

# IPWAVE Basic Protocols Project

## @ IETF-105 Hackathon



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Sungkyunkwan University

# Goal of IPWAVE Basic Protocols Project

## ❖ Implementation of IPv6 Over IEEE 802.11-OCB and IPv6 Vehicular Neighbor Discovery

1. IPv6 over IEEE 802.11-OCB with WAVE Logical Link Layer
2. Vehicular Neighbor Discovery (VND) with Address Registration and Multihop Duplicate Address Detection (DAD)
3. Multihop DAD and UDP/TCP Transmission via Intermediate Vehicles in VANET

# IPWAVE Internet Drafts for Hackathon

- IPv6 over IEEE 802.11-OCB
  - [\*\*draft-ietf-ipwave-ipv6-over-80211ocb-50\*\*](#)
    - Basic Support for IPv6 over IEEE Std 802.11 Networks Operating Outside the Context of a Basic Service Set (IPv6-over-80211-OCB)
- Vehicular Neighbor Discovery
  - [\*\*draft-jeong-ipwave-vehicular-neighbor-discovery-07\*\*](#)
    - Vehicular Neighbor Discovery for IP-Based Vehicular Networks

# IPWAVE Hackathon Project Poster

## IP Wireless Access in Vehicular Environments (IPWAVE) Basic Protocols Project

Champion: Jaehoon Paul Jeong (SKKU)



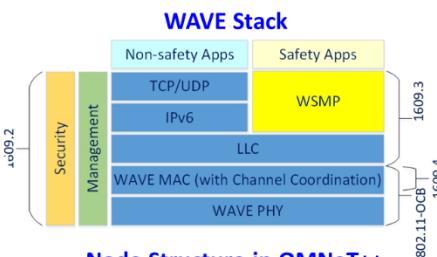
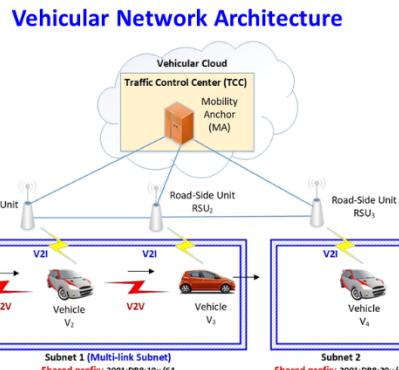
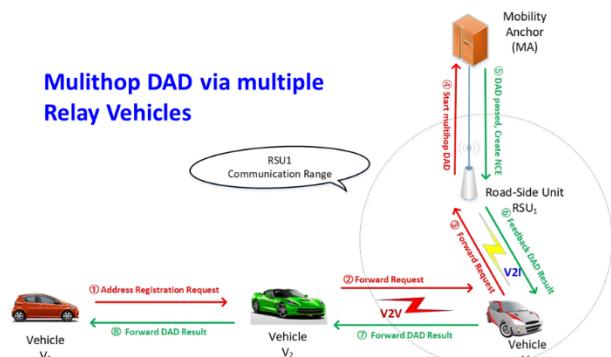
### Professor

- Jaehoon Paul Jeong (SKKU)

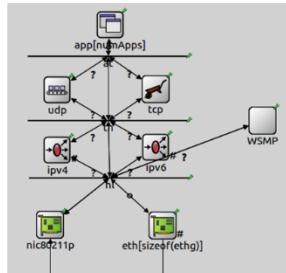
### Students

- Zhong Xiang (SKKU)
- Yiwen Chris Shen (SKKU)
- Haesung Lee (SKKU)

### Mulithop DAD via multiple Relay Vehicles



### Node Structure in OMNeT++



### Objective of this Hackathon

- Demonstrate IPWAVE basic protocols
- Discover technology gaps

### Where to get code

- Github – Source Code
  - ✓ <https://github.com/ipwave-hackathon-ietf>

### Where to get video clip

- Youtube – Demonstration
  - ✓ <https://youtu.be/5OpnYUiLhg>

### What to pull down to set up an environment

- OS: Ubuntu 16.04
- OMNeT++: 5.4.1
- SUMO: 0.32.0
- Veins: 4.7.1
- INET Framework: 4.0.0

