



భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
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ITS Use Case Visualization Toolkit

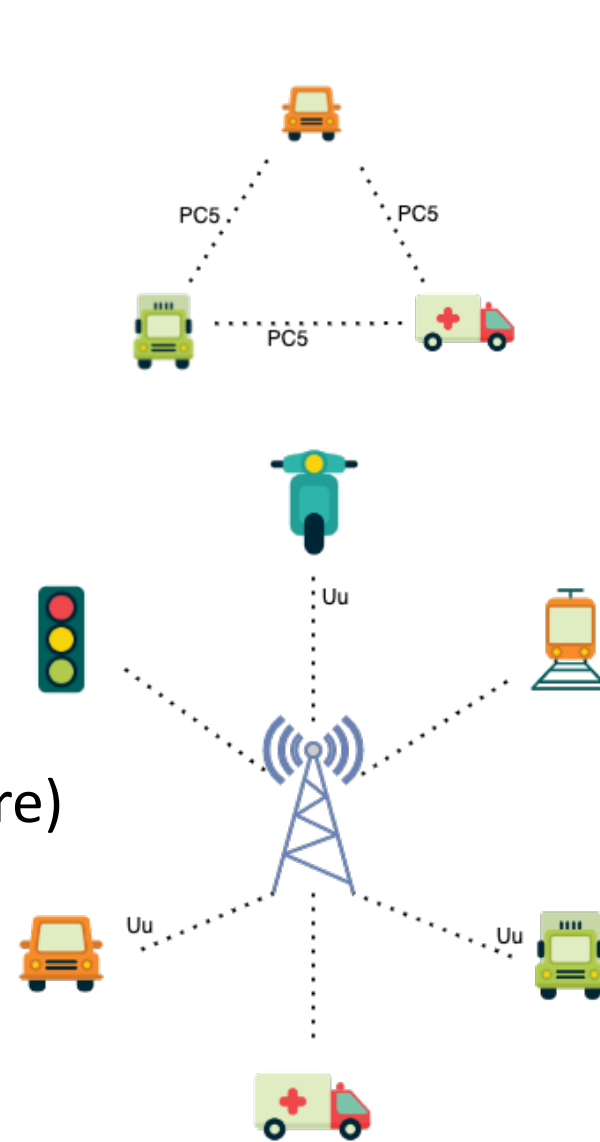
Integration of SUMO & OAI RAN on a 5G Testbed

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Introduction: C-V2X

- Short Range Communication
 - Direct V2V or V2I Communication
 - Implemented over PC5 Interface
 - Network Assisted or Unassisted
- Long Range Communication
 - V2N2X (X - Vehicle, Person, Infrastructure)
 - Implemented over Uu Interface in 5G

