

# IETF Hackathon

## IPWAVE Basic Protocols Project

**IETF 111**  
**July 19-23, 2021**  
**Online**



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

Champions: Jaehoon (Paul) Jeong (SKKU) and Yiwen (Chris) Shen (SKKU)



## Professors:

- Jaehoon (Paul) Jeong (SKKU)
- Younghan Kim (SSU)

## Researcher:

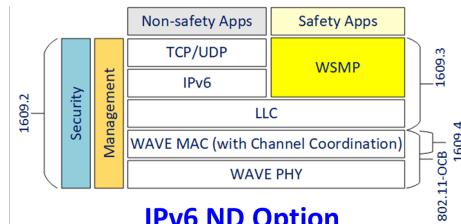
- Yiwen (Chris) Shen (SKKU)

## Students:

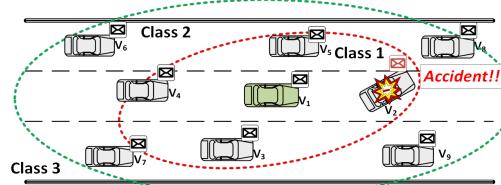
- Bien Aime Mugabarigira (SKKU)
- Hyeonah Jeong (SKKU)
- Junhee Kwon (SKKU)
- Gilteun Choi (PNU)
- Jinho Park (KNU)



## WAVE Protocol Stack



## IPv6 ND Option



IPv6 ND with Cooperative Context Option  
IPv6 ND with Emergency Context Option

## Objectives:

- Demonstrate IPWAVE Basic Protocols
- New IPv6 ND option verification by two laptops
- Discover technology gaps for IPWAVE

## Where to get source code:

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

## How to set up an environment:

### Hardware

- Two laptops with AR94XX wifi modules (ath9k)

### Software

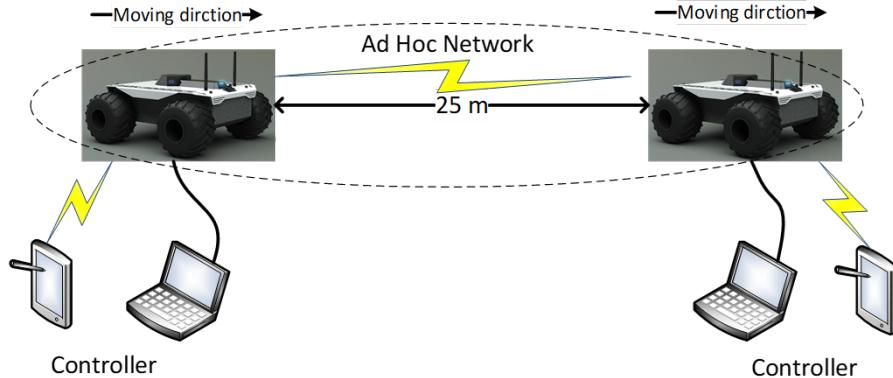
- OS: OCB-enabled Linux kernel (version 4.4) in Ubuntu 18.04

## Implementation Contents:

- Develop a vehicular communication system for safe and secure driving using IETF IPWAVE protocols.
- Vehicular Mobility Information (VMI) option in IPv6-based vehicular network with raw socket-based ICMPv6.
  - ✓ The New IPv6 ND options development and verification for vehicular networks by raw socket-based ICMPv6.
  - ✓ ND messages exchange with CC and EC options.

