Vehicular Prefix/Service Discovery, DNS Naming, and Seamless IP Networking

(draft-jeong-ipwave-vehicular-neighbor-discovery-02,
draft-jeong-ipwave-iot-dns-autoconf-02, and
draft-ietf-ipwave-vehicular-networking-02)

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Suggested Work Items for IPWAVE

1. Vehicular Neighbor Discovery for V2X Networking
   - Prefix Discovery
   - Service Discovery
   - ➤ **draft-jeong-ipwave-vehicular-neighbor-discovery-02**

2. DNS Naming Services
   - DNS Name Autoconfiguration
   - Device Discovery
   - Service Discovery
   - DNS Name Resolution
   - ➤ **draft-jeong-ipwave-iot-dns-autoconf-02**

3. Seamless IP Networking
   - Handling of MAC Address Change for Pseudonym
   - Handling of Subnet Change between RSUs
   - ➤ **draft-ietf-ipwave-vehicular-networking-02**

Vehicular Network Architecture

Vehicular Cloud

Traffic Control Center (TCC)

Road-Side Unit RSU$_1$

Road-Side Unit RSU$_2$

V2I

V2I

V2I

V2V

Vehicle V$_1$

Vehicle V$_2$
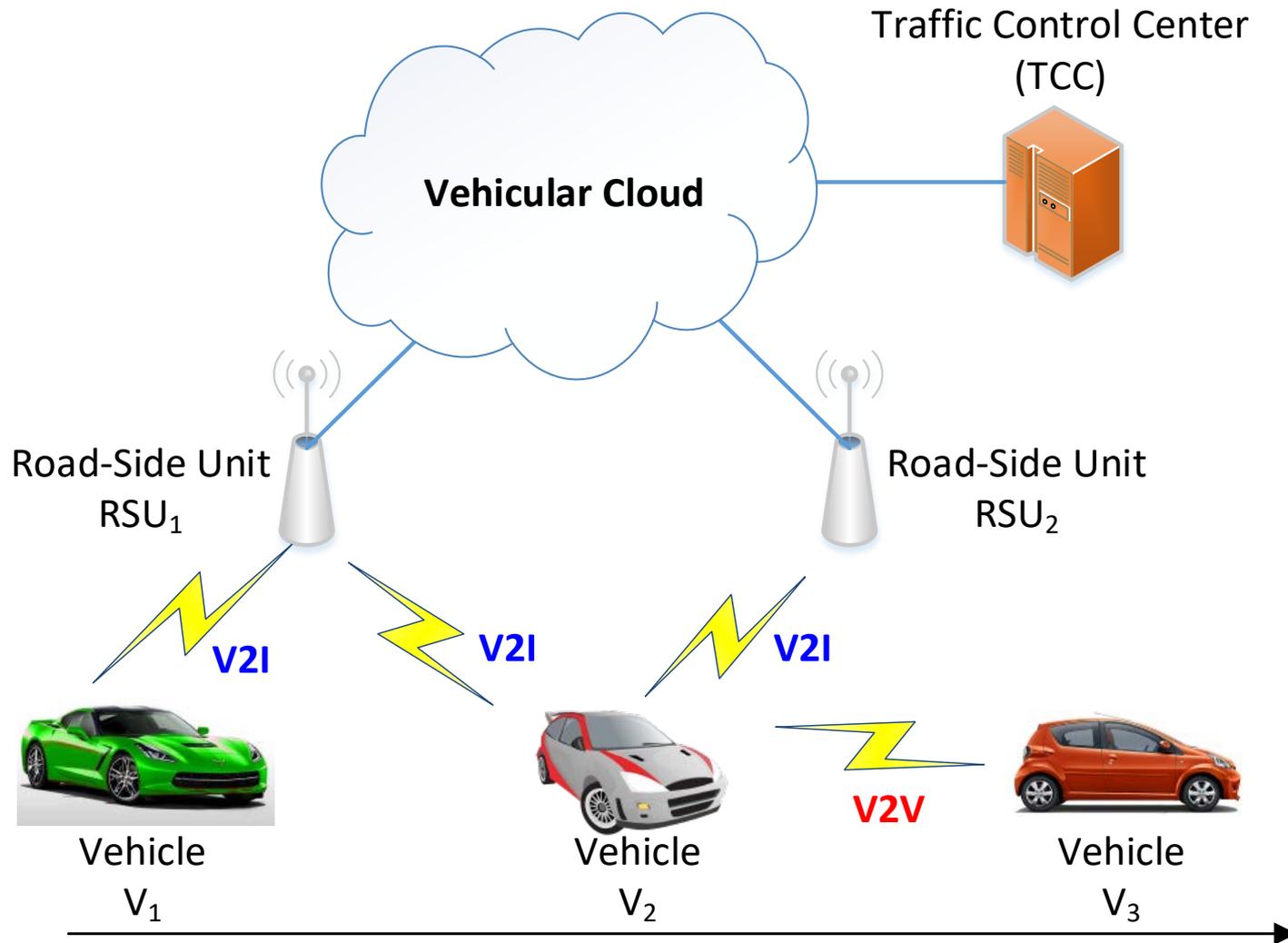
Vehicle V$_3$

Internetworking between Vehicle Network and RSU Network via V2I

Vehicle₁ (Moving Network₁)

RSU₁ (Fixed Network₁)
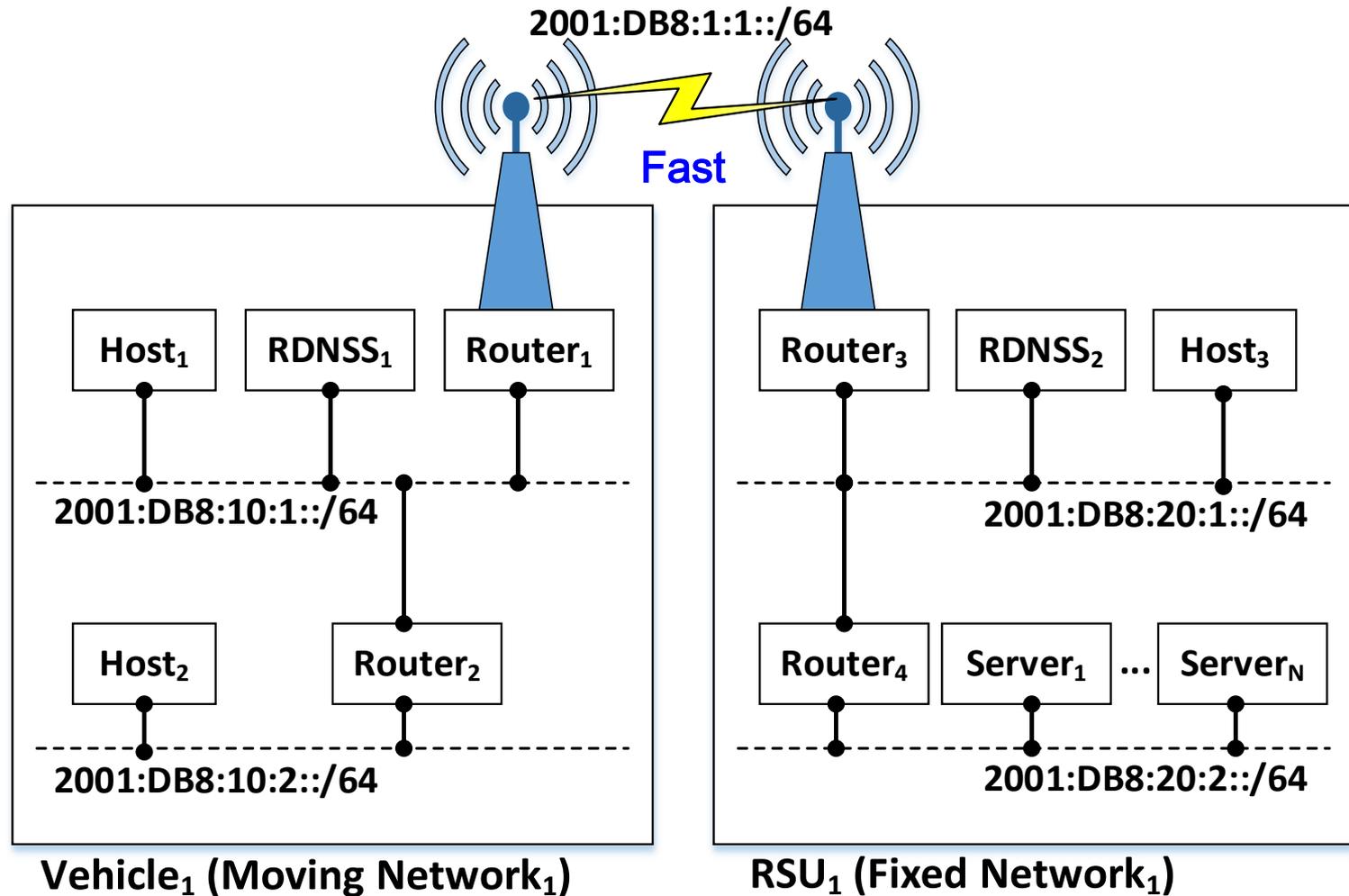
Internetworking between Two Vehicle Networks via V2V

