设计交通灯控制

RoadRunner



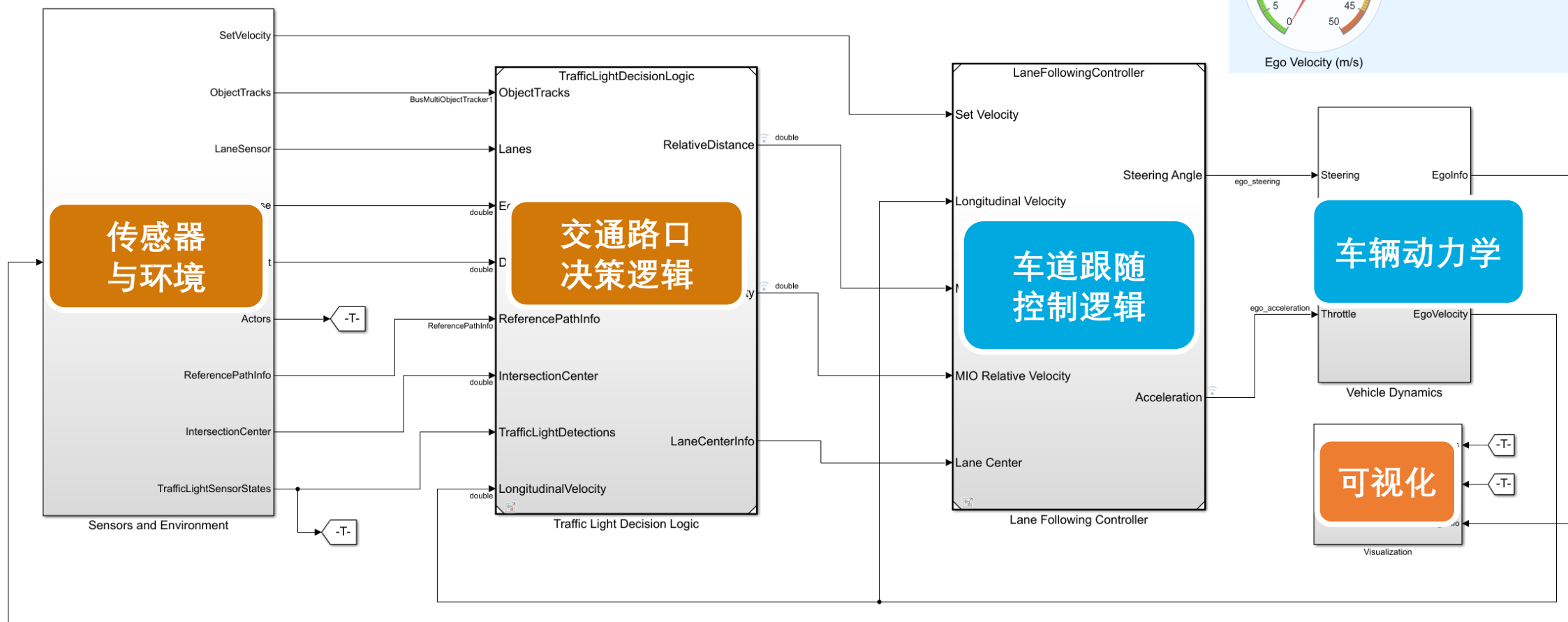
Traffic Signal Assets

RoadRunner™

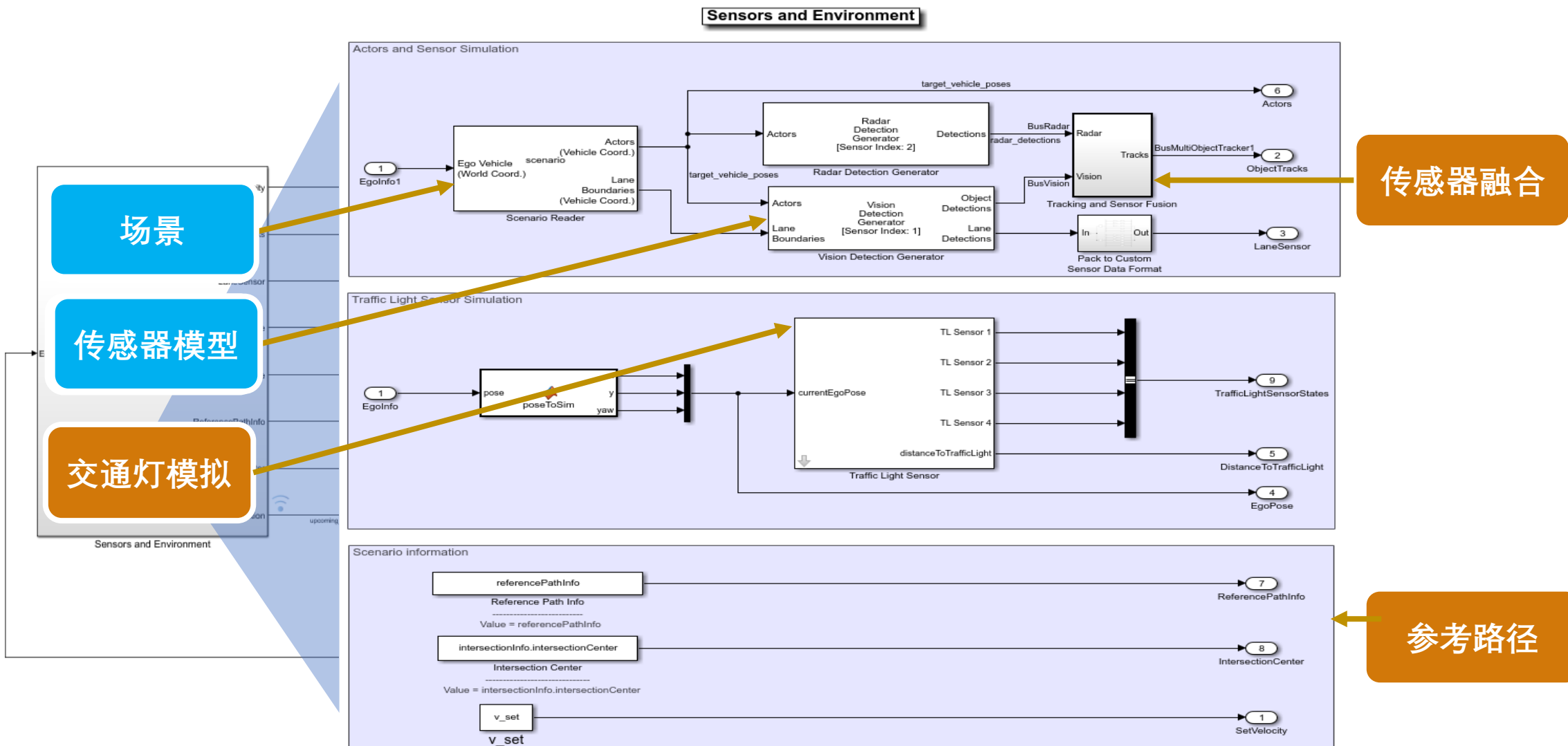
- 设计自定义场景
- RoadRunner工作流程

基于Cuboid的交通路口车辆控制及场景仿真

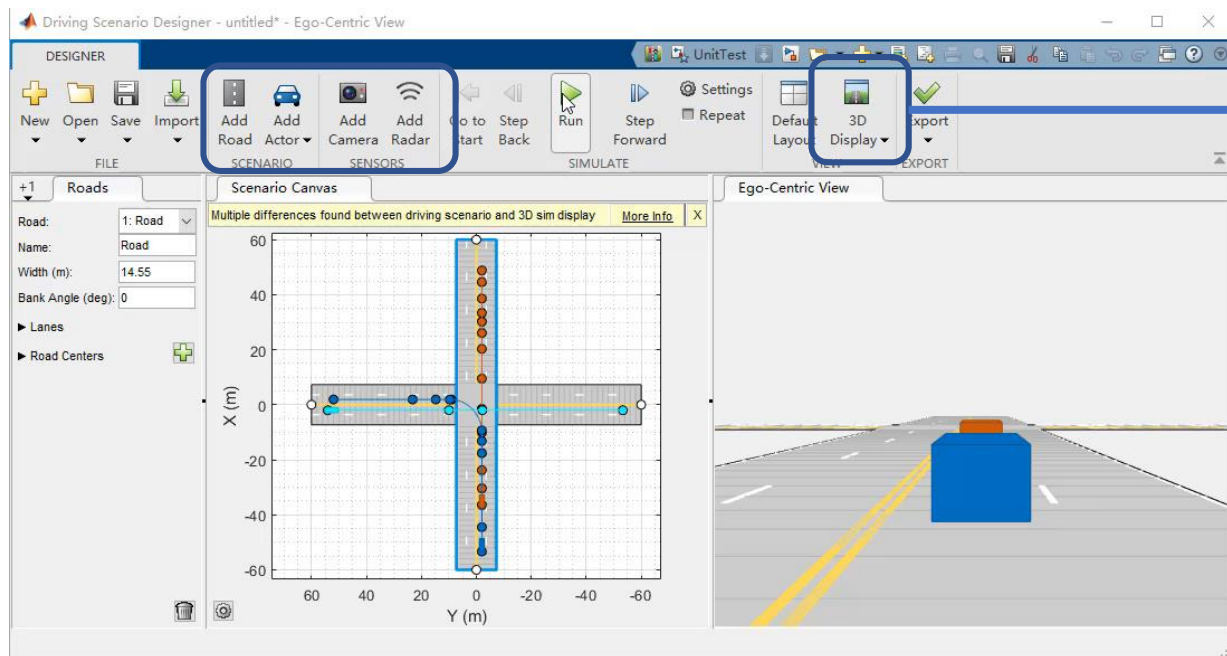