### Contents of Implementation

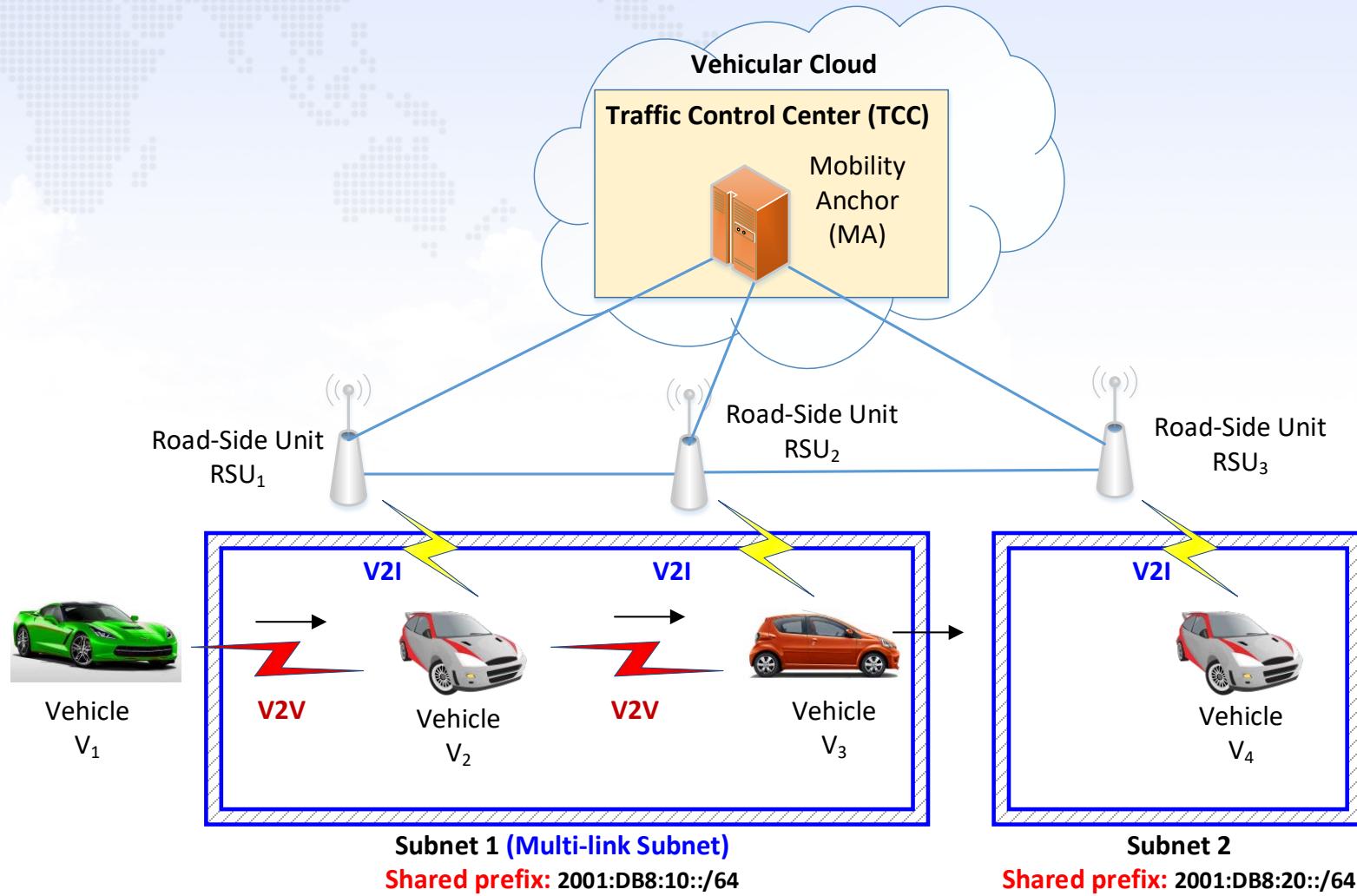
- Transmission of IPv6 Packets over IEEE 802.11-OCB
- IPv6 Neighbor Discovery for IP-Based Vehicular Networks
  - ✓ Address Registration and Duplicate Address Detection Process
  - ✓ Multihop DAD Process via V2V communications
  - ✓ UDP/TCP Transmission via intermediate vehicles
- Build IPv6/TCP/UDP protocol stack based on VEINS-4.7.1 and INET-4.0
- Build a basic IPWAVE running scenario via V2I and V2V based on VEINS-4.7.1 and SUMO-0.32.0