2001:DB8:1:1::/64

| Host$_1$ | RDNSS$_1$ | Router$_1$ |

2001:DB8:10:1::/64

| Host$_2$ | Router$_2$ |

2001:DB8:10:2::/64

Vehicle$_1$ (Moving Network$_1$)

| Router$_3$ | RDNSS$_2$ | Host$_3$ |

2001:DB8:20:1::/64

| Router$_4$ | Host$_4$ |

2001:DB8:20:2::/64

Vehicle$_2$ (Moving Network$_2$)
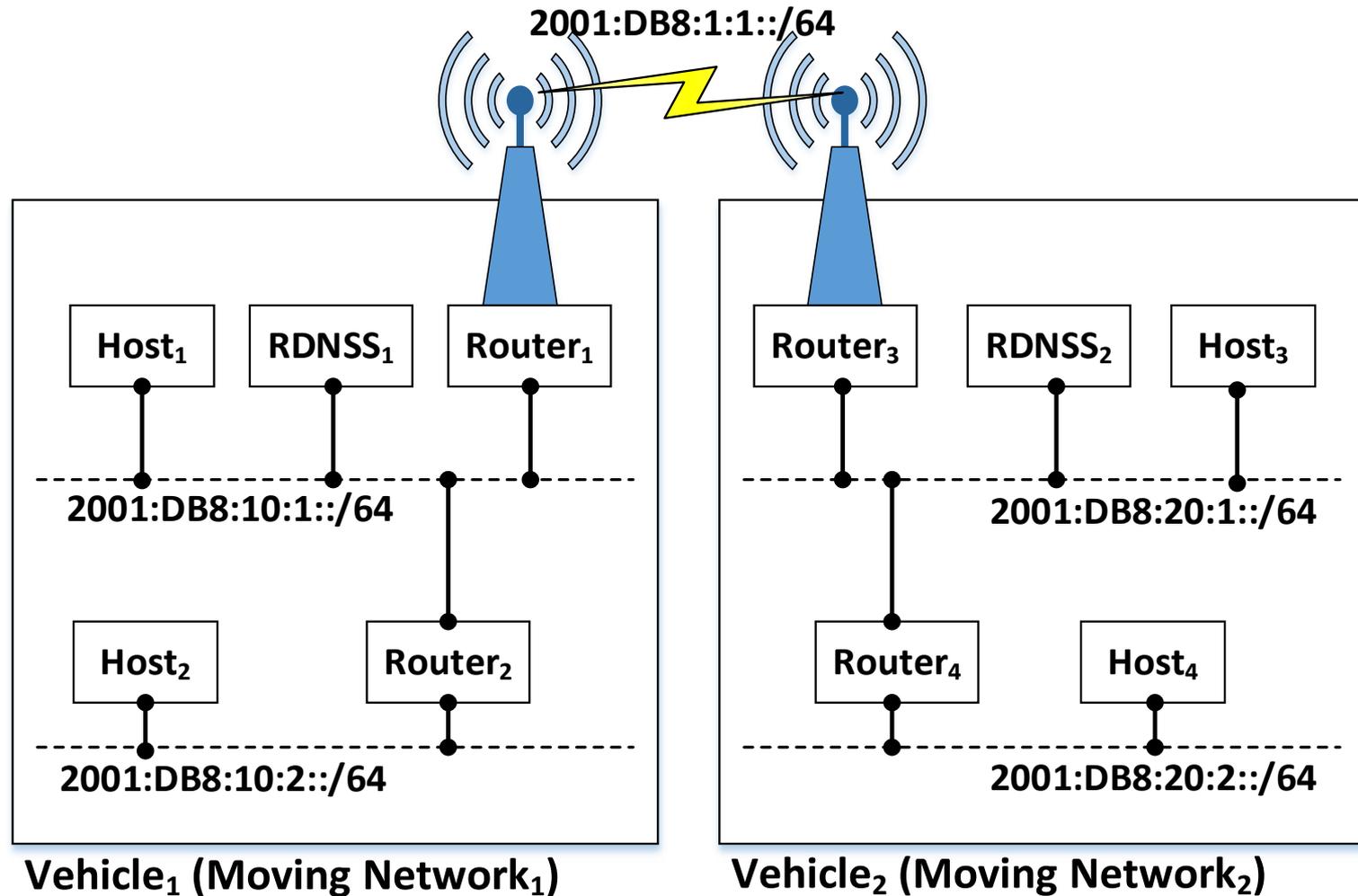
Vehicular Neighbor Discovery for V2X Networking