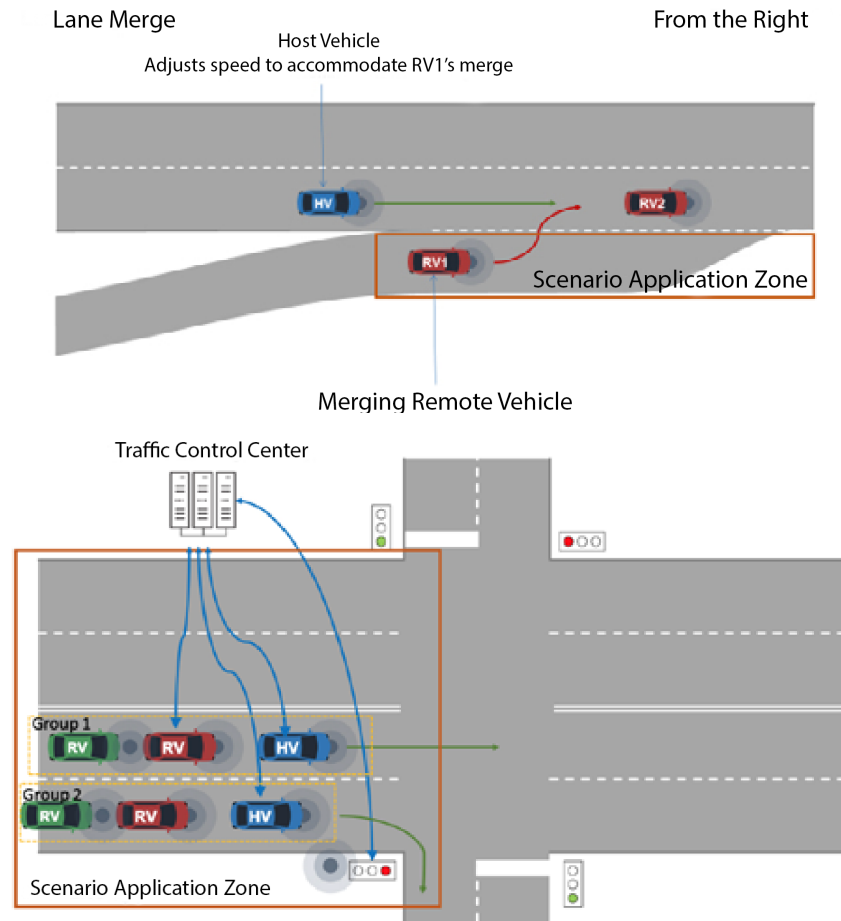


Introduction: ITS Use Cases



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- Safety
 - Cooperative Traffic Gap
 - Interactive VRU Crossing
 - Accident Report
- Vehicle Operations Management
- Convenience
 - Cooperative Curbside Management
 - Obstructed View Assist
- Autonomous Driving
 - Collision Avoidance
 - Automated Intersection crossing
 - Cooperative Lane Merge
 - HD Map Collecting and Sharing
- Platooning
- Traffic Efficiency and Environmental friendliness



Introduction - SUMO

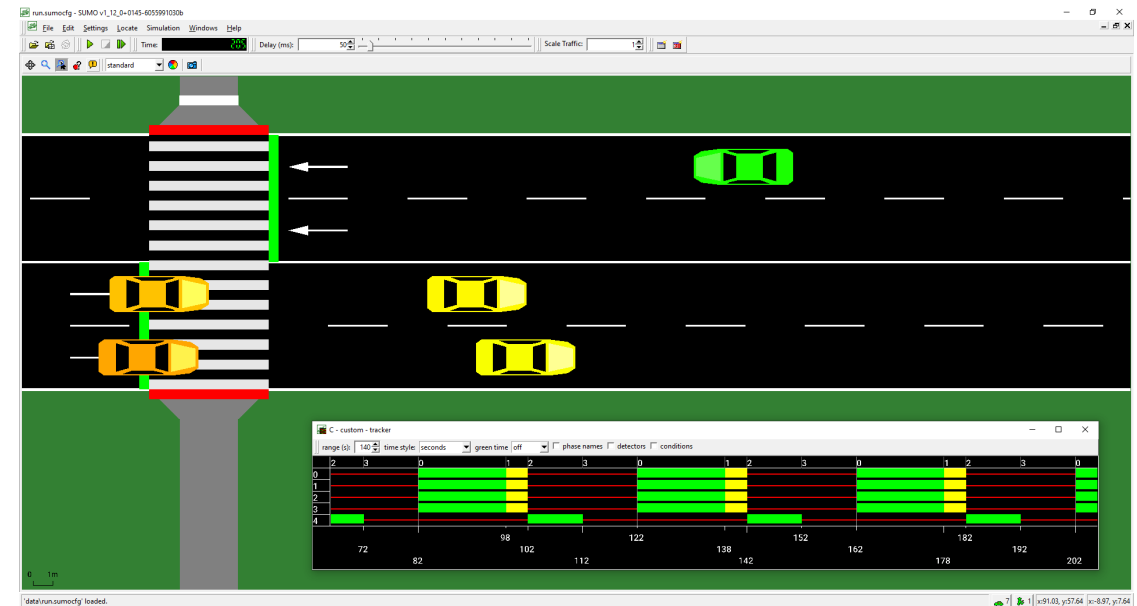
- SUMO - Simulation of Urban Mobility
- Allows large scale traffic simulations
- Traffic visualization tool
- Allows control of every individual object in the simulation (Cars, Buses, Traffic Lights, Pedestrians etc)
- Has support for OMNet++ and NS-3 for C-V2X simulations



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SUMO
SIMULATION OF URBAN MOBILITY