Traffic Light Negotiation Test Bench



传感器与环境模型

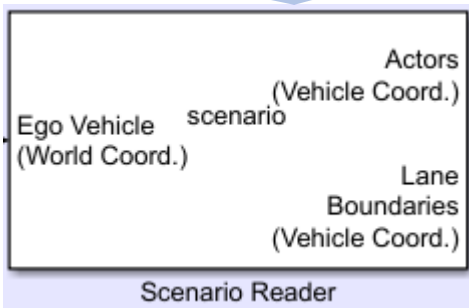
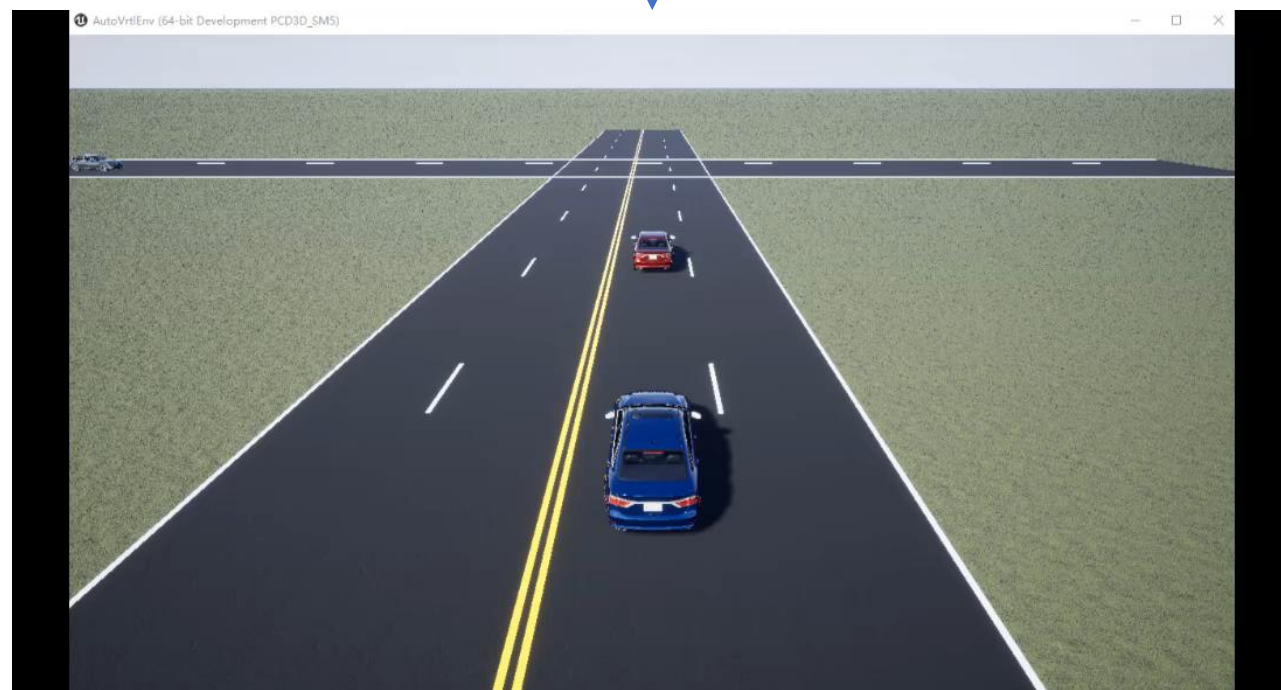


创建Cuboid的场景

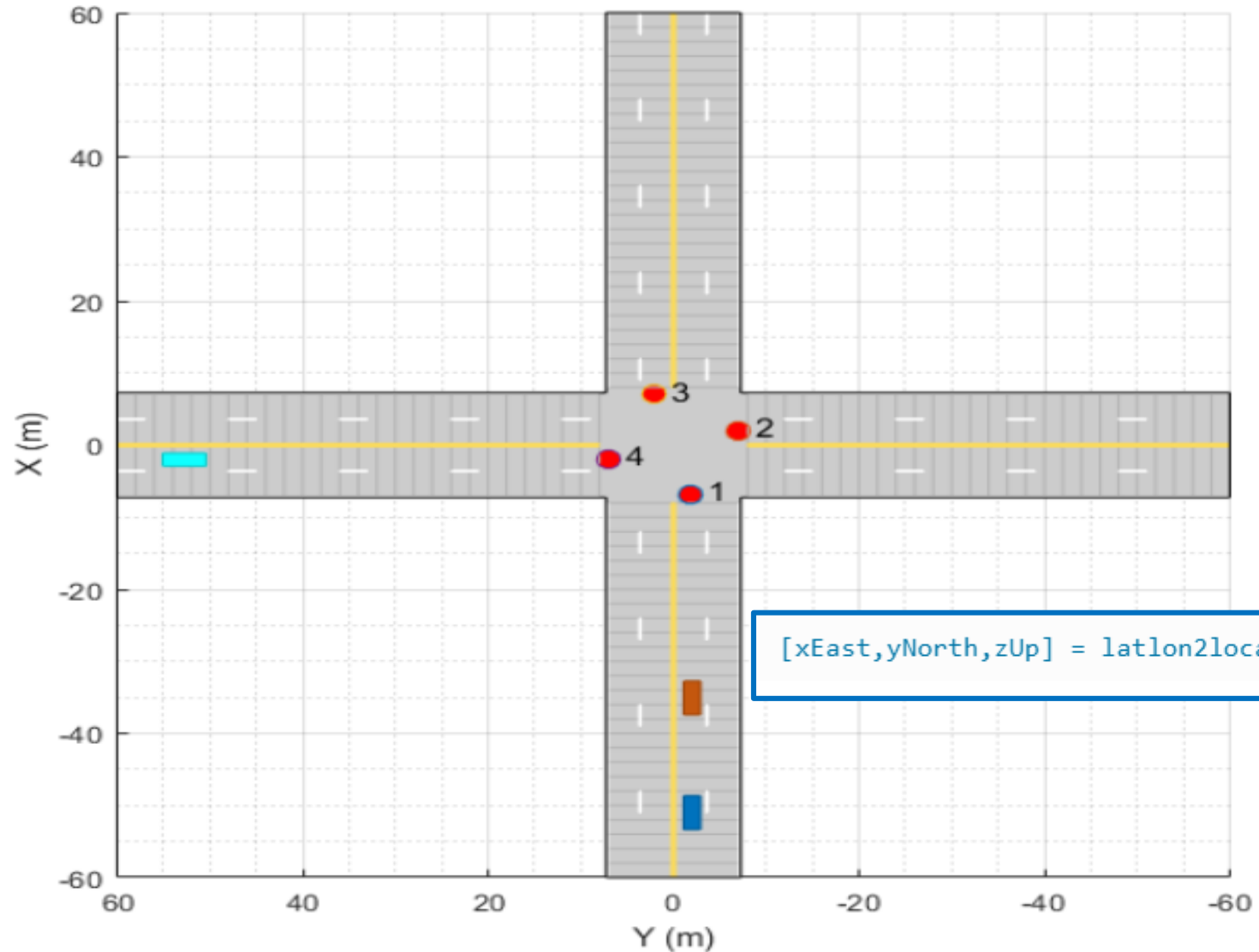
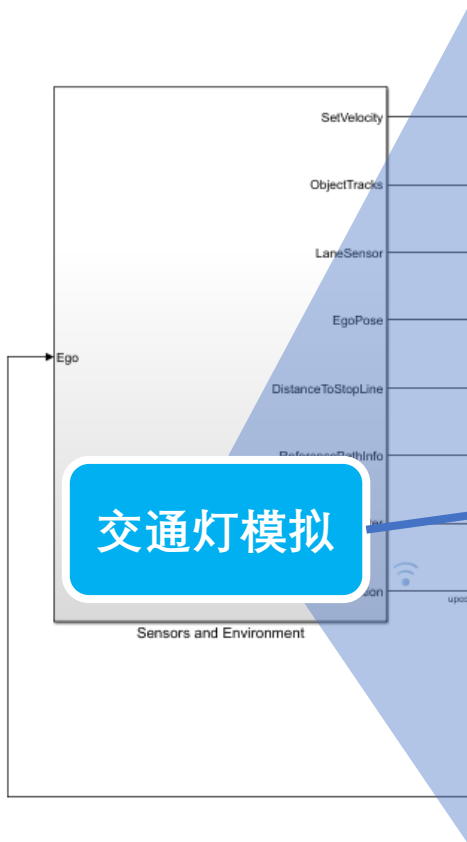