# Previous Hackathon Work (IETF-110)

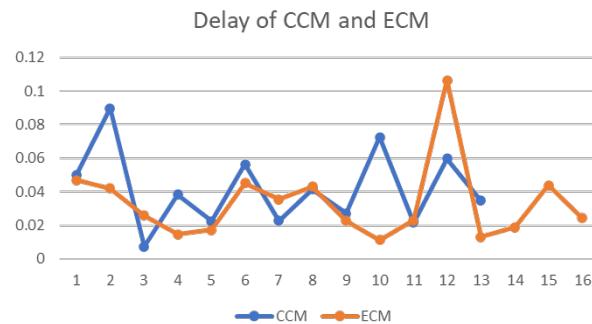
## Feasibility by UDP-based mobility information sharing



AION Robotics R1



Msg Type (VMI Option)	Delay
CCM	0.0419s
ECM	0.0333s



# Hackathon Plan

- How to use IPv6 ND messages for sharing mobility information among vehicles?
  - Vehicle mobility information (VMI) can be GPS coordinates, speed, and direction.
  - How to design a new ND option for VMI and how to test the ND option?
  - References
    - RFC 8691, RFC 3542, and RFC 4861
    - <https://www.pdbuchan.com/rawsock/rawsock.html>
    - <https://tools.ietf.org/html/draft-ietf-ipwave-vehicular-networking-20>
    - <https://tools.ietf.org/html/draft-jeong-ipwave-vehicular-neighbor-discovery-11>
    - <https://tools.ietf.org/html/draft-jeong-ipwave-context-aware-navigator-03>
- For proof-of-concept, we use the raw socket-based ICMPv6 to design and test the new ND VMI option.

# New ND VMI Option

- This new ND option is defined in two drafts:
  - <https://datatracker.ietf.org/doc/html/draft-jeong-ipwave-context-aware-navigator-03>
  - <https://datatracker.ietf.org/doc/html/draft-jeong-ipwave-vehicular-neighbor-discovery-11>

0	1	2	3																				
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1		
+-----+																							
Type   Length				Message   Reserved1																			
+-----+																							
Reserved2																							
+-----+																							
: Mobility Information :																							
+-----+																							

# Using NA Data Structure in Linux Kernel

- icmp6.h
  - nd\_neighbor\_advert
    - struct icmp6\_hdr
    - struct in6\_addr

```
#include <netinet/icmp6.h>      // struct nd_neighbor_adver
icmp6_hdr, ND_NEIGHBOR_ADVERT
/*
struct nd_neighbor_advert      // neighbor advertisement
{
    struct icmp6_hdr  nd_na_hdr;
    struct in6_addr   nd_na_target; // target address
    // could be followed by options
};
```

# IPv6 NA VMI Option Testing

- Using the GPS data of the Westin Josun Busan Hotel in Korea as an ND VMI option for testing.



```
// Westin Josun Busan: longitude 35.155988, latitude 129.154134
char longitude[14] = "35.1559880000";
char latitude[14] = "129.154134000";
char delimiter[2] = ",";

for (i = 0; i < sizeof(longitude); i++){
    options[i + 2] = (uint8_t)longitude[i];
}
options[2 + sizeof(longitude)] = (uint8_t)delimiter[0];

for (i = 0; i < sizeof(latitude); i++){
    options[i + 2 + sizeof(longitude) + 1] = (uint8_t)latitude[i];
}

// Report advertising node's mobility to stdout.
printf("Advertising car's VMI for interface %s is ", interface);
```

# What got done

- Tested IPv6 ND in the **raw socket-based ICMPv6** by open source code.
- Tested the **new IPv6 ND VMI option** for vehicular networks:
  - Using raw socket instead of modifying the kernel is a feasible way to test a new IPv6 ND option.
  - We use **two IEEE-802.11-OCB enabled laptops** to exchange NA messages that include VMI option.
  - Demo: <https://youtu.be/OTYtLOBX1CI>

# Test Result

- Sender:

```
iotlab-ocbtest2@iotlab-ocbtest2:~/Downloads/ipwave-hackathon-ietf-111-main$ sudo ./sender
Advertising car's VMI for interface wlp3s0 is 35.1559880000,129.154134000
Advertising node's index for interface wlp3s0 is 2
Checksum: c5af
iotlab-ocbtest2@iotlab-ocbtest2:~/Downloads/ipwave-hackathon-ietf-111-main$
```