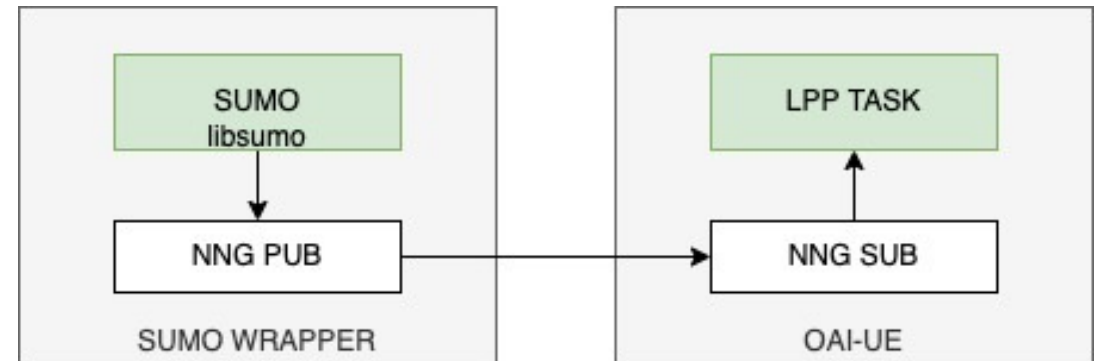
Introduction: LPP

- LTE Positioning Protocol - LPP
- Introduced in 3GPP Rel-9
- Flavors
 - UE Based: UE sends the exact latitude and longitude using GNSS
 - UE Assisted
 - DL-TDOA
 - DL-AoA
 - GNSS-RTK
 - RAN Assisted
 - New protocol NRPPa (NR Positioning Protocol A)
 - Defined in 3GPP Rel-16 to carry location assistance information from RAN to LMF
 - UL-RTOA
 - ULAoA



SUMO & OAI-UE Integration

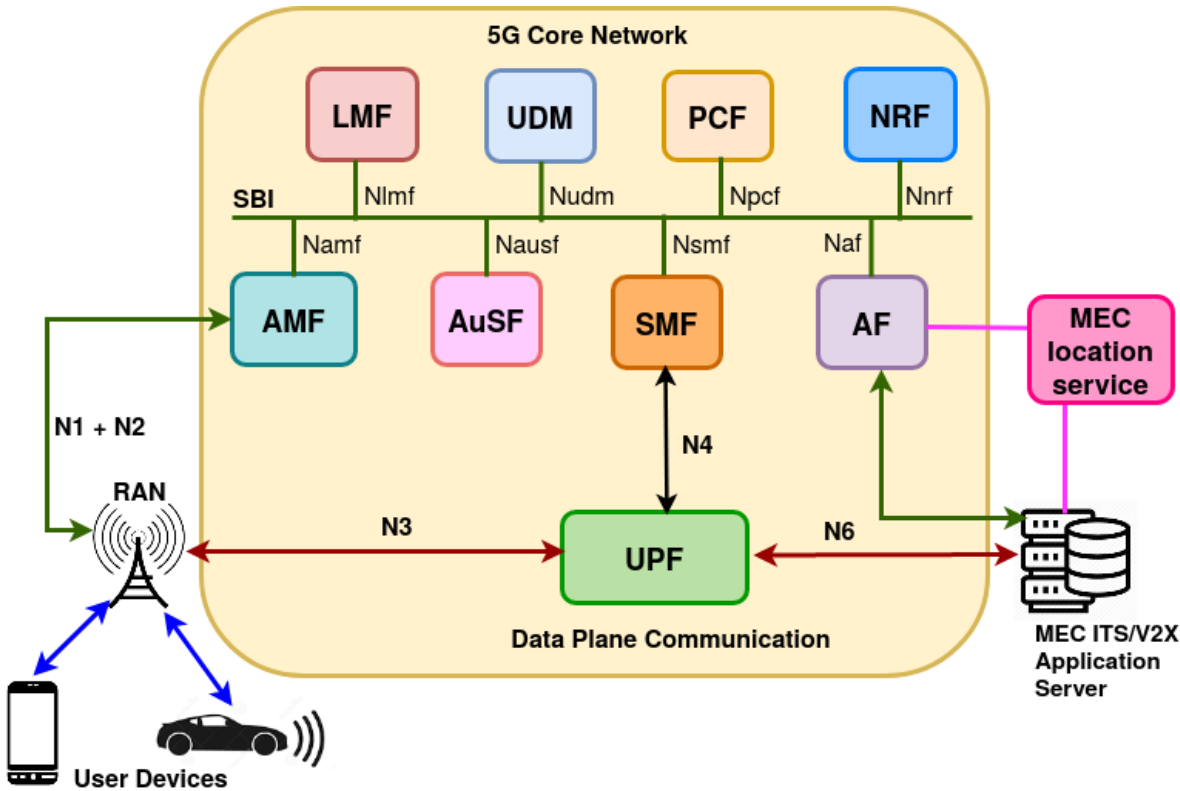
- SUMO provides official Python and C++ APIs
 - libsumo – allows direct interaction with sumo
 - libtraci – allows communication to sumo using client server architecture
 - TraCI - Traffic Control Interface is the protocol used by libtraci