3D Display

R2020a

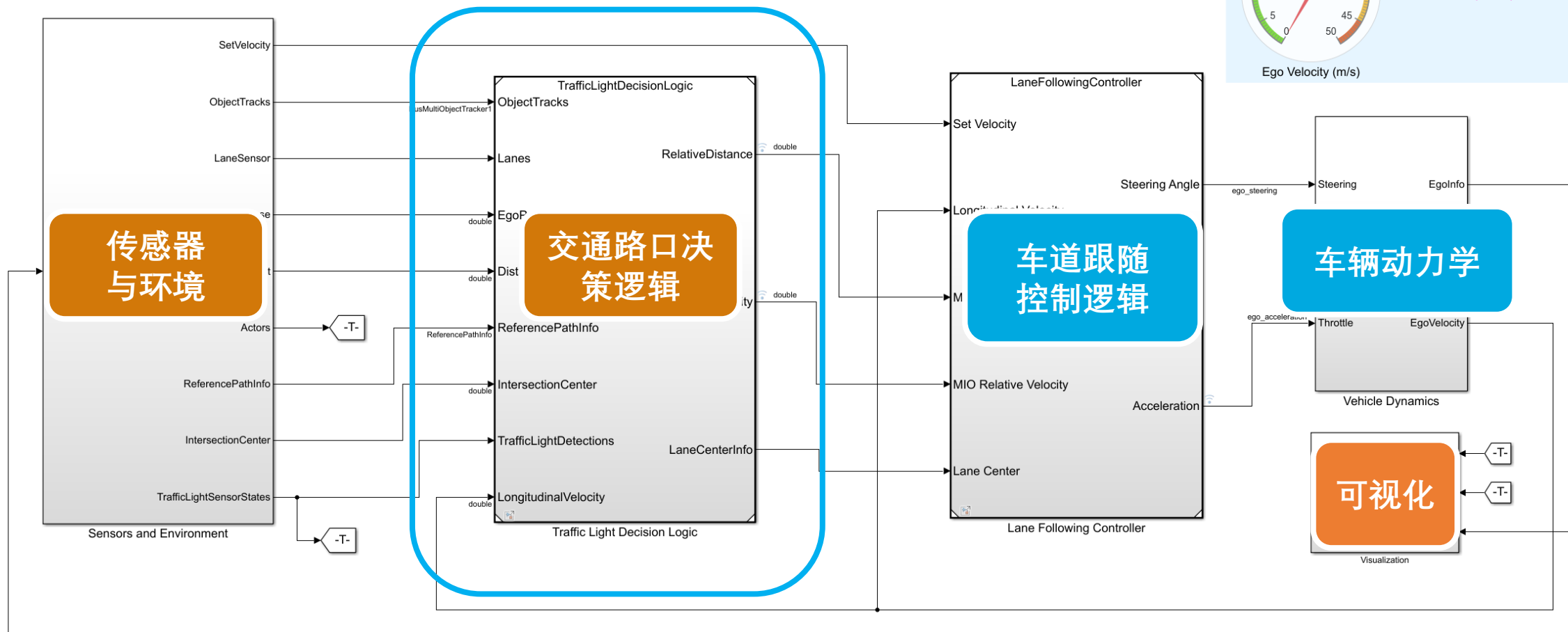


创建交通路口信号灯及可视化



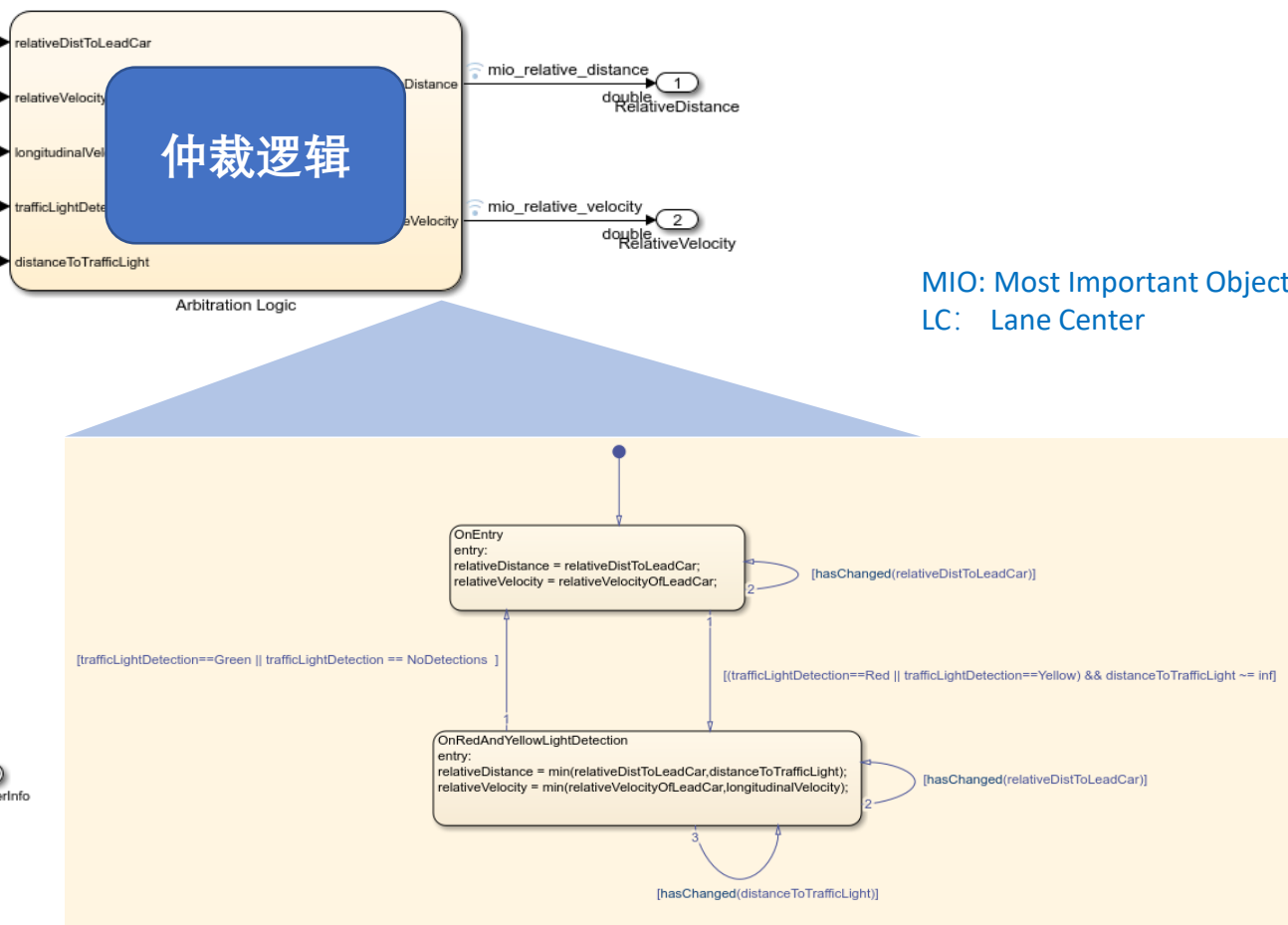
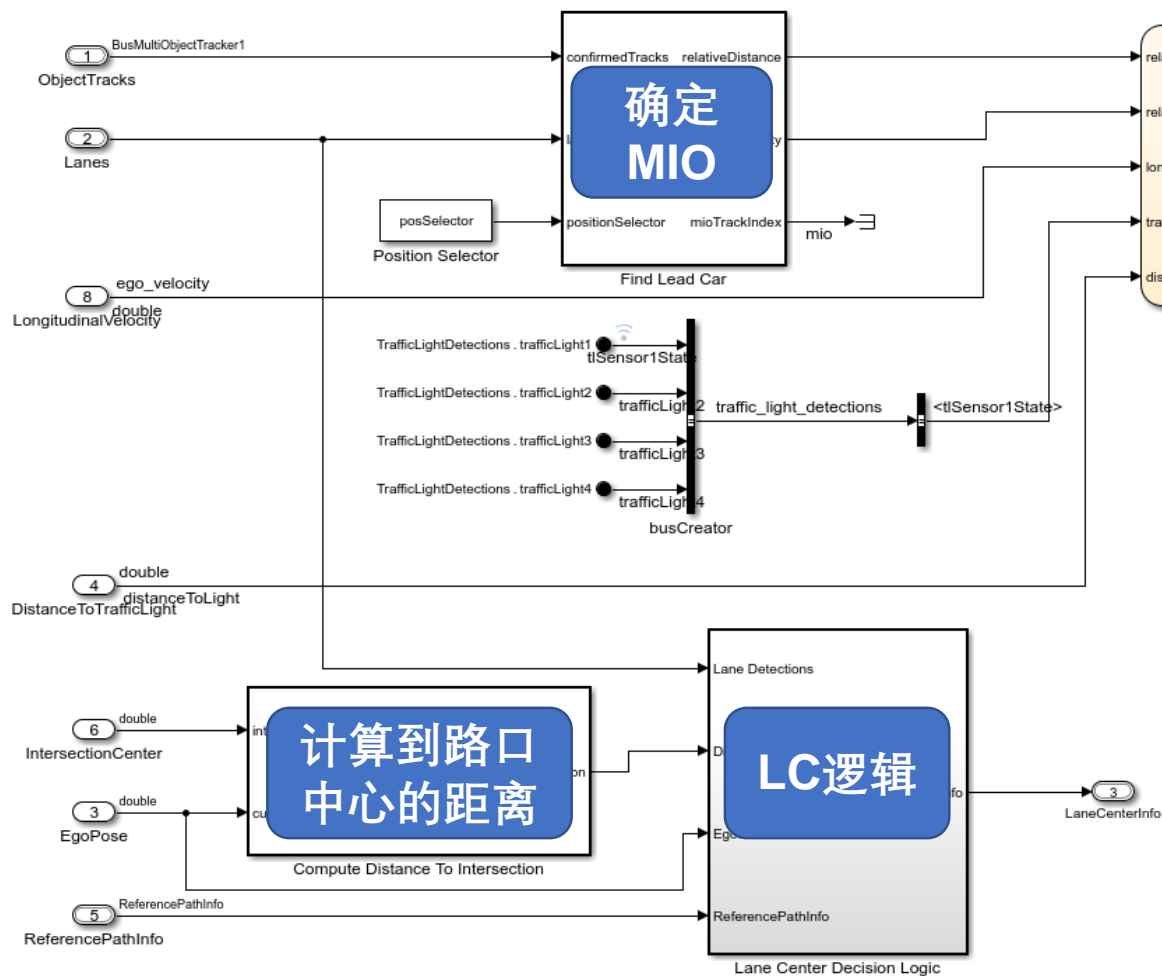
基于Cuboid的交通路口车辆控制及场景仿真