- **Prefix Discovery**
  - To <u>rapidly find</u> the <u>prefix information of an internal network</u> in a vehicle or an RSU
  - Two nodes in two different internal networks can communicate with each other.

- **Service Discovery**
  - To <u>rapidly find</u> the <u>service information of an internal network</u> in a vehicle or an RSU
  - A client in an internal network can contact a required server in another internal network.

New Vehicular ND Options

```
 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 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type       |     Length      | Prefix Length |   Distance    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Reserved                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                                |
:                             Prefix                             :
|                                                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
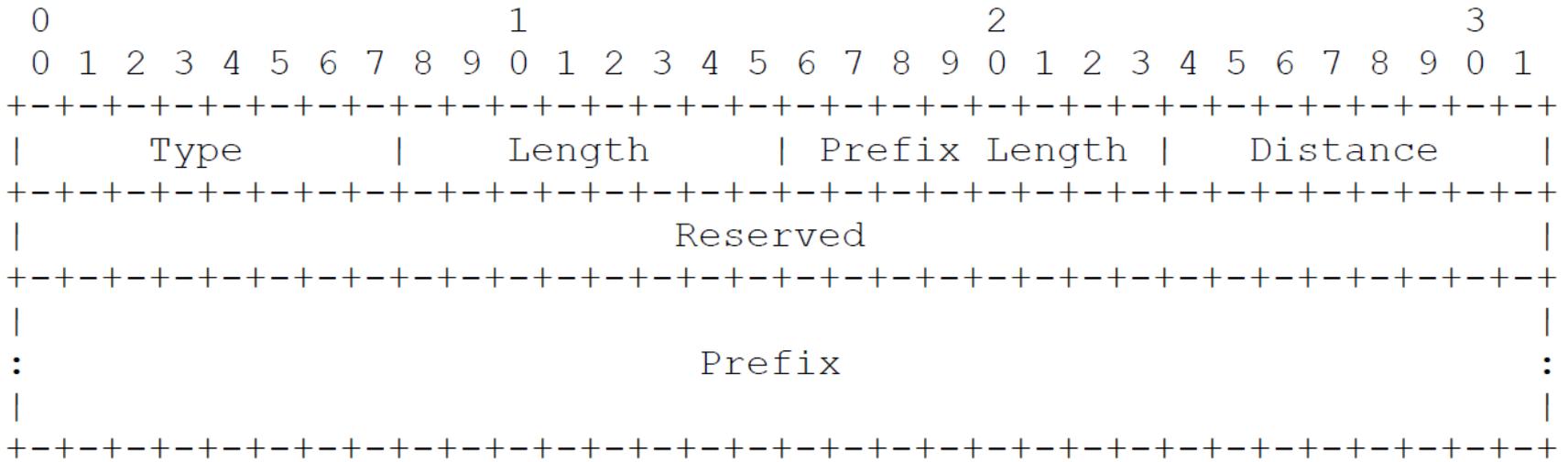
Vehicular Prefix Information (VPI) Option