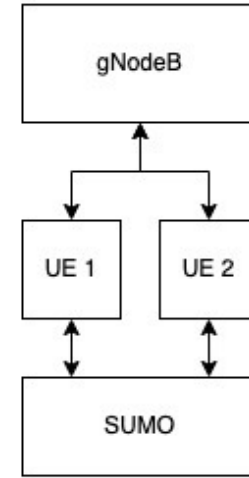
System Overview



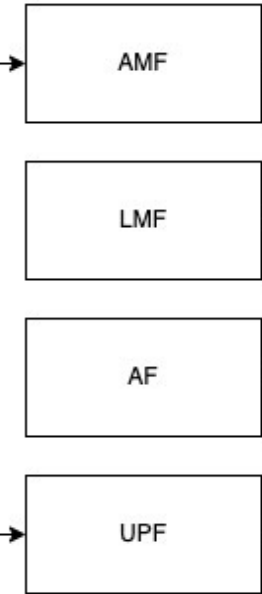
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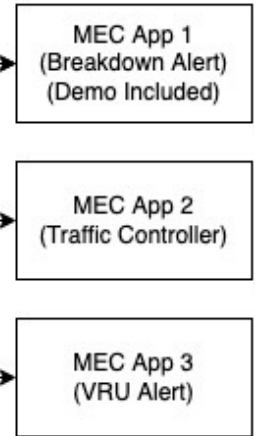
Access Network (OpenAirInterface5G)



Core Network (IITH Core)



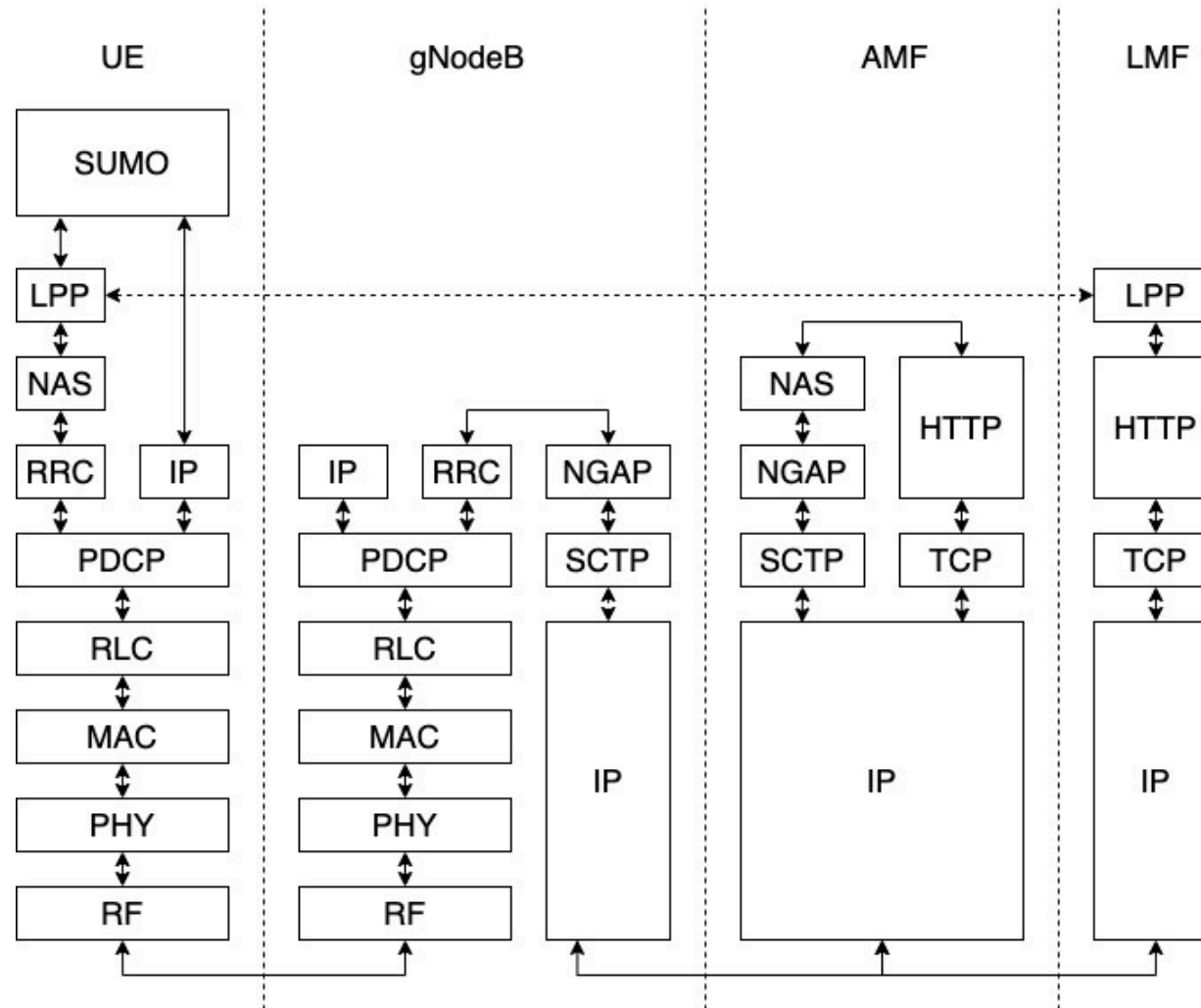
MEC (IITH MEC)