# IPWAVE Hackathon Project Team



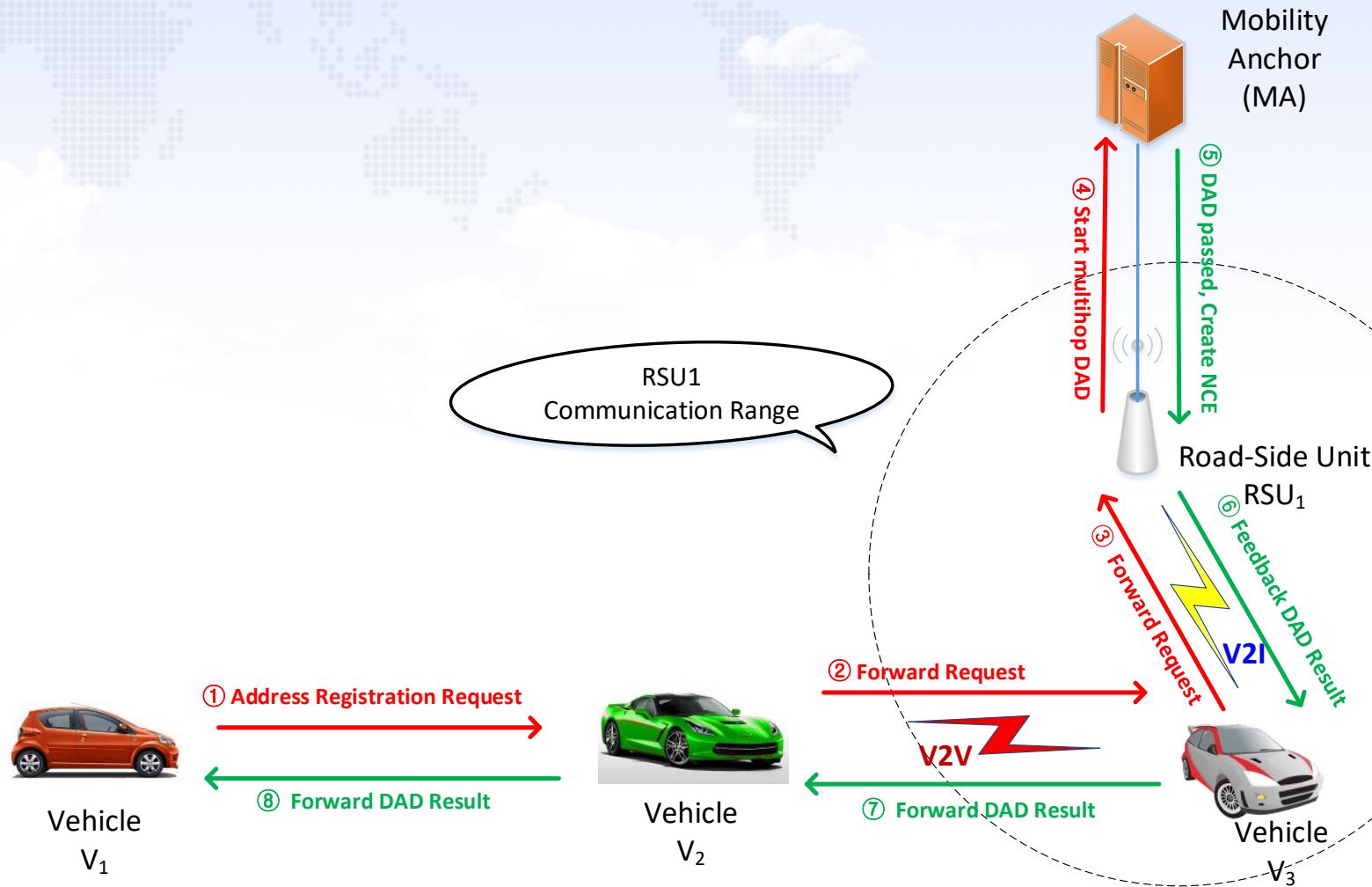
# Vehicular Network Architecture

- Multihop V2X in Vehicular Ad Hoc Networks (VANET)



