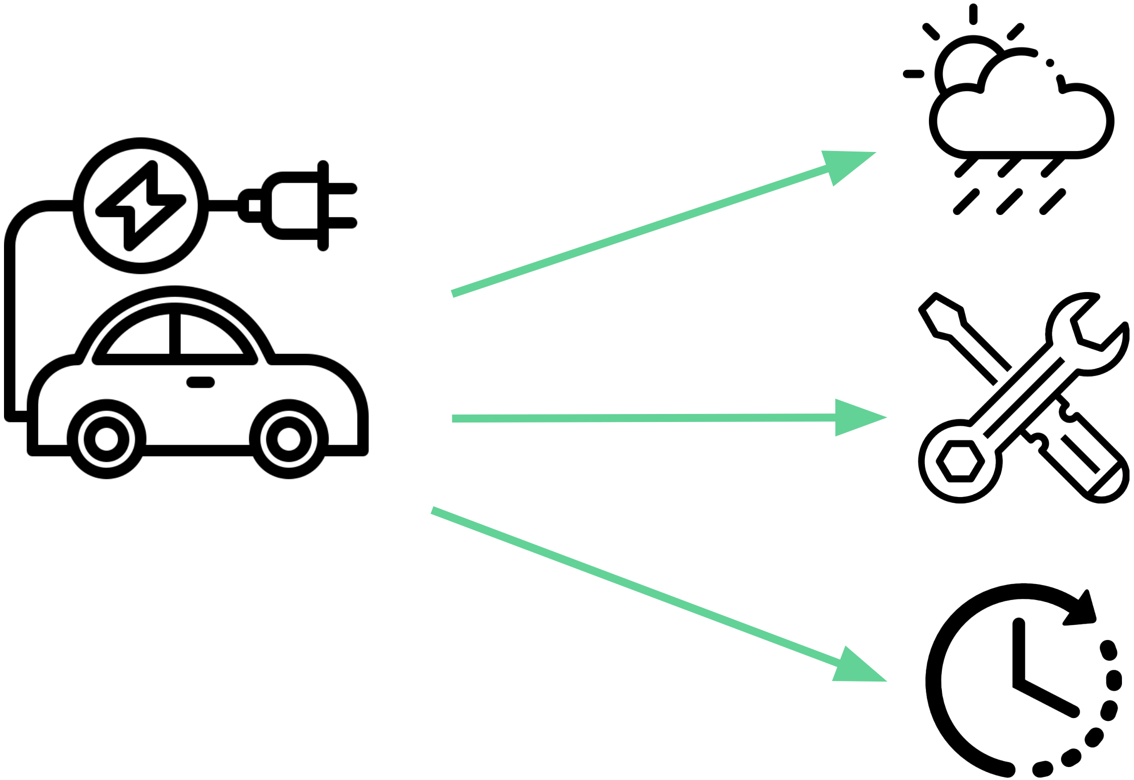
ME599 Simulation Workshop

CARLA, ROS and Docker

By: Urban Pistek

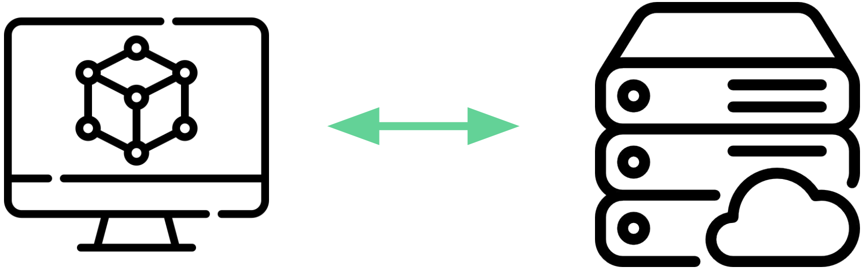
Background: Vehicle Software Development



Background: Vehicle Software Development

Need: Develop and test software without conflicting with rest of the team, in a controlled environment.

Solution: Leverage simulation and software tools to automate testing and parallelize development.



Background: Software & Simulation Tools

Solution: Leverage simulation and software tools to automate testing and parallelize development.

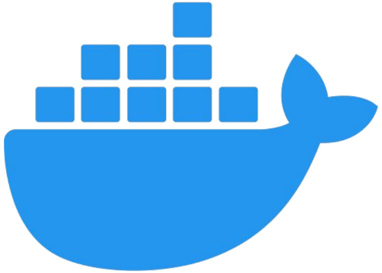
CARLA

ROS

foxglove

Simulation: Docker

Docker: A software platform that allows developers to easily create, deploy, and run applications in a virtual environment called a container.



Portability: Docker containers are platform-agnostic

Efficiency: Lightweight and use fewer resources than traditional virtual machines

Consistency: Built from a set of instructions called a Dockerfile, which ensures that the application is built and deployed in a consistent and repeatable way

Isolation: Docker containers provide a level of isolation between the application and the host system

Scalability: Docker makes it easy to scale applications horizontally by running multiple instances of the same container across multiple machines

Simulation: CARLA

CARLA: An open-source simulation platform designed for testing and developing autonomous driving systems.