UE Based – LCS - Protocol Stack



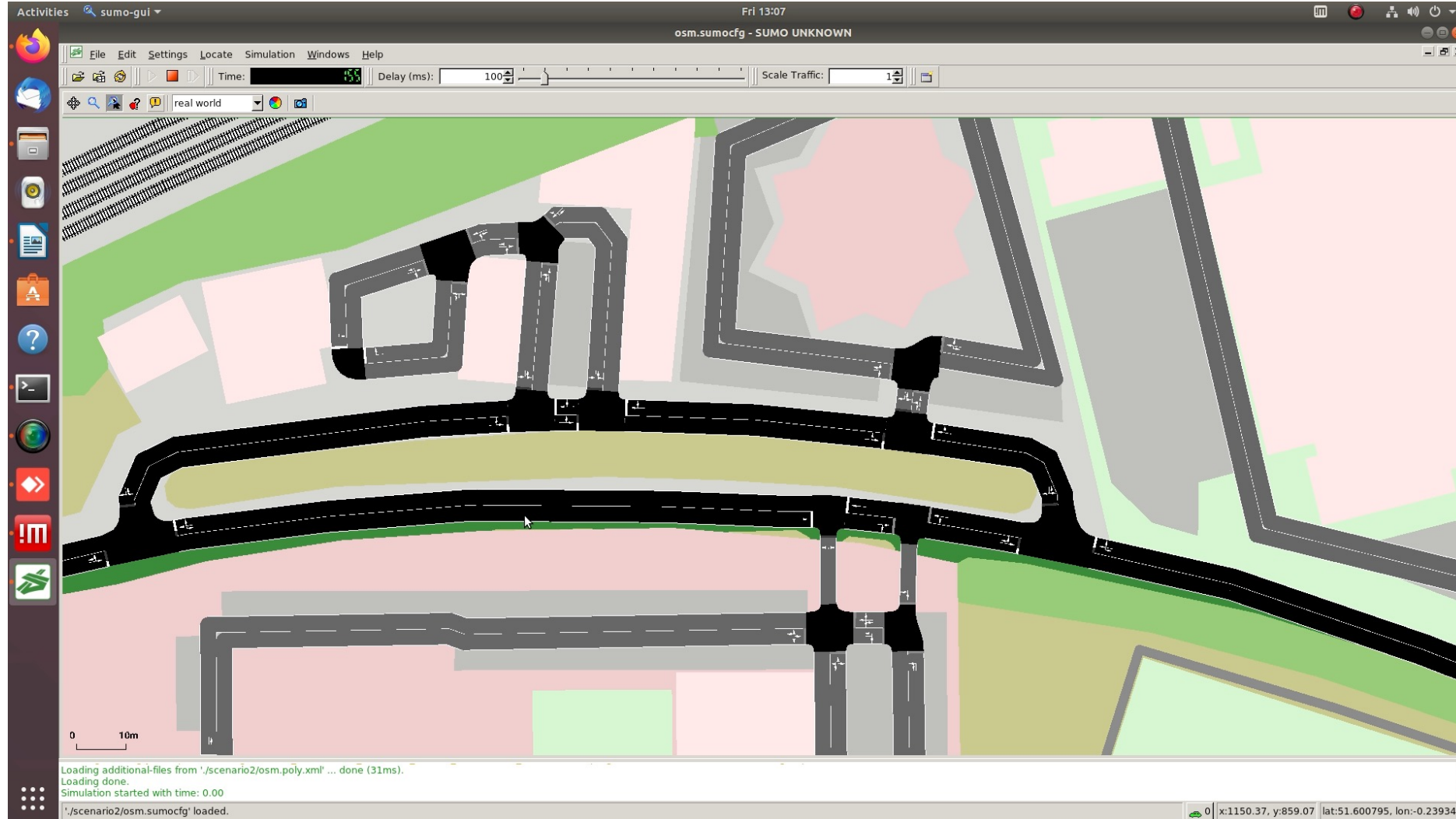
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Demo – Breakdown Alert (Reroute)