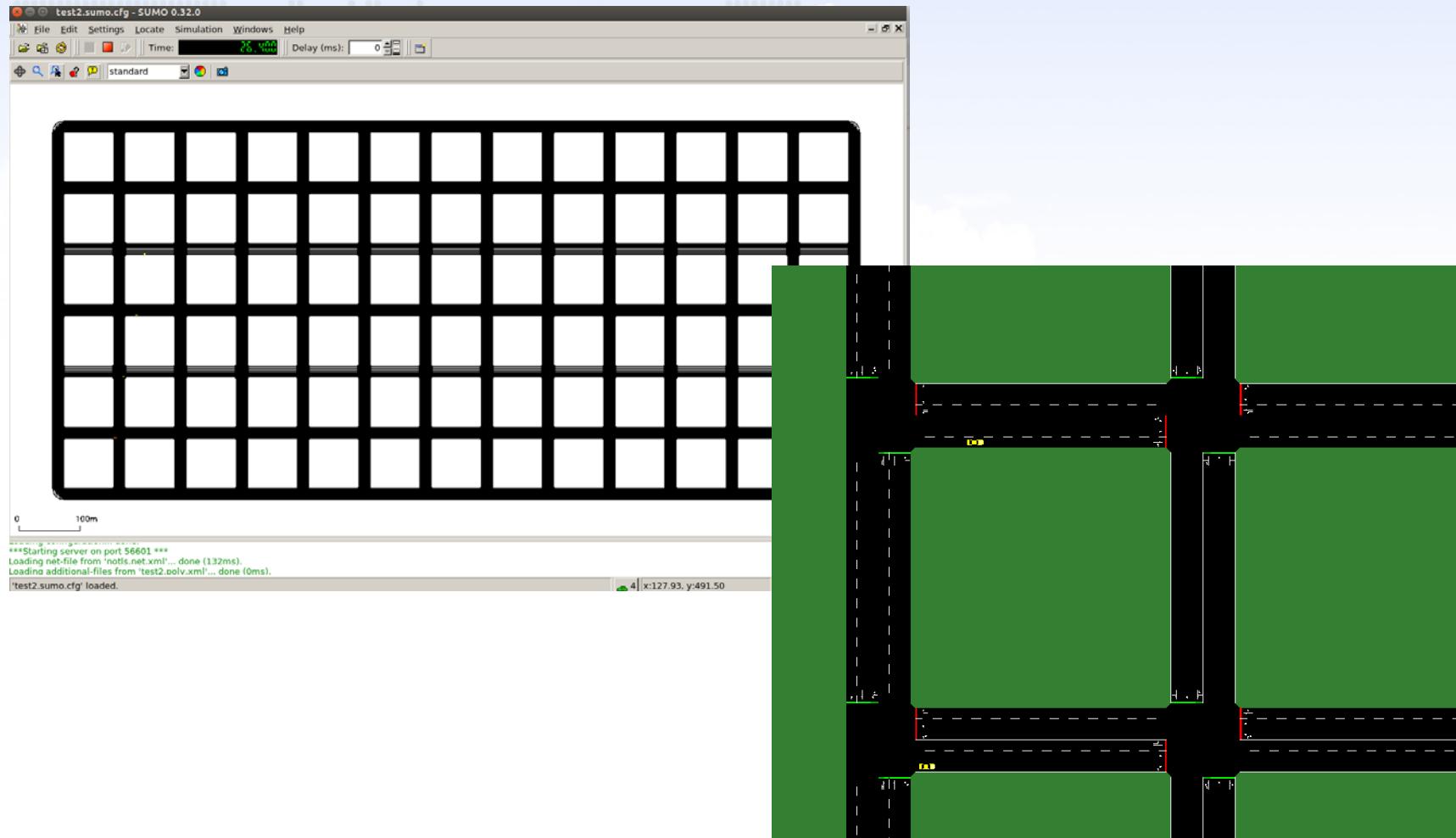
# Vehicular Neighbor Discovery (VND)