Semi-Realistic Environment: Realistic and configurable simulation environment that includes realistic physics, weather conditions, and a range of urban and suburban scenarios

Safe & Cost-Effective Testing: Test autonomous driving algorithms and systems in a safe and controlled environment, without the need for real-world testing

Sensor Simulation: Supports lidar, radar, and cameras

Open-source & Extensible: Open-source platform, which means it can be customized and extended to meet the specific needs of individual developers and research teams

Simulation: ROS

ROS: ROS (Robot Operating System) is an open-source framework for building and programming robots

Modularity: Easy to reuse code and build on existing components

Flexibility: Supports a wide range of hardware and software platforms

Large Community: Active community of developers, researchers, and users

Rich set of tools and libraries: Visualization tools, simulation environments, and software libraries

Open-source & Extensible: Open-source, which means it can be customized and extended to meet the specific needs of individual developers and research teams

Simulation: Foxglove

Foxglove: Foxglove is an open-source software platform designed to provides a suite of tools & libraries to quickly build robotic systems

foxglove

Simple: Foxglove provides a suite of pre-built tools and libraries that simplify the development of robotic applications

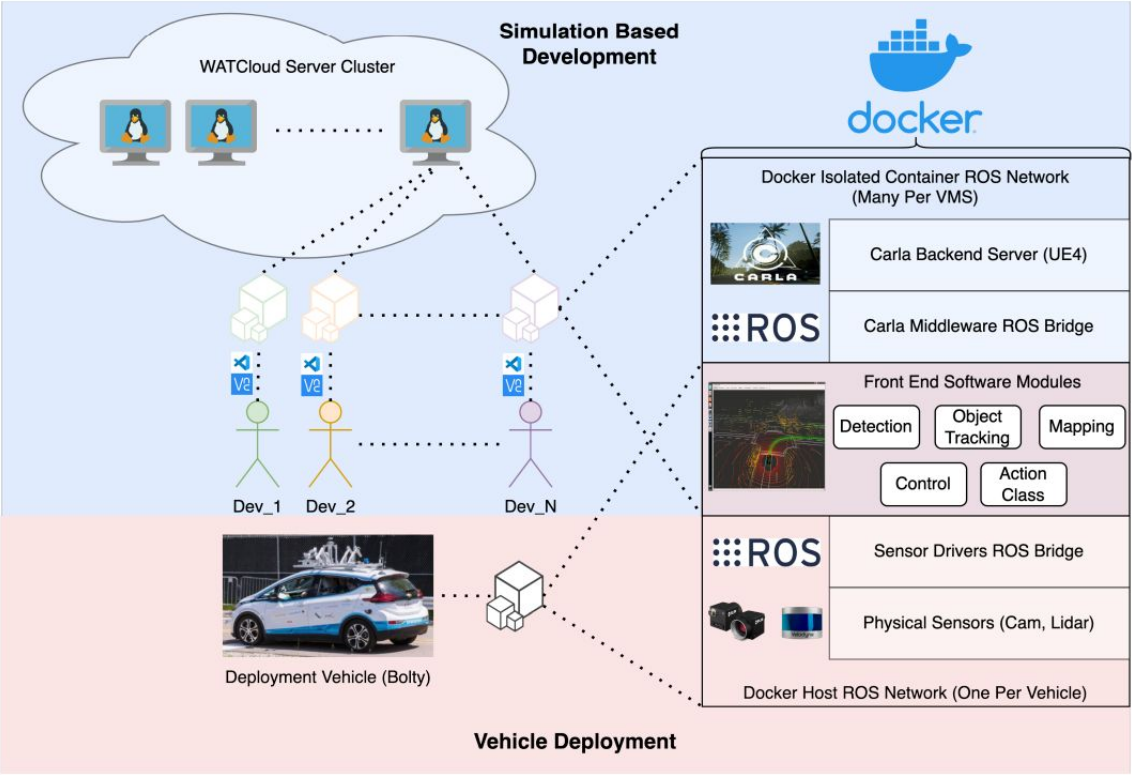
Modular: Foxglove's modular architecture allows users to create custom workflows by combining pre-built components and libraries

Real-Time Monitoring & Control: Foxglove's user interface makes it easy to monitor and control robotic systems in real-time