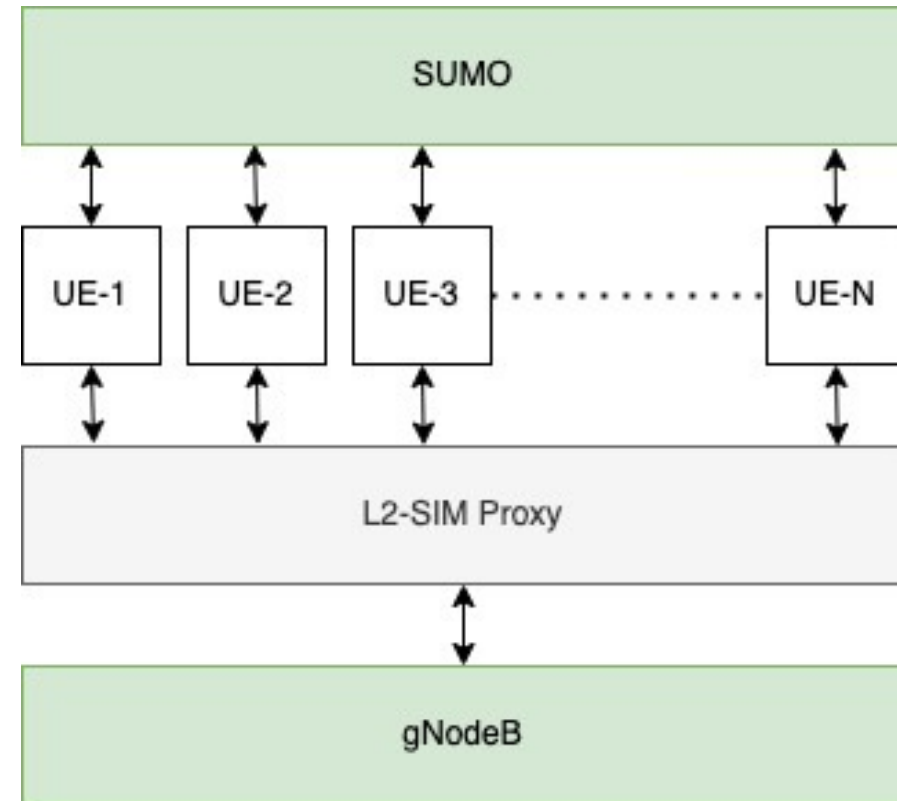
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Current Scalability Limitations

- All vehicles are simulated by a single instance of OAI-UE in RF-SIM or USRP Mode
- While SUMO can scale to thousands of vehicles and NNG can handle this load, this setup does not scale well with one OAI-UE instance
- L2-Simulator is a viable solution for scalable setup once it supports multiple UEs





Future Work

- Using L2 Simulator for large scale simulations with individual OAI-UE node for each traffic node.
- Adding Path Loss model to L2 Simulator.
- Current LPP implementation is UE-Based.
- NRPPa Implementation for RAN assisted Location.
 - E-CID Measurement
 - OTDOA Cell Information



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THANK YOU