- Multihop DAD for IP Address Registration with Intermediate Vehicles in VANET



# Road Network Architecture (1/2)

- ✓ A 14\*7 grid map with 3 lanes for a road network



# Road Network Architecture (2/2)

## ✓ Two RSUs :

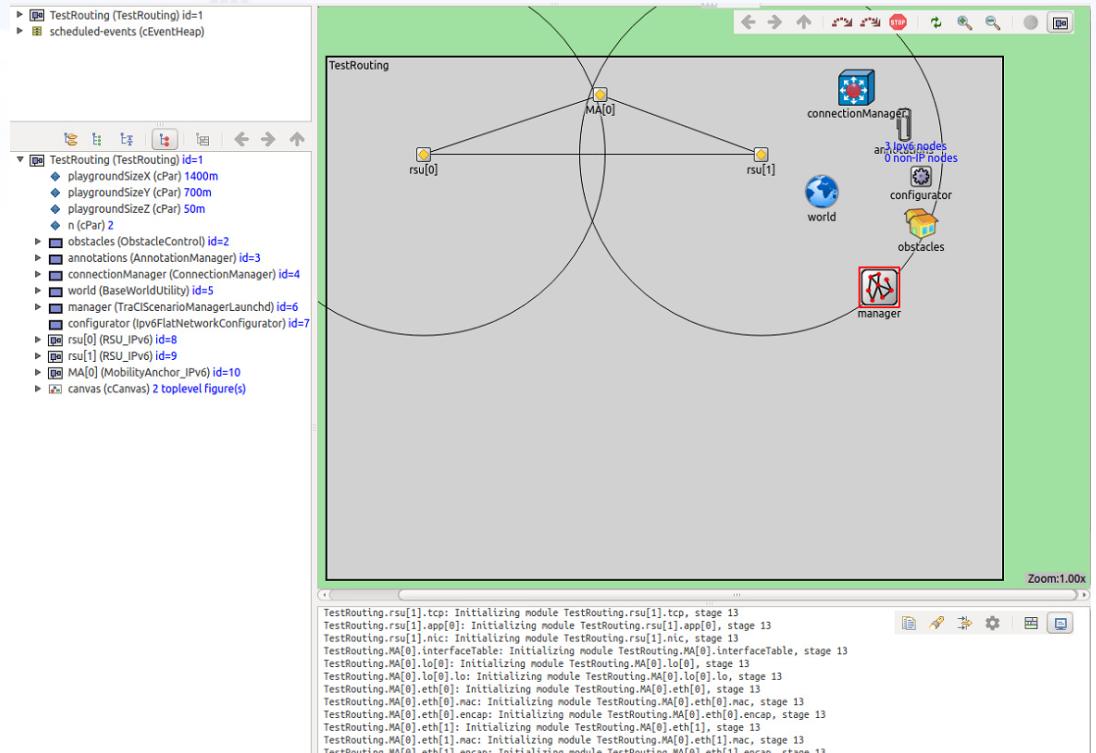
- They belong to one subnet.
- They are connect with each other through Ethernet.

## ✓ Multiple Vehicles :

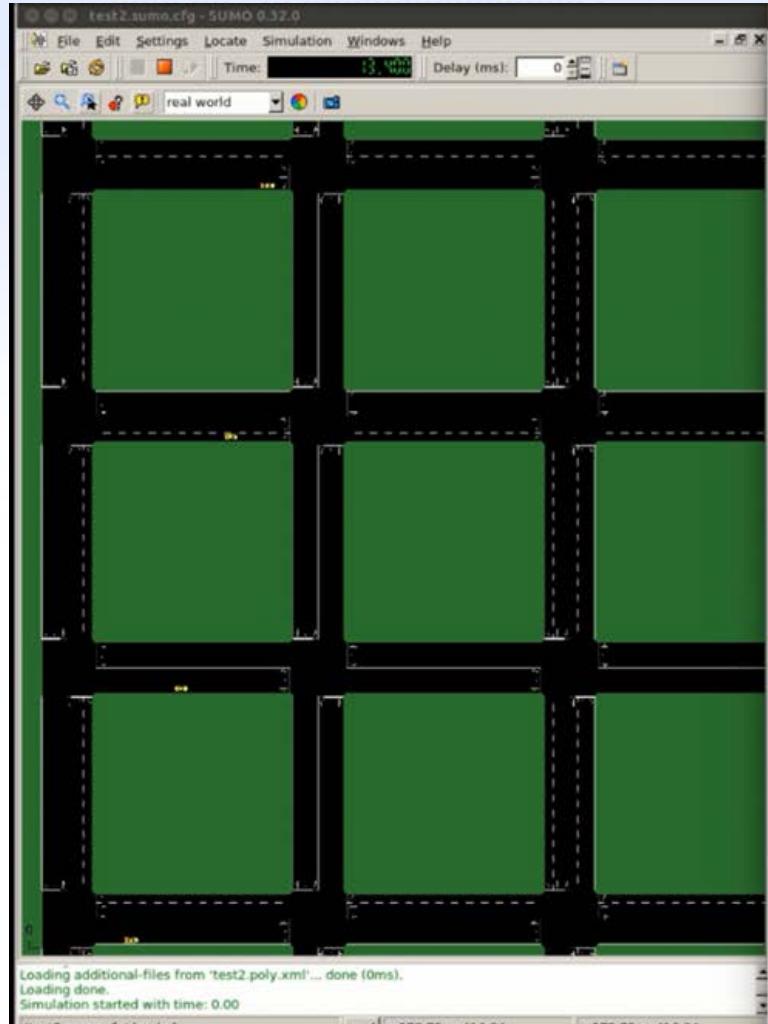
- Some are outside the coverage of RSUs.