Traffic Light Negotiation Test Bench



交通路口车辆决策逻辑

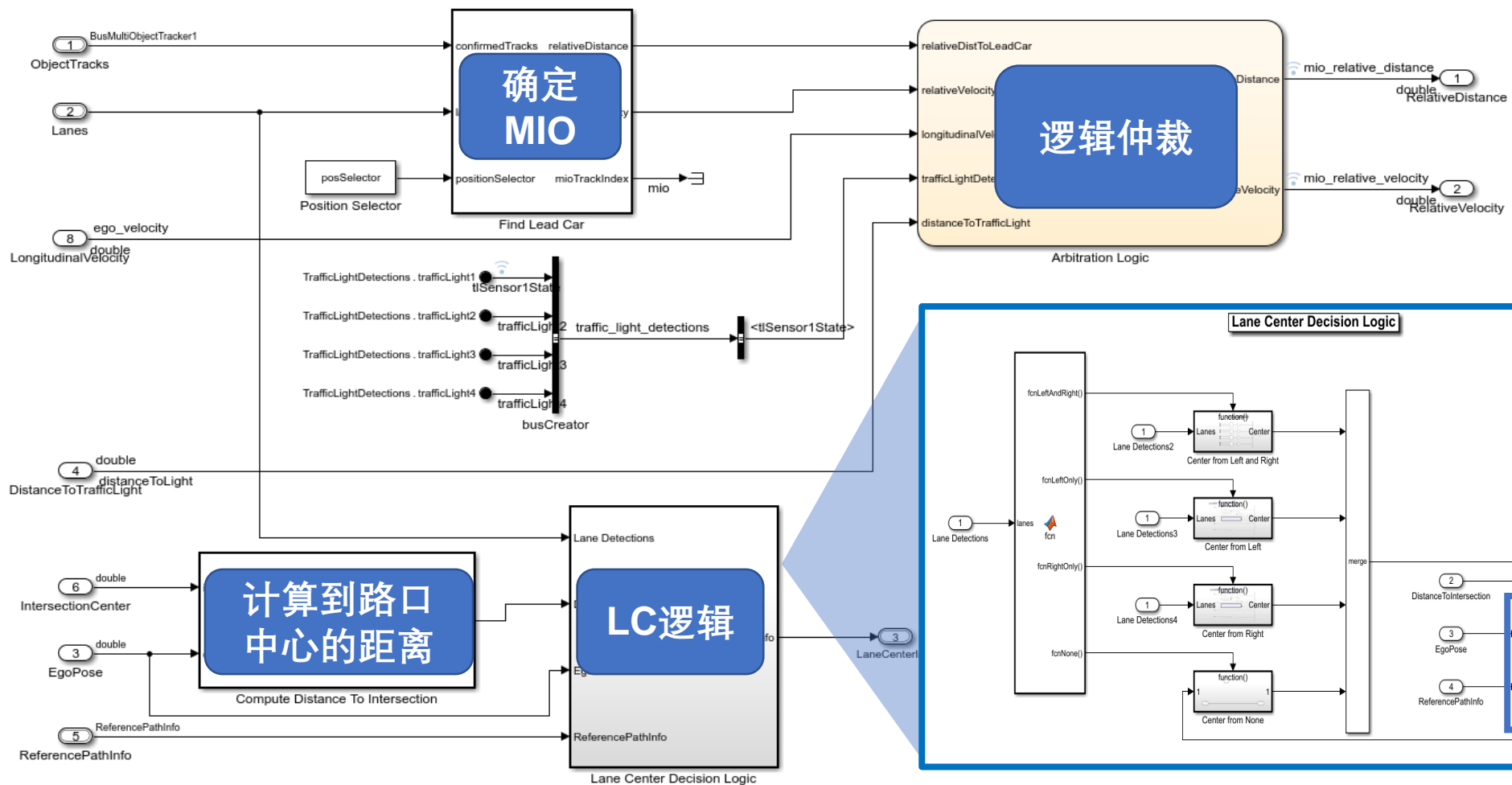
Traffic Light Decision logic



MIO: Most Important Object
LC: Lane Center

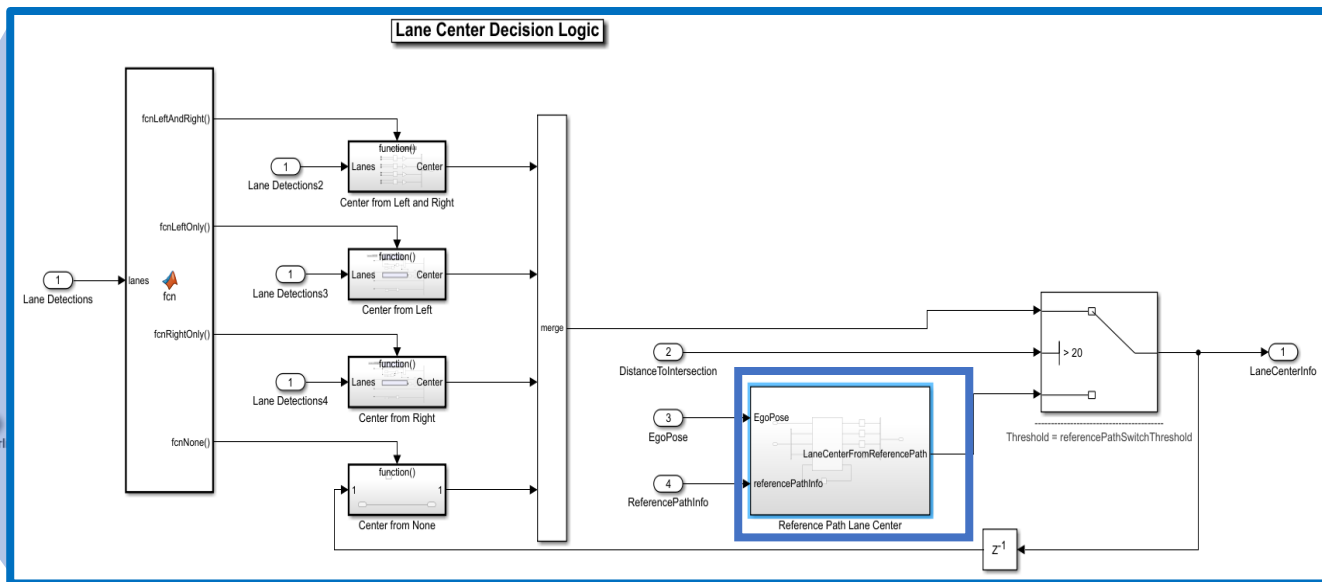
交通路口车辆决策逻辑

Traffic Light Decision Logic



MIO: Most Important Object
LC: Lane Center

Lane Center Decision Logic

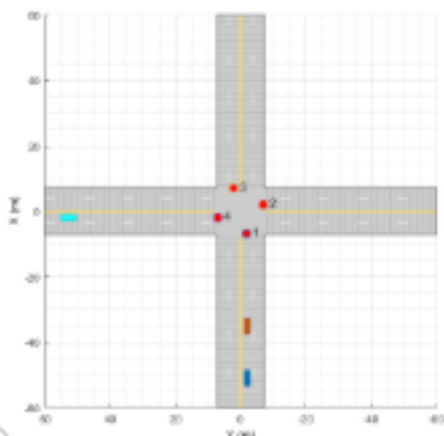


基于Cuboid的交通路口车辆控制及场景仿真



交通路口车辆控制及场景仿真

Cuboid

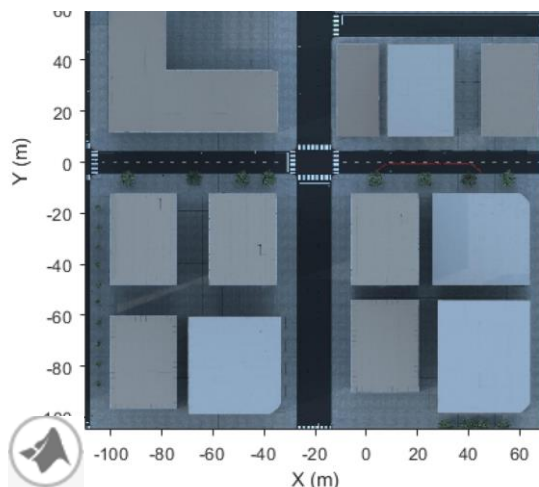


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Traffic Light Negotiation
Automated Driving Toolbox™

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- 设计交通路口决策功能

UE4 3D



Traffic Light Negotiation with
Unreal Engine Visualization
Automated Driving Toolbox™