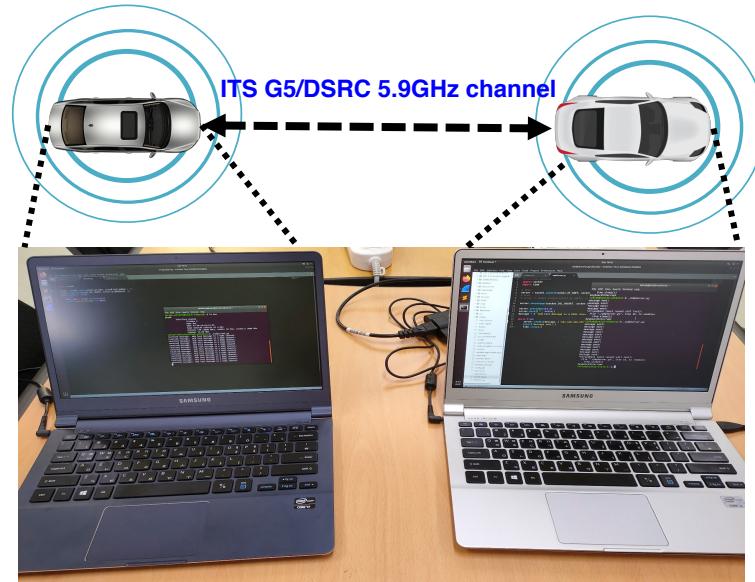
- Receiver:

```
Reserved: 0
Target address of neighbor solicitation: 2001:db8:100:15a::3

Options:
Type: 2
Length: 4 (units of 8 octets)
VMI data: 35.1559880000,129.154134000
iotlab@iotlab-ocbtest:~/ipwave-hackathon-ietf-111-main$
```

# What we learned

- IPv6 NA messages can be used **for sharing vehicle mobility information** in IPv6-based vehicular networks.
- The **sending interval** of NA messages may affect the freshness of neighbor vehicles' mobility information.
- If we use NA messages for mobility info sharing, the default IPv6 ND process may **need to be updated** by defining
  - a new option type,
  - a different mechanism for sending NA, and
  - a neighbor cache dedicated for VMI option.



# Next Step

- We will apply our implementation of ND VMI Option to Robot Vehicles (i.e., AION Robotics R1).
- We will implement and test our Context-Aware Navigation (CNP) in such Robot Vehicles.
- We will also try to design and implement the ND VMI Option with IPv6 over 5G V2X interfaces.