## ✓ Mobility Anchor:

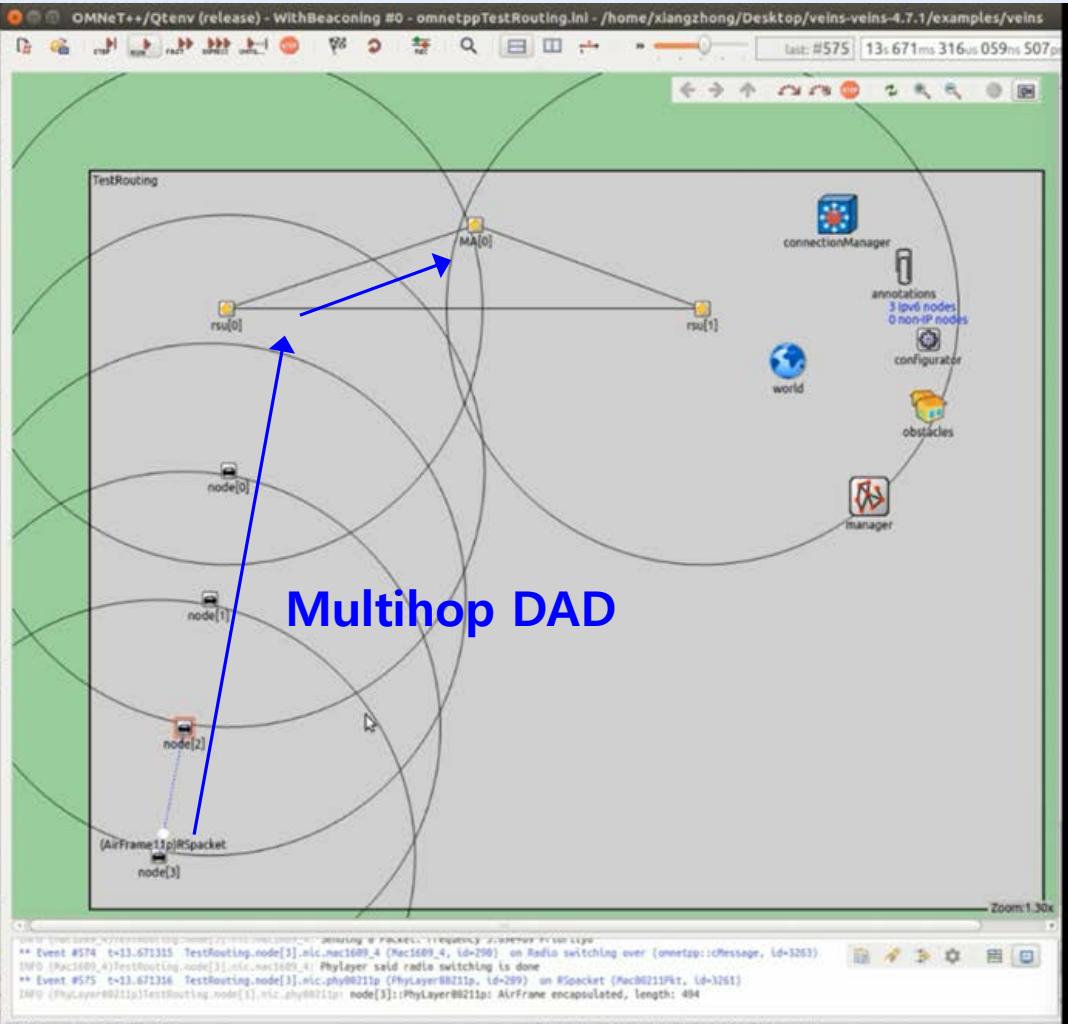
- It manages RSUs and Vehicles.



