**Questions to discuss with CARLA support team**

1. We are spending significant time simply waiting for load screens (hours a day). How can we load CARLA more quickly, and run the simulations faster? On our computer, even one of our simple scenarios takes 5 mins to launch. The default scenario (town) can take 20 minutes to load on our best computer, and 2 hours on our worst. We need to test thousands of scenarios.
2. Can CARLA be run faster than wall time? We are concerned about simulations that may take tens of minutes for each scenario.
3. Can we initialize the vehicle at a specific condition, such as we don’t have to let it fall onto the ground before it starts to drive? Can vehicles be initialized at a non-zero speed? The time to initialize the vehicle in the simulation, and the run-in area into the simulated work zone, tie up significant additional time.
4. Is there some means to verify that the imported and exported data match for the purpose of securing data quality, other than to use the vehicle’s sensor’s feed?
5. What tools exist to create specialized object definitions within CARLA, such as specialized coatings that match our field measurements?

**More specific questions related to these goals:**

1. Is there a way to export the truth of object positions, lane markers etc. out of CARLA? We are trying to verify the object positions, lane marker definitions, road geometry etc. that are used by CARLA match the measurements we are trying to import. One way we are thinking is to run a simulated mapping vehicle in CARLA. We are wondering whether there is any easier solution?
2. We would like to know whether there is any down-sampling of the real data when imported into CARLA. For example, in our real data, we can achieve GPS data to centimeter level accuracy or even better, and in other projects we have road definition meshes of 2 cm square. We do not think that CARLA can support this resolution. When fine data is imported into CARLA, are there any down-sampling happening, due to reasons such as optimizing memory usage or resolution limits on data size (for example, using a single or double representation)?
3. What coordinate system is used in CARLA? Is appears to be ENU. Conversion from LLA to ENU will introduce small errors that may be visible in our data analysis, so we want to import the correct native format.
4. **Goal:** to convert mapping data of real world into maps that can be used in CARLA

**Background information about PSU mapping data:**

PSU mapping vehicle is instrumented with following sensors that can collect corresponding data: GPS (measures vehicle's position); IMU (measures rotation rate and acceleration of the vehicle); cameras (collect images of surrounding environment); wheel encoders (measure angular position of the tire); road wheel angle string potentiometers (measures steering wheel position) and LiDAR (measures the reflectivity and distance for a laser to strike surrounding surfaces and reflecting back). For details, see https://connectedvehicles.psu.edu/.

**Questions related to this goal:**

1. **Is there a tool to validate xodr files and show which errors are occurring during import?** We have files that pass the xodr check on ASAM website, and can be viewed using xodr online viewers (<https://odrviewer.io/>) or in MATLAB driving scenario designer, but cannot be imported into CARLA.
2. **What is the largest environment suggested to be import**? For example, we may have work zones that span many miles on a highway. (Note the largest CARLA built-in map, Town10, is just a few blocks.)
3. **Do you have tools that automatically do the following?**
   1. How to convert the elevation data, into elevation of roads in CARLA?
   2. How to convert the lane markers of roads from real world into lane markers in CARLA?
   3. How to create a user-defined object with a given image and sensor properties, such as reflectivity?
   4. How to texture the road surfaces with our own images of the road?
   5. How to create the surrounding environment, such as buildings, mountains, into these entities in CARLA?
4. **Goal:** to define the data elements in CARLA.

**Questions related to this goal:**

**What are the full data element definitions used by CARLA for the following, and where is the documentation?**

1. **Road surface**
2. **Objects**
3. **Buildings**

We would like to make sure that we collect enough data to build a digital twin of the real world in CARLA. To approach this, we need to know the definition of the data elements in CARLA. For example, to build a road in CARLA, what data we need to collect, such as road material, lane markers, lane width, speed limit and so forth? This work can be easy when the road is created in Roadrunner then imported into CARLA. However when it is created from real world data, it becomes complicated. Thus we would like to carefully define the data elements and collect them accordingly using corresponding sensors.