- 在Simulink中配置 3D场景
- 设计交通灯控制

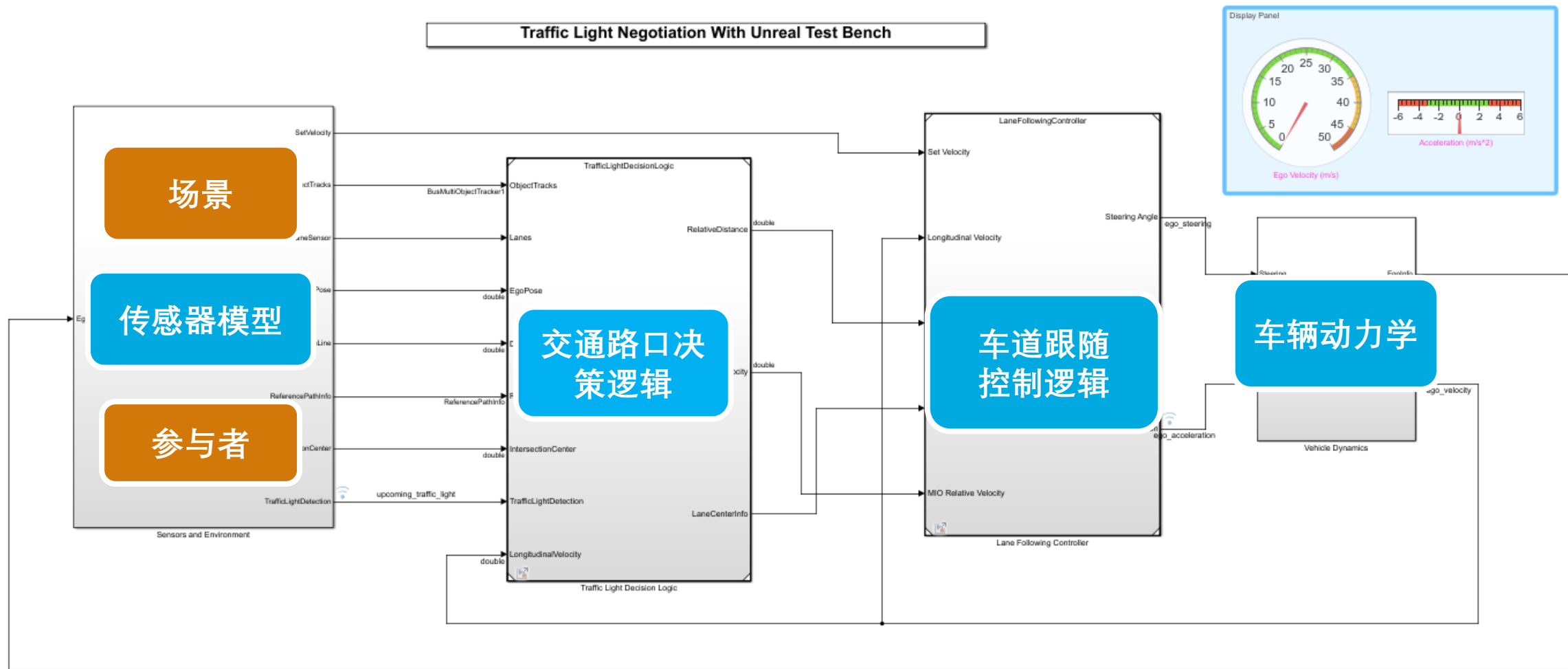
RoadRunner



Traffic Signal Assets
RoadRunner™

- 设计自定义场景
- RoadRunner工作流程

基于Unreal Engine的交通路口车辆控制



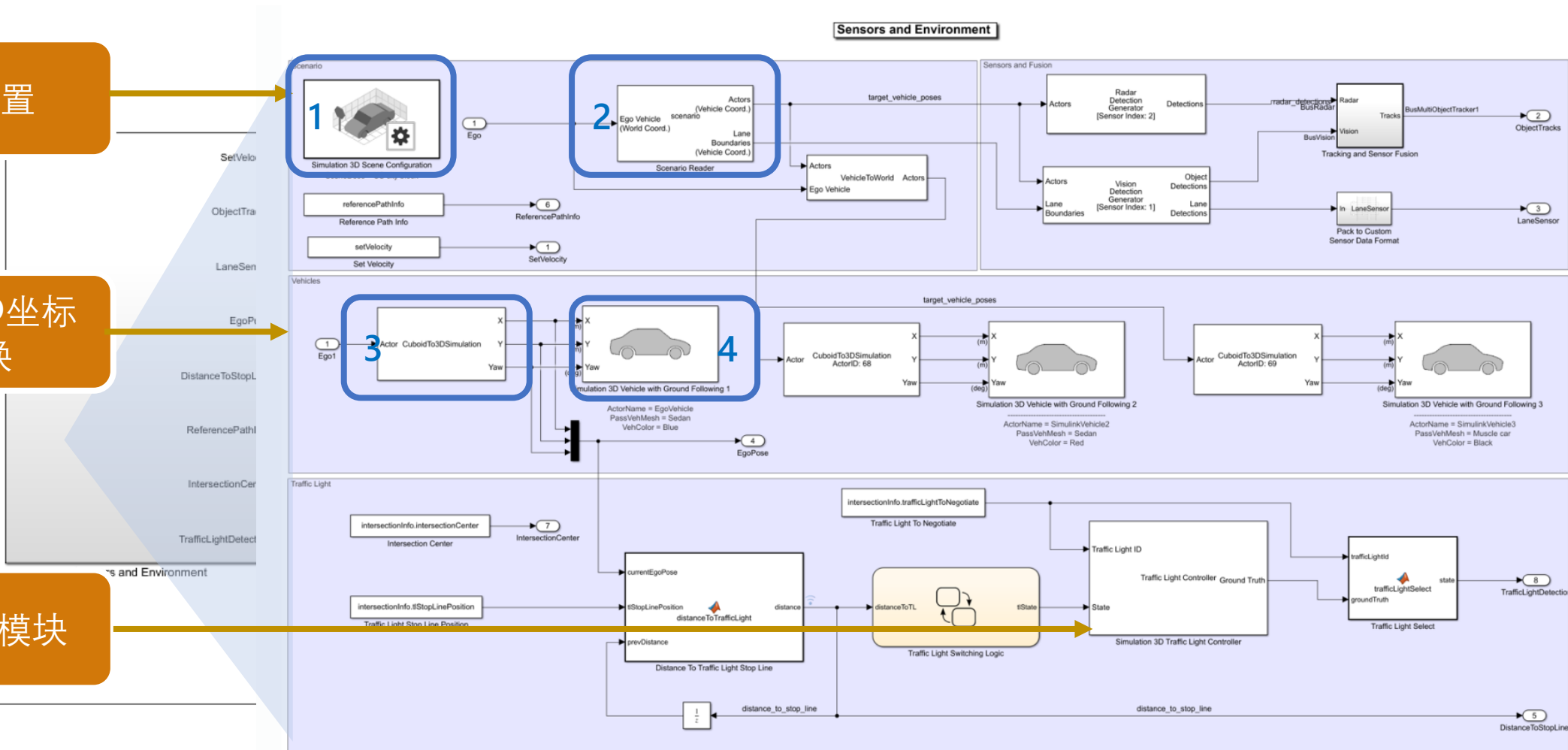
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基于Unreal Engine的交通路口场景设计

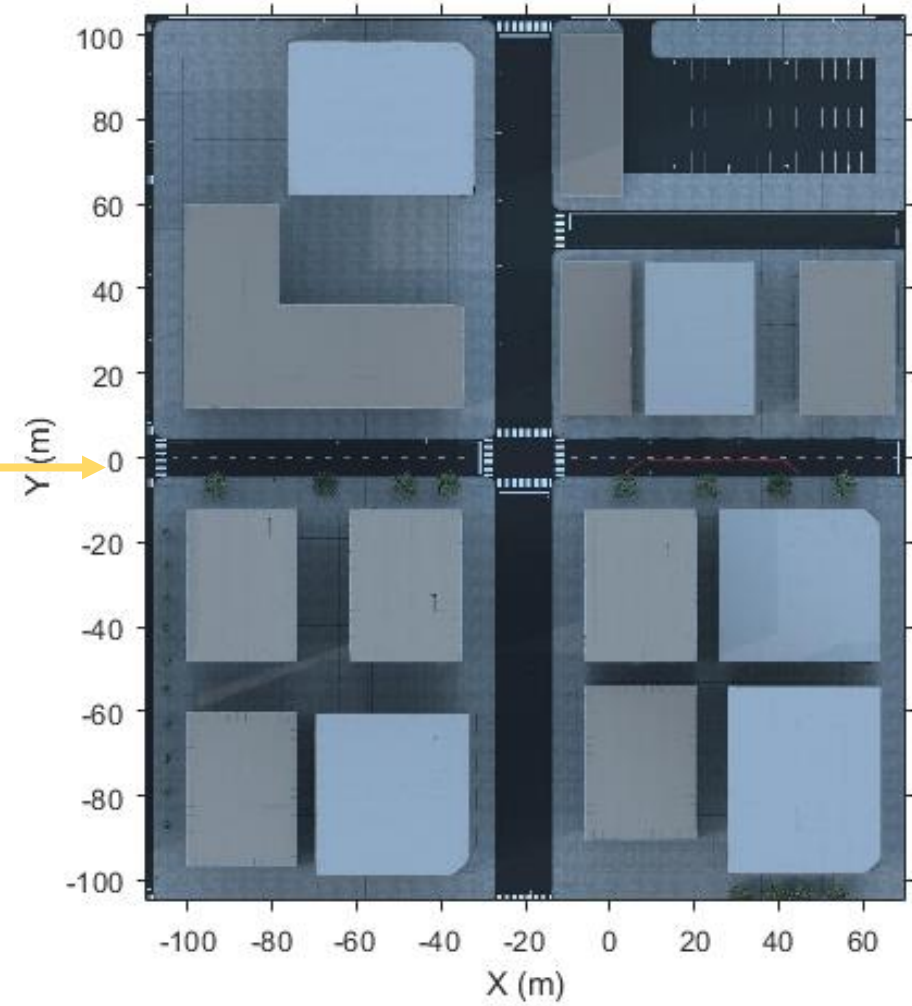
3D场景配置

Cuboid与3D坐标
原点转换

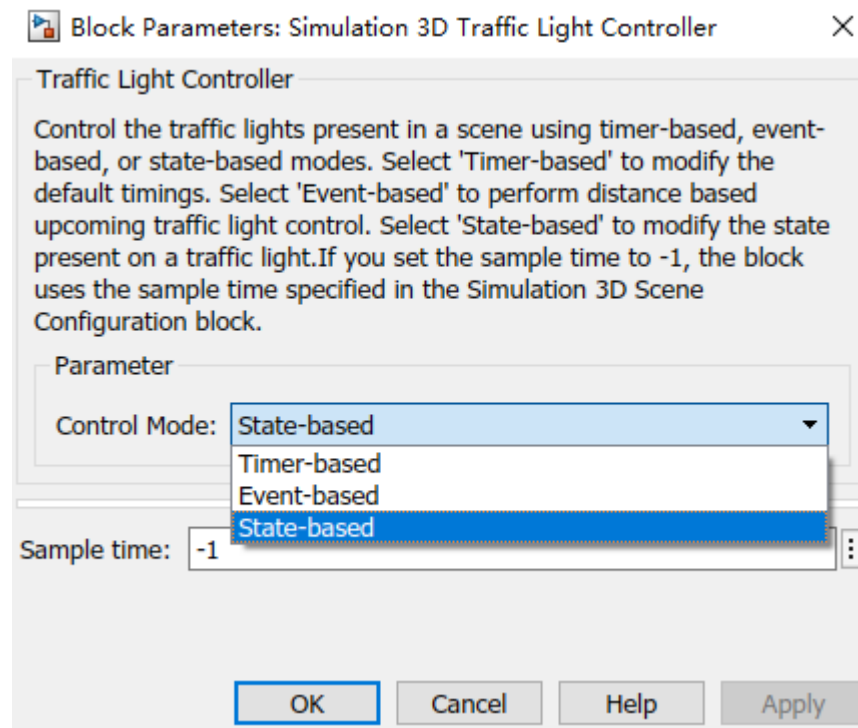
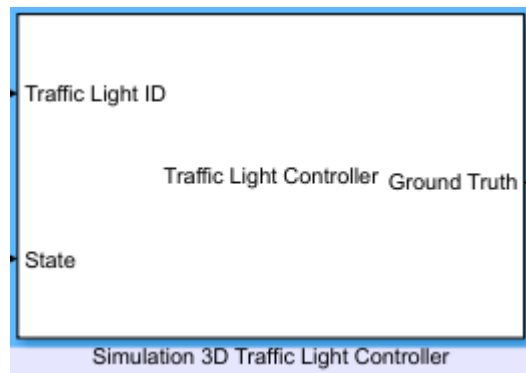
交通灯控制模块