```
 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 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type       |      Length     |           Reserved1         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Protocol      |    Reserved2    |          Port Number        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                                |
:                          Node Address                          :
|                                                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
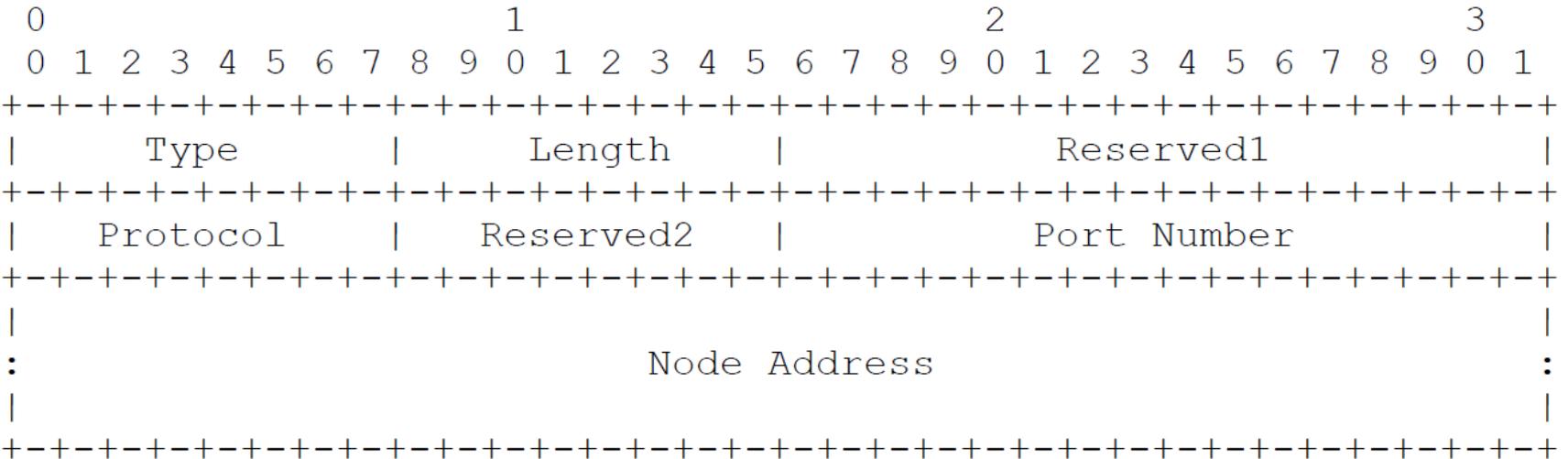
Vehicular Service Information (VSI) Option

DNS Naming Services

- DNS Name Autoconfiguration (DNSNA)
  - In-vehicle devices (as IoT devices) <u>configure</u> their DNS names with a **domain suffix** advertised by a router.
  - They <u>register</u> their DNS names and the corresponding IPv6 addresses into a DNS server.

- Device Discovery
  - In-vehicle devices can <u>discover other devices</u> by getting **DNS DB** (i.e. zone file) from the DNS server.

- Service Discovery
  - In-vehicle devices can <u>discover service information</u> by getting **DNS DB** (i.e. zone file) from the DNS server.

- DNS Name Resolution
  - In-vehicle devices <u>resolve</u> the DNS names of other devices into IP addresses by contacting the DNS server.

DNS Autoconfiguration (DNSNA)

IoT Device   **Router**   **DNS Server**   **User Device**

RA
(DNSSL Option)

1. DNS Name Generation

DAD

DNS Name Generation

NI Query
(DNS Name?)

NI Reply
(DNS Name &
IPv6 Address)

2. DNS Name Collection

DNS Query
(DNS Name?)

DNS Response
(No Such DNS Name)

3. DNS Name Registration

DNS Dynamic Update
(DNS Name & IPv6 Address)

