IPWAVE Basic Protocols Project
@ IETF-105 Hackathon

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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](https://tools.ietf.org/id/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**
    • Vehicular Neighbor Discovery for IP-Based Vehicular Networks
IP Wireless Access in Vehicular Environments (IPWAVE) Basic Protocols Project
Champion: Jaehoon Paul Jeong (SKKU)

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/5OnpnYUIlhg

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

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++
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
✓ 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++

Multihop DAD
Vehicular Network Stack in OMNeT++

Vehicle Structure

WAVE Stack

Non-safety Apps
- TCP/UDP
- IPv6

Safety Apps
- WSMP
- LLC
- WAVE MAC (with Channel Coordination)
- WAVE PHY

802.11-OCB

1609.2

1609.3

1609.4
Simple Simulation Results

DAD Processing Time Comparison

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

<table>
<thead>
<tr>
<th>#Vehicle</th>
<th>Legacy ND (s)</th>
<th>Vehicular ND (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.665790753</td>
<td>0.000846651</td>
</tr>
<tr>
<td>10</td>
<td>1.614267702</td>
<td>0.000867451</td>
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<tr>
<td>15</td>
<td>1.622217908</td>
<td>0.000863119</td>
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<td>20</td>
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<td>0.000844052</td>
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<td>25</td>
<td>1.631985633</td>
<td>0.000839892</td>
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<tr>
<td>30</td>
<td>1.661594873</td>
<td>0.000844486</td>
</tr>
</tbody>
</table>

\[ \text{⇒ Our VND takes 0.0508\% time of the Legacy ND.} \]

* Average processing time of multiple vehicles
* Fixed speed: 10m/s
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

<table>
<thead>
<tr>
<th>Open Source</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ubuntu</td>
<td>Operating System</td>
<td>Version 16.04</td>
</tr>
<tr>
<td>OMNeT++</td>
<td>Network Simulator</td>
<td>Version 5.4.1</td>
</tr>
<tr>
<td>SUMO</td>
<td>Road Simulator</td>
<td>Version 0.32.0</td>
</tr>
<tr>
<td>Veins</td>
<td>IEEE 802.11-OCB</td>
<td>Version 4.7.1</td>
</tr>
<tr>
<td>INET Framework</td>
<td>IPv6, TCP/UDP</td>
<td>Version 4.0.0</td>
</tr>
</tbody>
</table>
Demonstration Video Clip of IPWAVE Basic Protocols Project

• Youtube link:
  https://youtu.be/5OnpnYUiLhg
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- Github link: https://github.com/ipwave-hackathon-ietf