# 802.11-OCB and VND Simulation

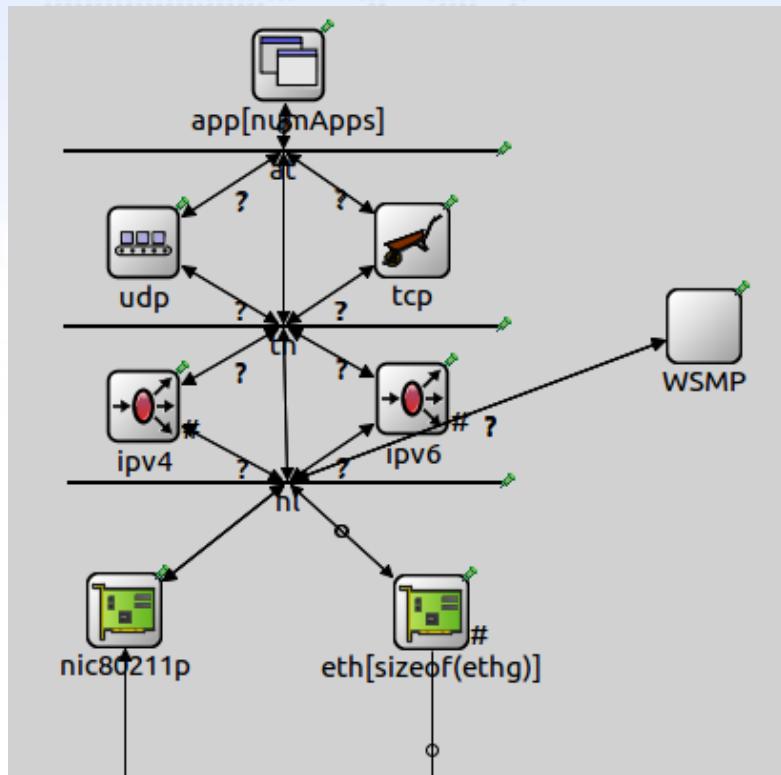


SUMO



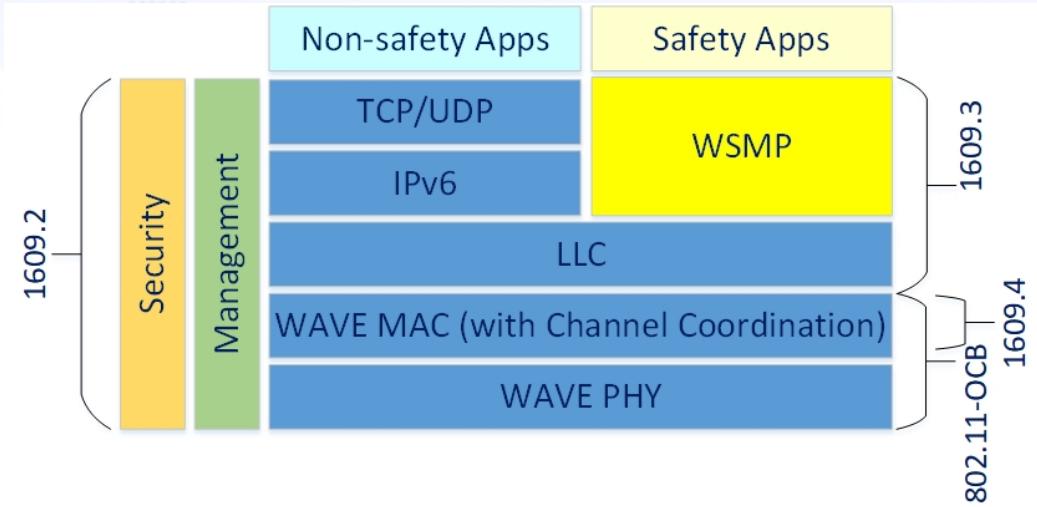
OMNeT++

# Vehicular Network Stack in OMNeT++



Vehicle Structure

## WAVE Stack



# Simple Simulation Results

## DAD Processing Time Comparison

- Legacy IPv6 ND Default Setting:
  - = Random (0, Max\_RTR\_SOLICITATION\_DELAY) + Retrans\_Timer
    - Retrans\_Timer: 1s
    - Max\_RTR\_SOLICITATION\_DELAY: 1s
    - DuplicateAddressDetectionTransmit: 1 Transmission

#Vehicle	Legacy ND (s)	Vehicular ND (s)
5	1.665790753	0.000846651
10	1.614267702	0.000867451
15	1.622217908	0.000863119
20	1.593333245	0.000844052
25	1.631985633	0.000839892
30	1.661594873	0.000844486

\* Average processing time of multiple vehicles

\* Fixed speed: 10m/s

⇒ Our VND takes 0.0508% time of the Legacy ND.

- **Proof of Concept (POC) of IPWAVE VND Protocol**
  - IPv6 over IEEE 802.11-OCB
  - Vehicular Neighbor Discovery (VND)
  - Multihop DAD and UDP/TCP Transmission in VANET
- **Design and Implementation of IPWAVE VND in OMNeT++ and SUMO**
  - Design of IPWAVE VND Framework in OMNeT++
  - Implementation of IPv6 over IEEE 802.11-OCB

# Appendix

- Hackathon Development Environment
- Demonstration Video Clip of IPWAVE Basic Protocols Project
- Open-Source Depository of IPWAVE Basic Protocols Project