Unreal Engine城市场景

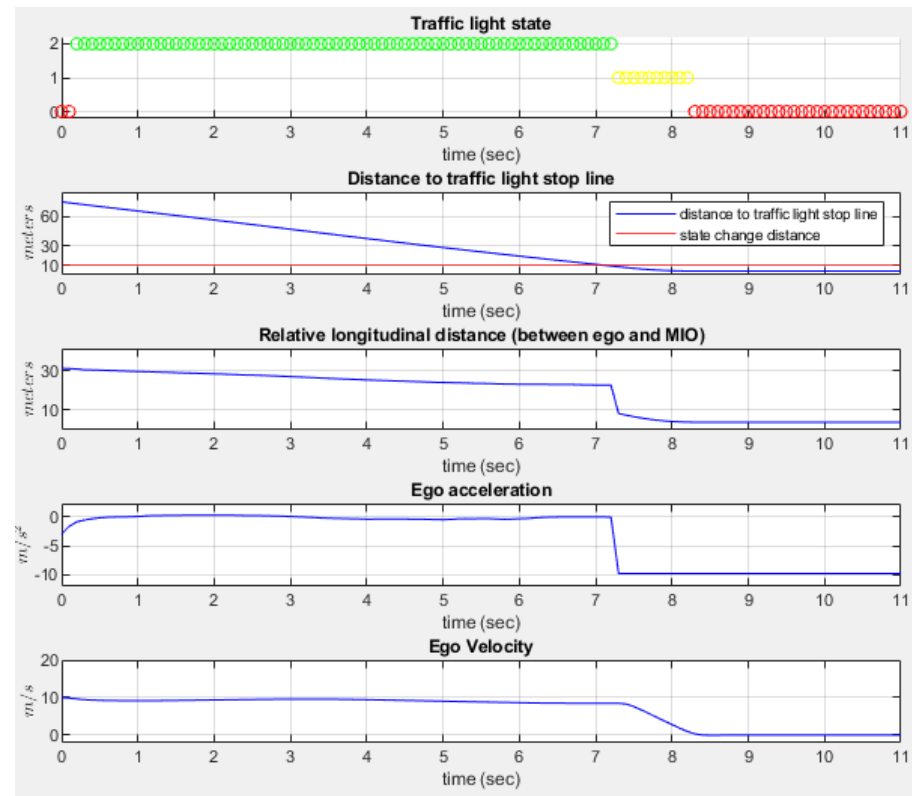
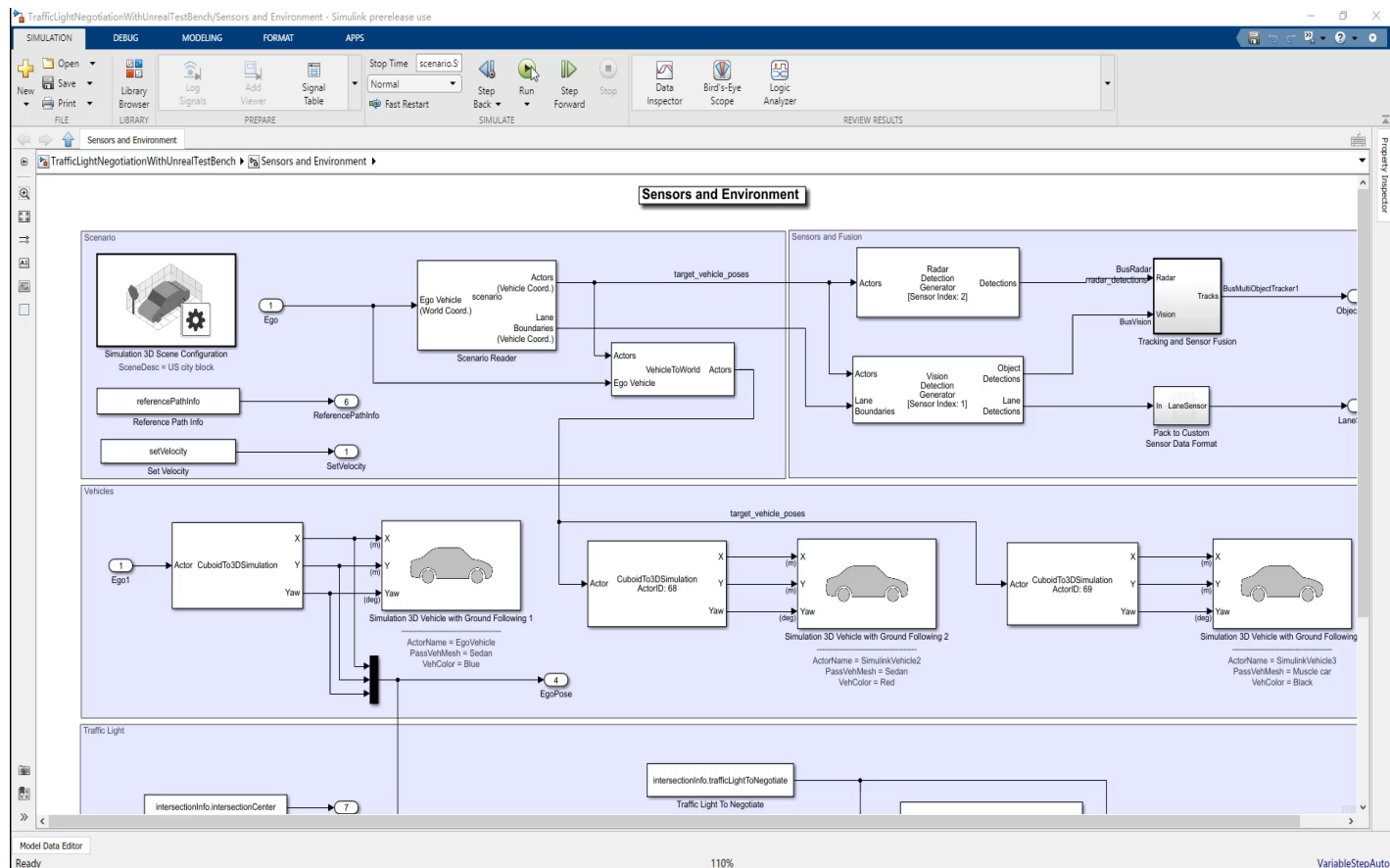


3D交通灯控制模块

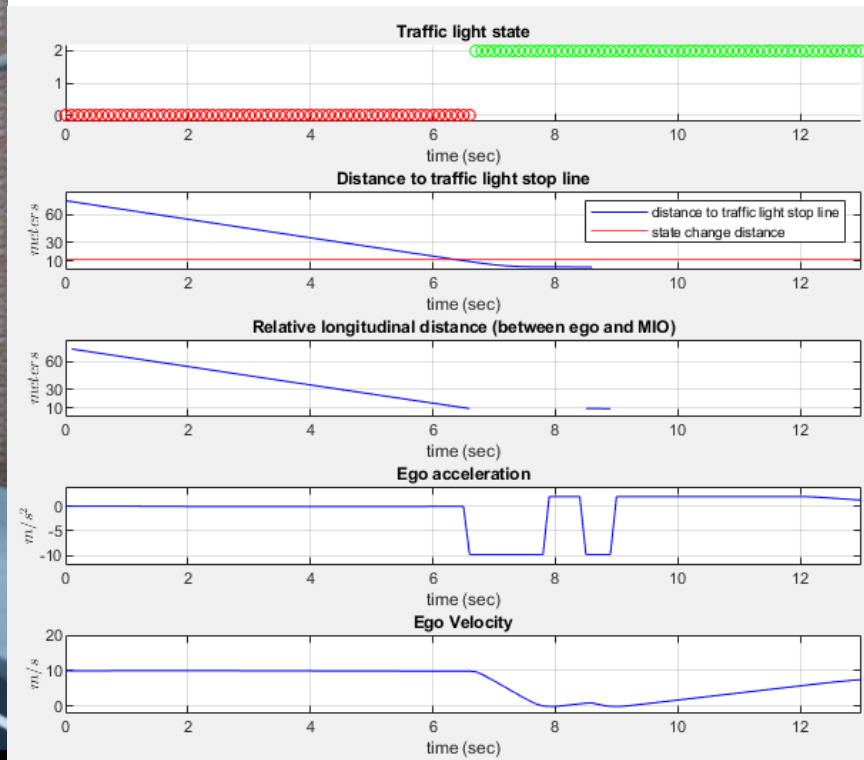


- Timer-based: 基于时间的方式，设定特定的交通灯切换时间
- Event-based: 基于事件的方式，例如自行车在距离路口满足距离要求时，控制交通灯的变化
- State-based: 基于状态的方式，状态由外部输入，如通过Stateflow创建逻辑
- Traffic Light Controller输出: 交通状态灯状态的真值

场景1——交通路口信号灯由绿变红

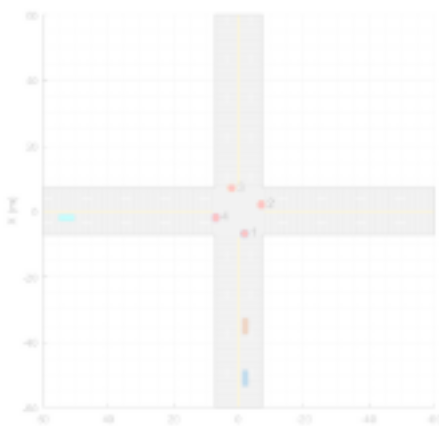


场景2——交通信号灯由红变绿，且避让横穿车辆



交通路口车辆控制及场景仿真

Cuboid

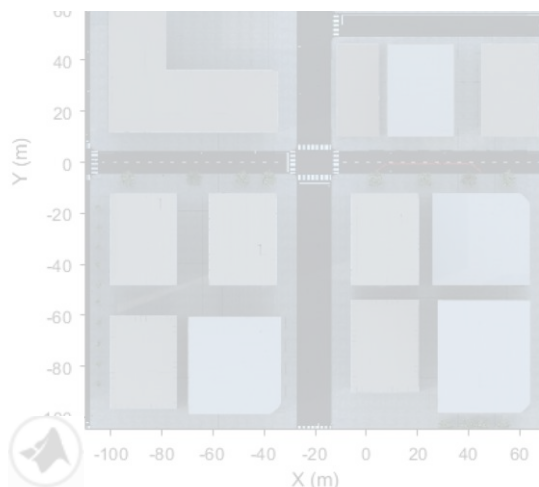


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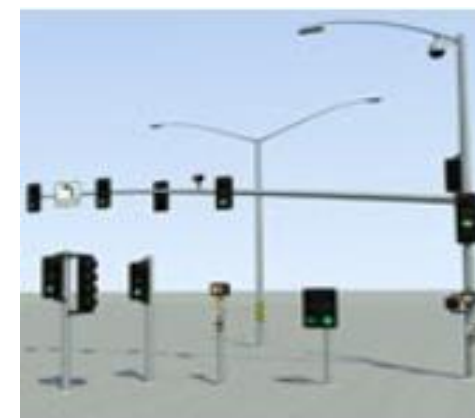
UE4 3D