Get Device List

Put Device List

4. IoT Device List Retrieval

Remote Control
by Device Icon
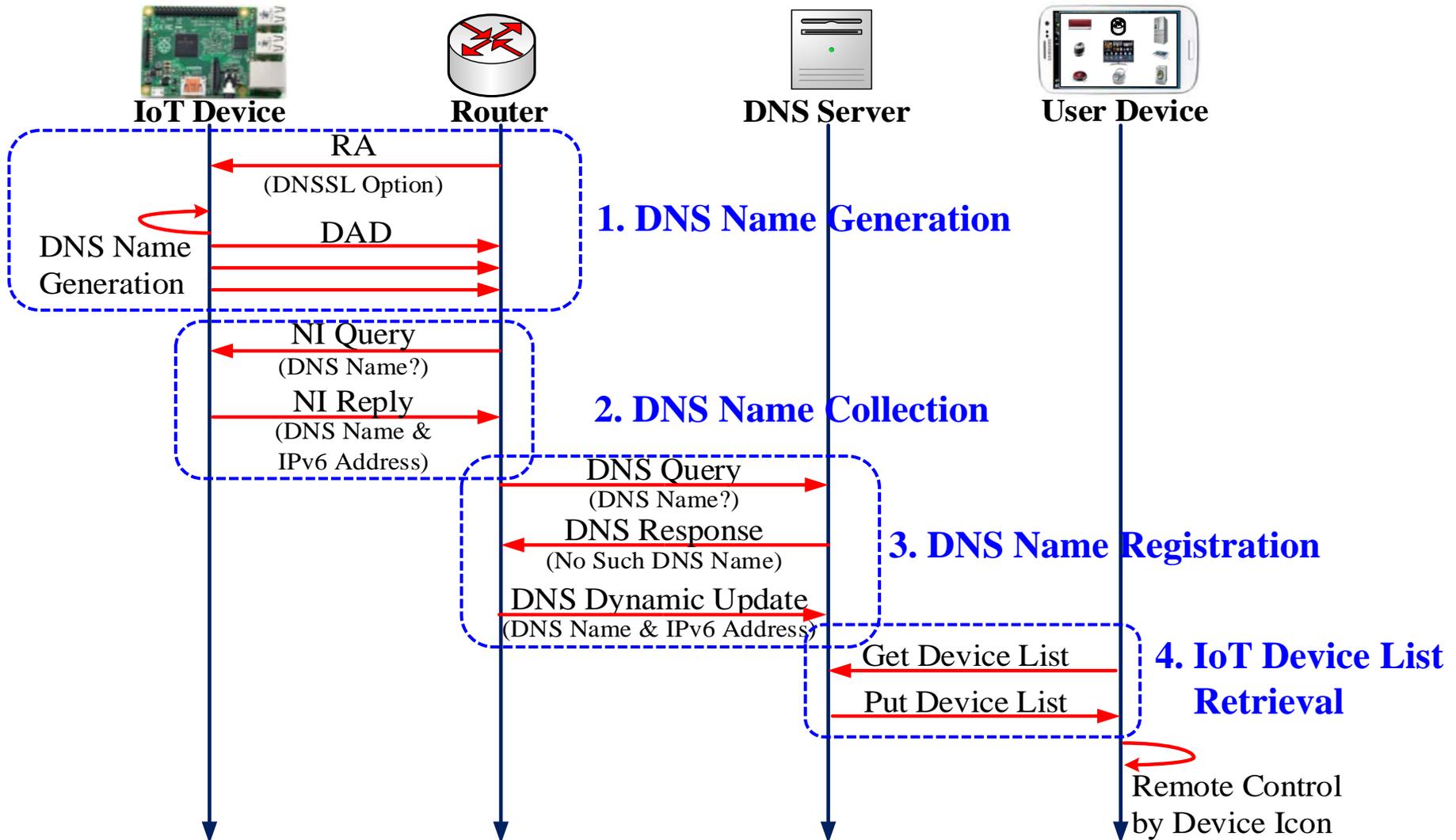
Seamless IP Networking (1/2)

- Handling of MAC Address Change for Pseudonym
  - The <u>MAC address</u> of an external interface can <u>change for pseudonym</u> over time.
  - This MAC address change <u>affects the IPv6 address</u> of the interface.
  - The interface's IPv6 address needs to be updated for routing and be notified to the router (i.e. RSU).
  - This IPv6 address change <u>affects on-going TCP (or UDP) sessions</u>.
  - The IPv6 address change can be notified to the session partner through <u>MIPv6 binding update</u>.

Seamless IP Networking (2/2)

- Handling of Subnet Change between RSUs
  - Assume that a vehicle <u>moves</u> from the coverage of an RSU <u>to the coverage of another RSU</u> where <u>these RSUs have different prefixes</u>.
  - The <u>IPv6 address</u> of the vehicle's external interface <u>changes</u> due to the <u>different prefixes</u>.
  - This IPv6 address change <u>affects on-going TCP (or UDP) sessions</u>.
  - The IPv6 address change can be notified to the session partner through <u>MIPv6 binding update</u>.

Next Steps

- We suggest the following three topics as <u>work items in the rechartering</u> of IPWAVE WG:

  – Vehicular Neighbor Discovery for V2X Networking

  – DNS Naming Services

  – Seamless IP Networking

- We will design a detailed <u>Vehicular Network Architecture</u> for those topics.

  – Vehicular Network Architecture for V2V and V2I