# Open Source Project at Github

URL: <https://github.com/ipwave-hackathon-ietf/ipwave-hackathon-ietf-111>

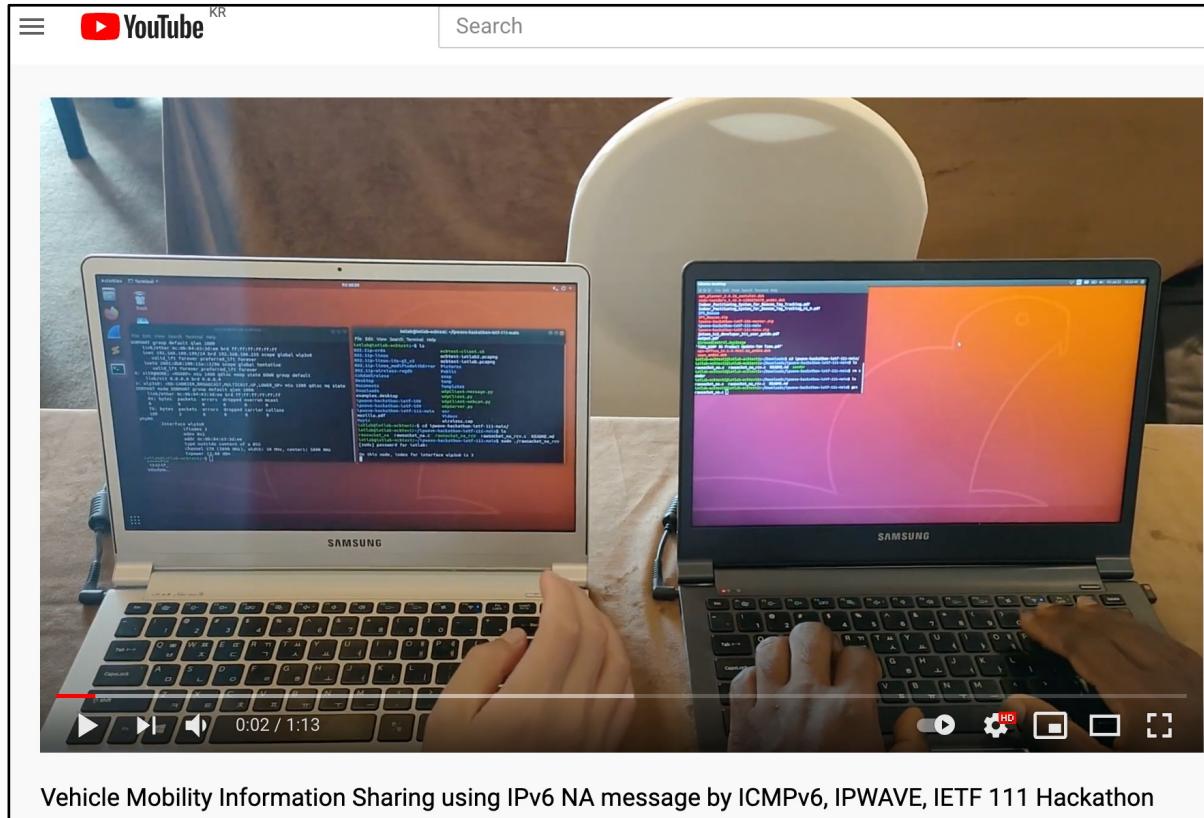
The screenshot shows a GitHub repository page. At the top, there's a navigation bar with links for Why GitHub?, Team, Enterprise, Explore, Marketplace, and Pricing. On the right side of the header are buttons for Search, Sign in, and Sign up. Below the header, the repository name "ipwave-hackathon-ietf / ipwave-hackathon-ietf-111" is displayed, along with buttons for Notifications (0), Star (0), and Fork (0). The main navigation menu includes Code, Issues, Pull requests, Actions, Projects, Wiki, Security, and Insights. The "Code" tab is currently selected. Below the menu, there's a summary showing 1 branch and 0 tags. A "Go to file" button is next to a "Code" dropdown. The main content area displays a list of commits from a user named chrisshen. The commits are:

- Update README.md (8339219, 24 minutes ago)
- .gitignore (Initial commit, 2 days ago)
- README.md (Update README.md, 24 minutes ago)
- rawsocket\_na.c (minor, 21 hours ago)
- rawsocket\_na\_rcv.c (Add VMI option, 21 hours ago)

Below the commit list, there's a preview of the README.md file, which contains the text "ipwave-hackathon-ietf-111". At the bottom of the page, it says "IETF 111 IPWAVE WG Hackathon". To the right of the main content, there are sections for "About", "Releases", "Packages", and "Languages".

# Demo Video Clip at YouTube

URL: <https://github.com/ipwave-hackathon-ietf/ipwave-hackathon-ietf-111>



# Wrap Up

## Hackathon Team

### Champions:

- Jaehoon Paul Jeong (SKKU)
- Yiwen (Chris) Shen (SKKU)

### Professor:

- Younghan Kim (SSU)

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- Jinho Park (KNU)



Our IPWAVE Hackathon Team worked with I2NSF and BMWG Hackathon Teams in the Westin Josun Busan Hotel in Korea this hackathon week.

# Sponsors



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# IETF Korea Hackathon Teams