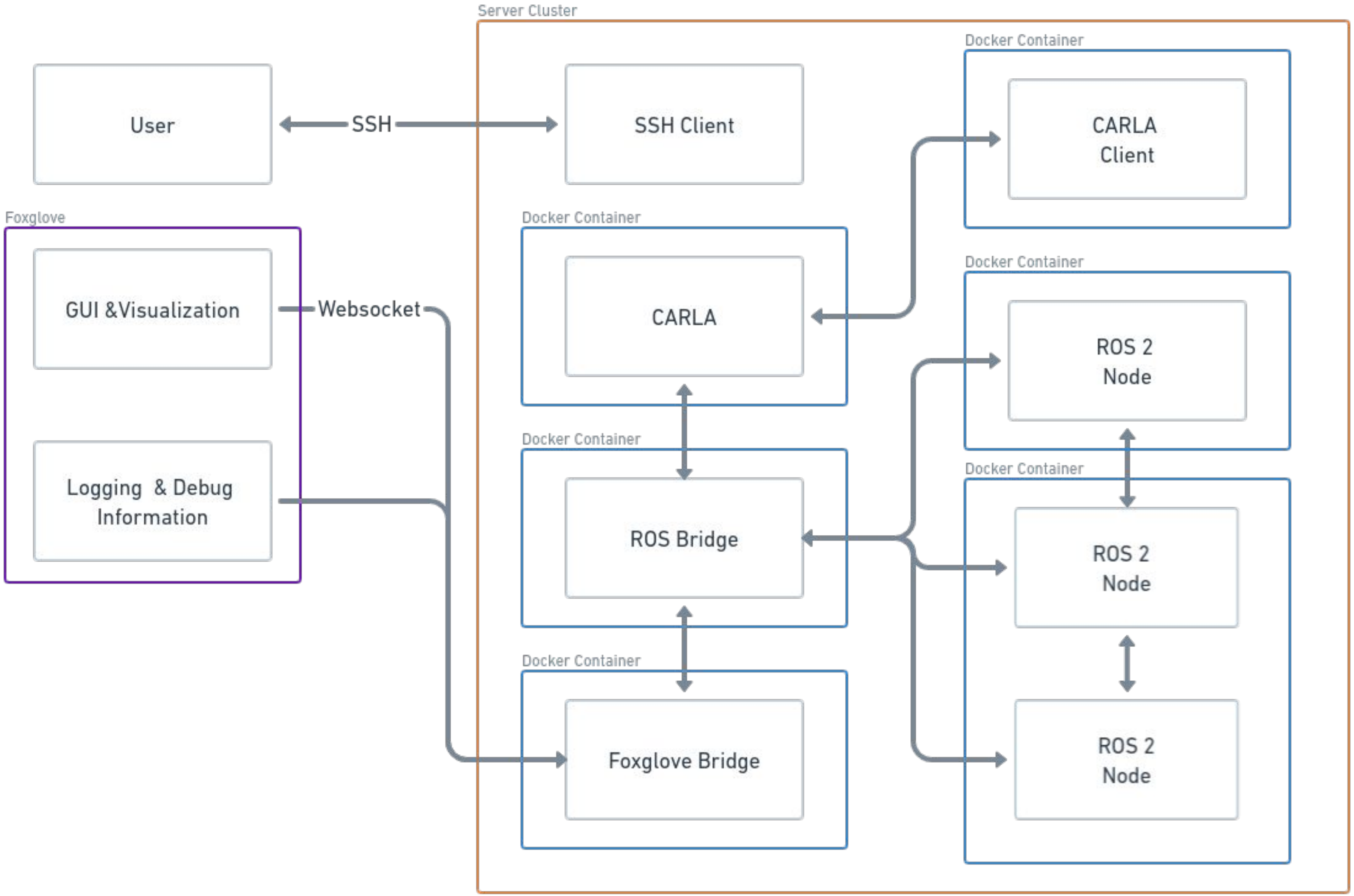
Support: Foxglove supports a wide range of hardware platforms and communication protocols

Open-source & Extensible: Open-source, which means it can be customized and extended to meet the specific needs of individual developers and research teams

Simulation: Architecture


WATCloud Server Cluster
Simulation Based Development
docker
Docker Isolated Container ROS Network (Many Per VMS)
CARLA
Carla Backend Server (UE4)
ROS
Carla Middleware ROS Bridge
Front End Software Modules
Detection
Object Tracking
Mapping
Control
Action Class
Dev_1
Dev_2
Dev_N
Deployment Vehicle (Bolty)
ROS
Sensor Drivers ROS Bridge
Physical Sensors (Cam, Lidar)
Docker Host ROS Network (One Per Vehicle)
Vehicle Deployment

[1] WATonomous Software Architecture and Data Pipeline


Server Cluster
User
SSH
SSH Client
Docker Container
CARLA Client
Foxglove
GUI &Visualization
Websocket
Docker Container
CARLA
Docker Container
ROS 2 Node
Logging & Debug Information
Docker Container
ROS Bridge
Docker Container
ROS 2 Node
ROS 2 Node
Docker Container
Foxglove Bridge

Workshop Outline:

1. Docker Overview
2. Docker Compose Overview
3. ROS with Docker
4. CARLA with Docker
5. Foxglove Overview
6. Running the simulation stack locally
7. Watonomous Server Cluster
8. Running the simulation stack from the server