Traffic Light Negotiation with
Unreal Engine Visualization
Automated Driving Toolbox™

- 在Simulink中配置 3D场景
- 设计交通灯控制

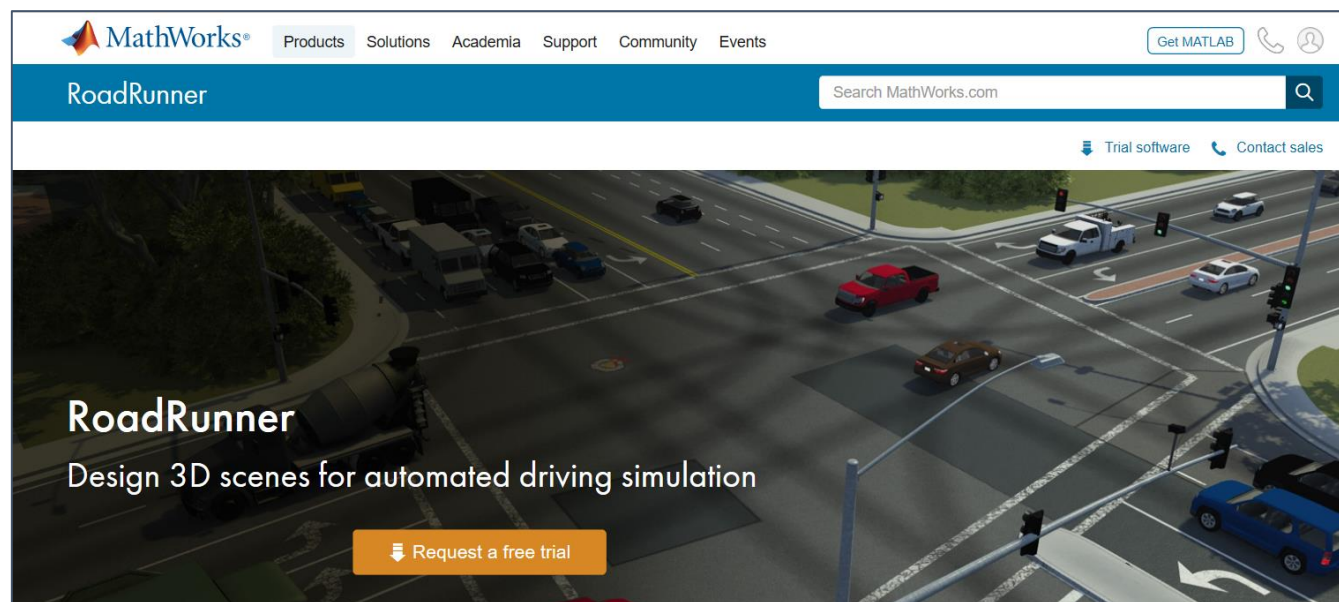
RoadRunner



Traffic Signal Assets
RoadRunner™

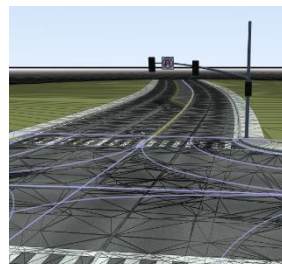
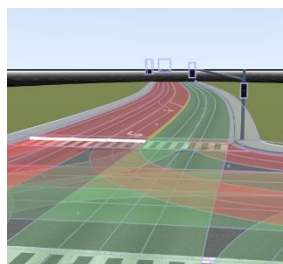
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为自动驾驶仿真设计3D场景

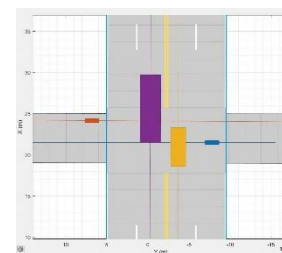


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导出到外部仿真器



MATLAB & Simulink



设计包括道路、标志、附属物的驾驶场景

- 道路和标线
- 交通标志
- 护栏
- 树木
- 指示牌
- 编辑路面海拔高度
- GIS文件



[Assets](#)

RoadRunner™

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数百种预先创建的道路附属物

- 道路和高速公路标志
- 信号灯
- 路面标记
- 树木
- 路障
- 道路破损纹理
 - 裂痕, 油污等



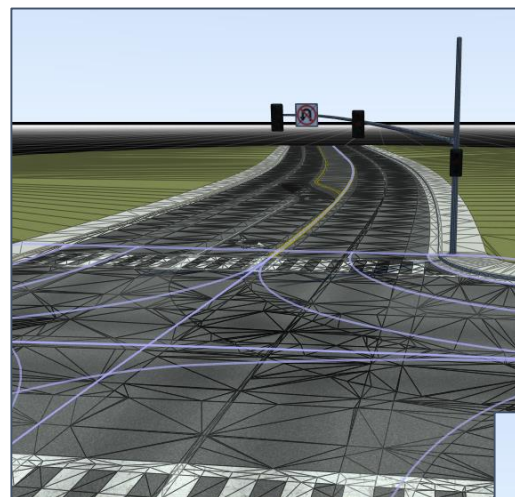
[Asset Library](#)

RoadRunner™ Asset Library

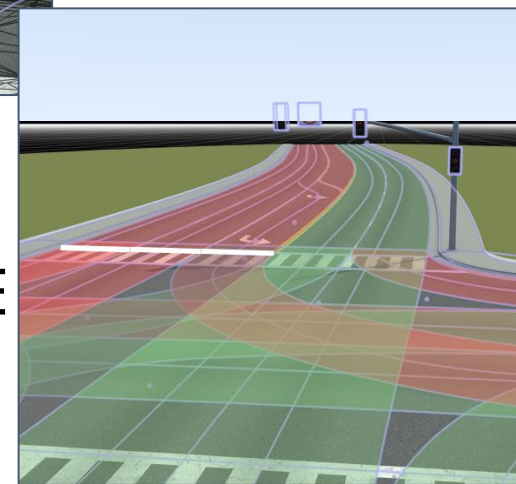
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导出场景到各种文件格式和自动驾驶仿真软件

- 导出常用的文件格式，用于各种第三方应用程序
 - Filmbox (.fbx), OpenDRIVE (.xodr)
 - Unreal Engine®, CARLA
 - Unity®, LGSVL
 - VIRES Virtual Test Drive, Metamoto
 - IPG Carmaker, Cognata, Baidu Apollo
 - Tesis Dynaware, TaSS PreScan
 - Universal Scene Description (USD)



FBX
(3D网格)



OpenDRIVE
(道路语义)

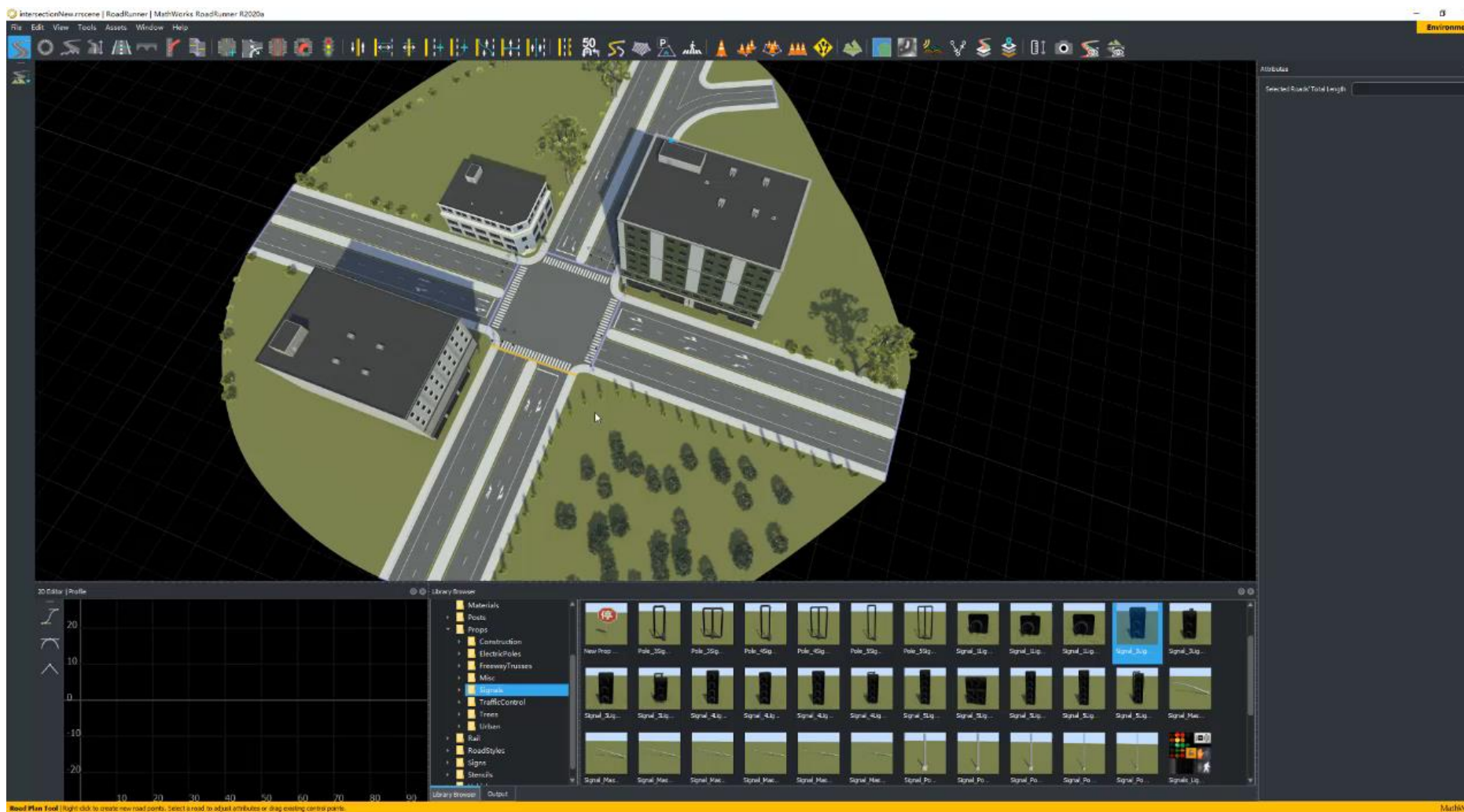
[Exporting](#)

