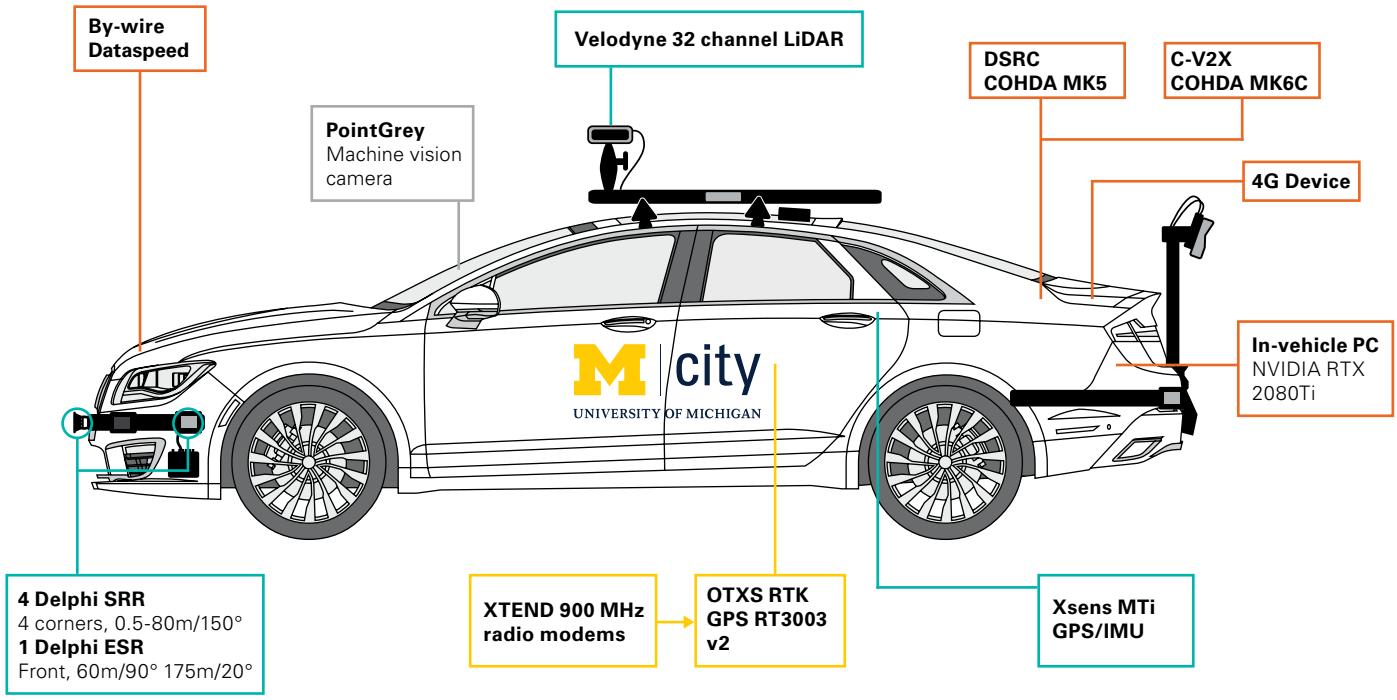
Lincoln MKZ 2017
Vehicle Features

The Mcity Test Facility's Lincoln MKZs are set up with a distributed computing framework. Using a PC and an Ethernet cable, each individual user or group can communicate with the vehicles' sensors and actuators via ROS middleware. The vehicles operates on Linux.

Additionally, the vehicles are designed to be flexible. Mcity Test Facility users can add their own hardware for testing and research.



VEHICLE CAPABILITIES

- Motion control
- Lane keeping control
- Decision making
- Path planning
- Challenge vehicle for testing
- Data collection

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Hardware

1. Dataspeed By-Wire Control
   Function: apply the electronic control of the vehicle's brake, throttle, steering, and shifting for autonomous vehicle applications. With the ROS driver, we can publish specific ROS messages to control the vehicle's brake, throttle, steering, and shifting.

2. GNSS (Oxford RT3000 v2)
   Function: provide high-accuracy GPS position, heading, velocity, etc. of the vehicle. The RTCM signal obtained from the Internet is fed to the RTK receiver through a serial port to improve the accuracy and reliability of real-time positioning. With the ROS driver, we can subscribe to the ROS messages containing the GPS position, heading, velocity, etc., of the vehicle. More information can be found here.

3. Cohda Wireless MK5 OBU
   Function: provide vehicle-to-vehicle and vehicle-to-infrastructure communications. Note that even though it is an OBU, we installed with an RSU image because the Immediate forwarding (IMF) function is only supported by functions of RSU. Both IMF and WAVE Short Message forwarding (WSMF) can be configured for any type of message communication defined in SAE J2735_201603. In the Mcity CAV platform, BSMs can be subscribed to and published through a ROS node.

4. LiDAR (Velodyne Ultra Puck VLP-32C)
   Function: provides a full 360-degree environmental view of real-time 3D point cloud data The LiDAR data can be subscribed to with the ROS driver. More information can be found here.

5. Pointgrey Camera (Blackfly BFLY-PGE-20E4C)
   Function: provide the front view of the vehicle for perception or other purposes. The raw images can be subscribed to through the ROS driver. More information can be found here.

6. 4G Device
   Function: provide Internet access for all onboard devices.

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Software

1. Vehicle Platform
   The Vehicle Platform is developed based on Autoware.AI, which is an open-source full-stack autonomous driving system. It is composed of four modules, i.e., localization, detection, planning, and control.
   1. Localization module is aimed to determine the position of the ego vehicle in the local coordinate given the GPS position.
   2. Detection module will process the information of background vehicles and other road users such as pedestrians, and the information from the infrastructures.
   3. With the ego and surrounding information, the Planning module will plan the shortest route from the origin to the destination and the optimal local trajectory based on the detection result.
   4. Control module can apply the specific PID algorithm to calculate the real-time control commands, including the throttle, brake, and steering angle of the ego vehicle, so that the ego vehicle can follow the optimal local path.

2. Simulation Platform
   The Simulation Platform provides a microscopic simulation environment based on SUMO with the developed Naturalistic Driving Environment (NDE) and Naturalistic and Adversarial Driving Environment (NADE) for the purpose of AV testing.
   1. APIs are developed to control vehicles, other road users, and traffic signals in the SUMO simulator, and retrieve their information.
   2. Some safety metric algorithms are implemented to help researchers analyze the simulation results.
   3. NDE is constructed through a data-driven algorithm to accurately test the safety performance of autonomous driving systems.
   4. To improve the testing efficiency, NADE is developed by injecting adversarial behaviors into the NDE based on the importance sampling theory.

3. Mixed Reality Platform
   Function: transfer information between the simulation and the real vehicle through ROS messages.
   1. To realize Augmented Reality, the virtual vehicles will be rendered on the raw image obtained from the dashboard camera.

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Software

2. Mixed-Reality Platform is also responsible for transferring the proxy objects' states to both the Simulation Platform and the Vehicle Platform and publishing the triggering signal for the proxy pedestrian to Mcity-OS.
3. Mixed Reality Platform will publish the simulated background vehicles' states to the Vehicle Platform and publish the ego vehicle's states and the real traffic signal information to the Simulation Platform.

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