1. **Goal:** to automate the map import process, and dynamically update the map in CARLA without completely rebuilding the map

**Questions related to this goal:**

1. **To create different scenarios, what is the suggested strategy?** To treat all objects as movable, or create multiple environments of fixed objects?
2. **If we are doing many fixed objects, how to script the creation of an environment to create permutations of object locations for testing?** If we build an environment, and we want to move the objects randomly thus to create variations of the environments, what is the best way to do that?
3. **If we are doing many moving objects,** we would like to know whether there is a way to script the process of data import. Specifically, once we get the data out of our mapping vehicle, how to automate the process that we can be turn-key ready to import real world data into CARLA?
4. **Goal:** to figure out the best CARLA configuration to work with CARLA support team.

**Questions related to this goal:**

Currently PSU team has two versions of CARLA setup. One running CARLA 0.9.12 on Ubuntu 18.04, another on running CARLA 0.9.13 (the latest version) on Ubuntu 18.04, and we are open to run other versions. We would like to know what the best version is to work with CARLA support team.

1. **Goal:** to figure out the best SUMO configuration to work with CARLA support team.

**Questions related to this goal:**

PSU team is preparing for co-simulation between CARLA and SUMO. The latest SUMO release is version 1.13.0, and we would like to confirm whether this is the best version to work with CARLA support team.

1. **How do you suggest we do co-simulation**? This is how we are planning to do it: bridging CARLA and sumo, run a car-following model in SUMO. Does it automatically command the vehicles in CARLA, when bridged?

Follow-ups:

Find out how to run MOSAIC tool (FHWA), which integrates with CARLA (Cars Learning to Act) and SUMO (Simulation of Urban Mobility). Multidomain and multiscale simulation framework for automated and connected mobility scenarios.

NS-3 allows sim of communication layers – open-source software network simulator for Internet systems.

Using Intel CARMA Platform stack, same as used in physical vehicles

CARMA-streets – this is the integration from V2I for roadside platforms. This is the same software stack as used for intersection controllers, for example (traffic signal controllers, DMS signs, RSUs).

VOICES are another project that platforms distributed testing. Connects DoD resource (DINA) for distributed testing for xil framework for Cooperative Driving Automation testing. Enables distributed testing across locations.

MOSAIC replaces the SUMO support to enable additional simulators in the future. Goal is build it ourselves. It is open-source, and can download for integration into our models. It was developed by Eclipse.

They have a co-simulation tool (See Zhitong Huang)

HD map – many changes and corrections – conversion to SUMO not clear. They do everything in Roadrunner.

They have a simulation technical group that use similar tools, that meet to go through questions quarterly. If someone finds solutions, they let everyone know.

For co-simulation, they want to find potential partners to test the tools. They also contacted CARLA with issues and didn’t receive a response.

Usdot-carma.atlassian.net/wiki/spaces/CRMSIM/overview

<https://usdot-carma.atlassian.net/wiki/spaces/CRMSIM/pages/1037598796/Documentation+Resources>

They have the docker interface, and suggest that we do the same. They use 18.04 and 20.04 LTS.

Do they have funding they know of support the development of the toolset? Do they have any vehicle components in the co-simulation tools?

They are looking for partners for research for research. Their goal is adoption and in industry standardization / usage. Need state DOTs for deployment – this is where they want to move?

USDOT moving toward creation of technologies for creation of MUTUC for transportation research.

CARMA has a fleet of Avs, is this the same group? Yes, these vehicles are 20 feet away. Goal is cooperative driving automation or freeways and artials.

See Kyle Rush for CARMA project details. They need to develop the CDA simulations, such as scripting to test scenarios.

Email Safak Ercisili. FHWA wants them to reach out to work with partners for collaborative software development to improve the simulations and co-sim tools,