RoadRunner™

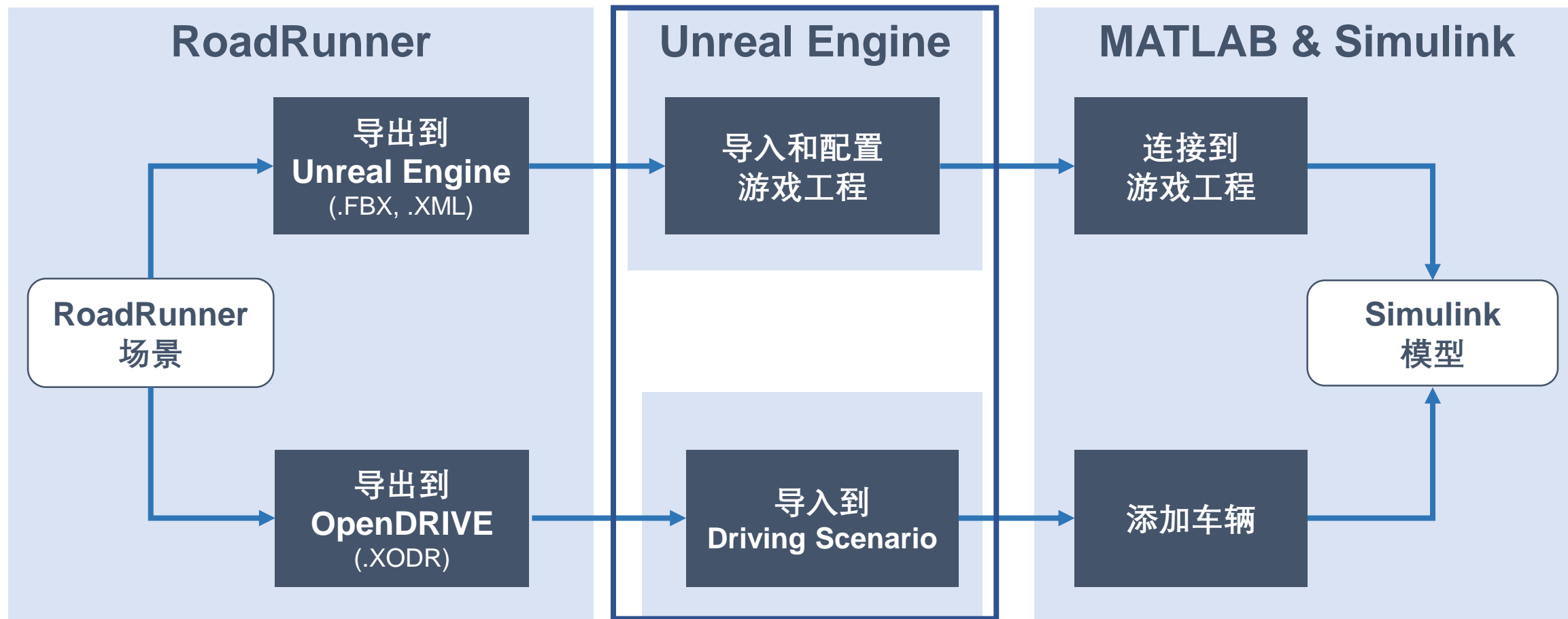
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Update 1

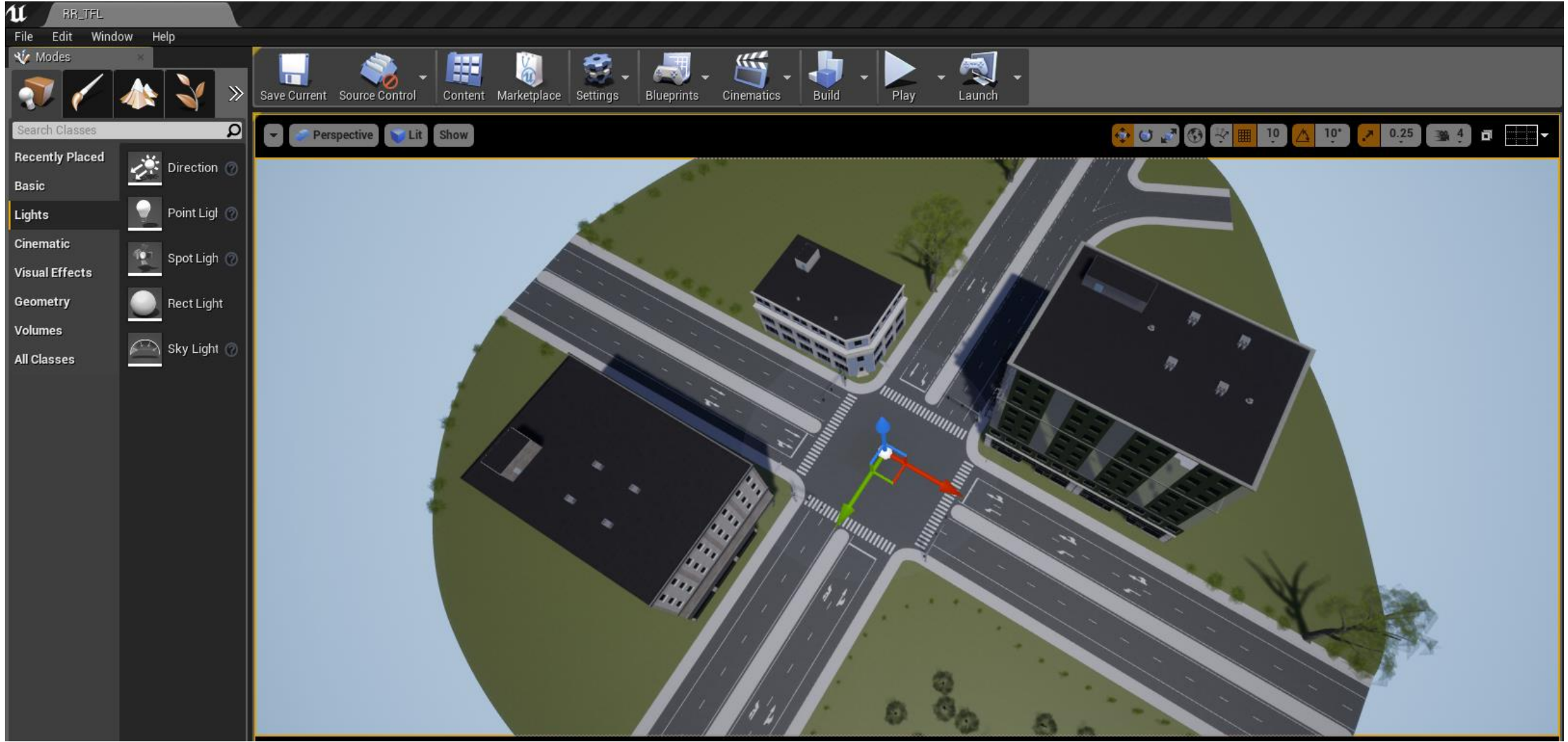
RoadRunner创建3D交通路口场景



将RoadRunner集成到MATLAB和Simulink的工作流程

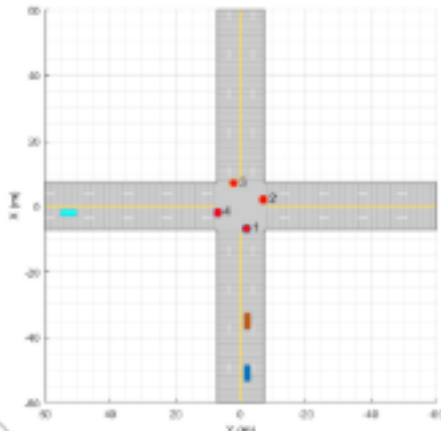


将RoadRunner导出到Unreal Engine



总结： 交通路口车辆控制及场景仿真

Cuboid

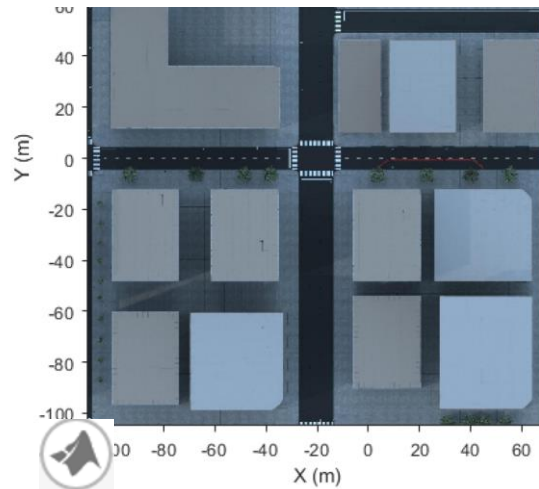


Traffic Light Negotiation

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UE4 3D



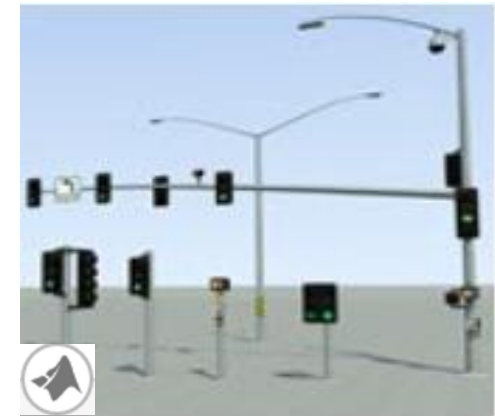
Traffic Light Negotiation with Unreal Engine Visualization

Automated Driving Toolbox™

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R2020b

RoadRunner



Traffic Signal Assets

RoadRunner™

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- RoadRunner工作流程

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