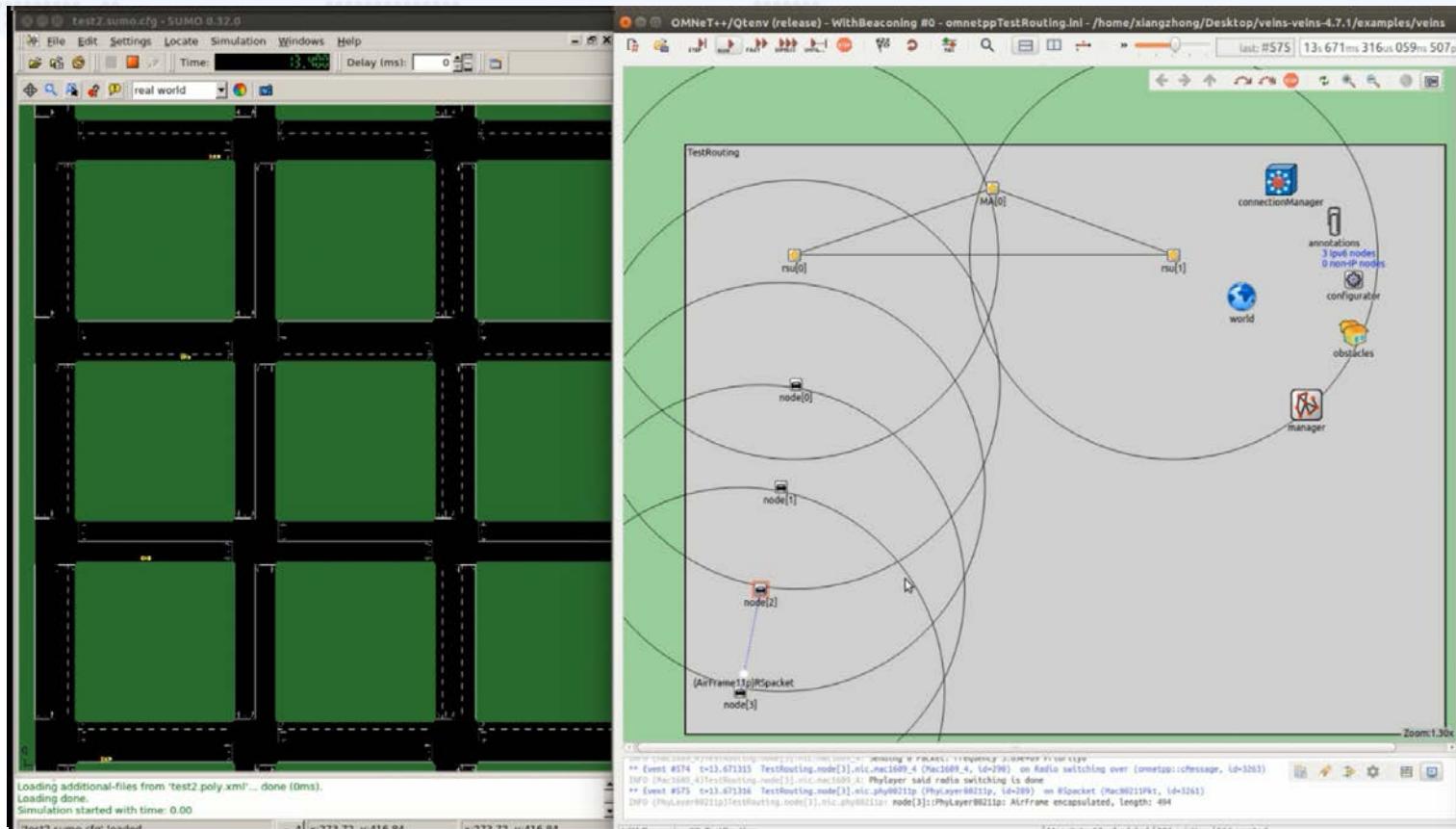
# Hackathon Development Environment

Open Source	Description	Version
Ubuntu	Operating System	Version 16.04
OMNeT++	Network Simulator	Version 5.4.1
SUMO	Road Simulator	Version 0.32.0
Veins	IEEE 802.11-OCB	Version 4.7.1
INET Framework	IPv6, TCP/UDP	Version 4.0.0

# Demonstration Video Clip of IPWAVE Basic Protocols Project

- Youtube link:

<https://youtu.be/5OnpnYUiLhg>



# Open-Source Depository of IPWAVE Basic Protocols Project

- Github link:

<https://github.com/ipwave-hackathon-ietf>

Branch: master ▾	New pull request	Find File	Clone or download ▾
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 inet-ipwave-hackathon-105	First commit		9 days ago
 sumo-0.32.0	First commit		7 days ago
 veins-ipwave-hackathon-105	some changes		4 days ago
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