IP Wireless Access in Vehicular Environments (IPWAVE): Problem Statement and Use Cases (draft-ietf-ipwave-vehicular-networking-07)

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Update from -05 and -06 Versions

- This document (-07) is updated from
  - draft-ietf-ipwave-vehicular-networking-05
  - draft-ietf-ipwave-vehicular-networking-06

- Major Updates
  - Comments from Volunteer Reviewers
    - Erik Nordmark (Done)
    - Dirk von Hugo (Done)
    - François Simon (Done)
    - Michelle Wetterwald (Done)
    - Amelia Andersdotter (TBD for Human Rights Review)
  - Key Work Items for IPWAVE Problem Statement
    - Neighbor Discovery (with Vehicular Link Model)
    - Mobility Management
    - Security and Privacy

Update from -05 and -06 Versions

- **Changes from -05 and -06**
  - In Section 5.1, a Vehicular Neighbor Discovery (VND) is introduced with a vehicular link model in a multi-link subnet. In the subnet, the description of MAC Address Pseudonym, Prefix Dissemination/Exchange, and Routing is clarified.
  - In Section 5.2, a proactive handover is introduced for an efficient mobility management with the cooperation among vehicles, RSUs, and MA along with link-layer parameters, such as Received Channel Power Indicator (RCPI).
  - In Figure 1, a vehicular network architecture is modified to show a vehicular link model in a multi-link subnet with vehicular wireless links.
  - In Figure 2 and Figure 3, the vehicle networks and RSU network are updated.

Vehicular Network Architecture

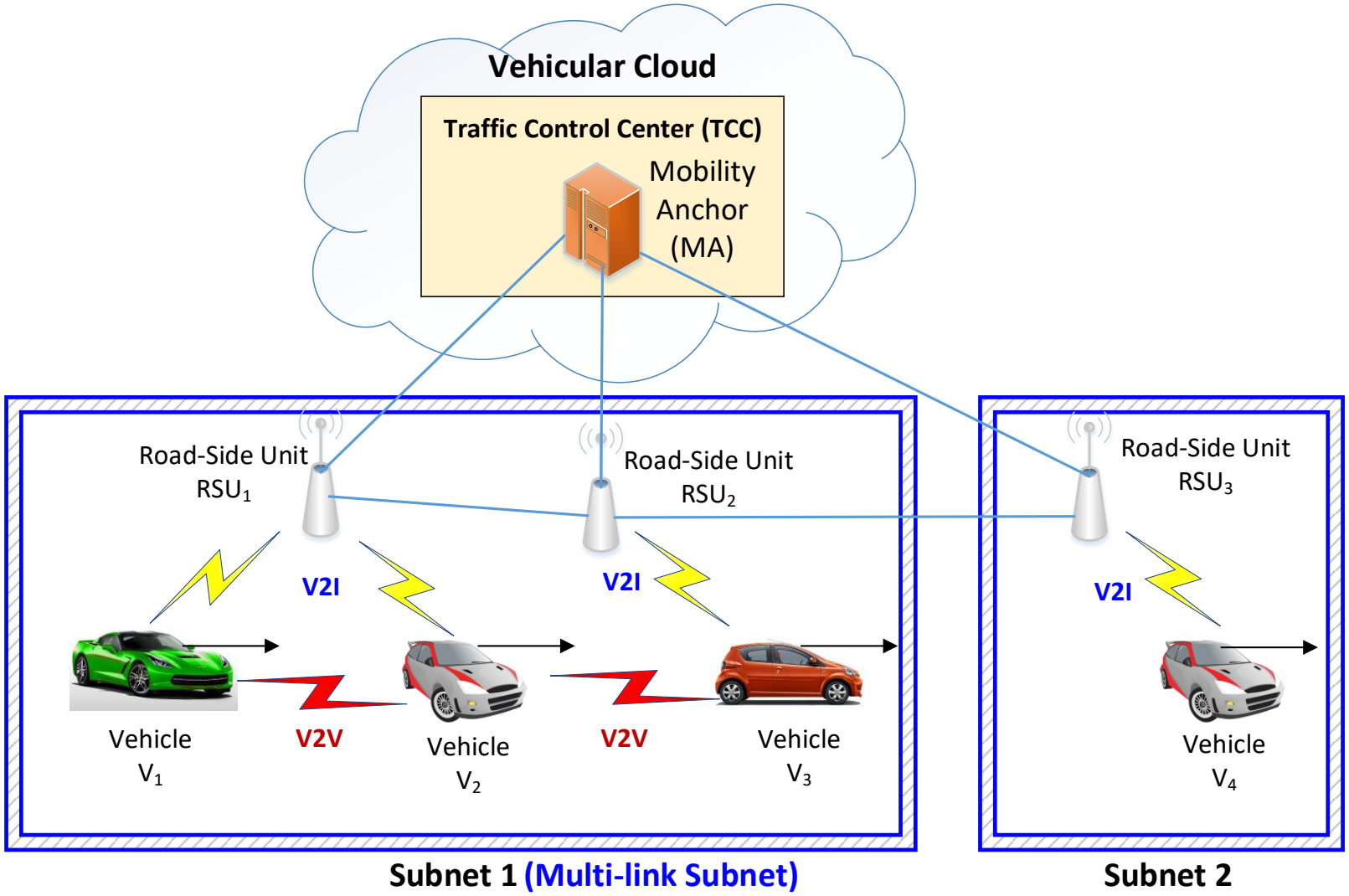

Figure 1: A **Vehicular Network Architecture** for V2I and V2V Networking

V2I Communication

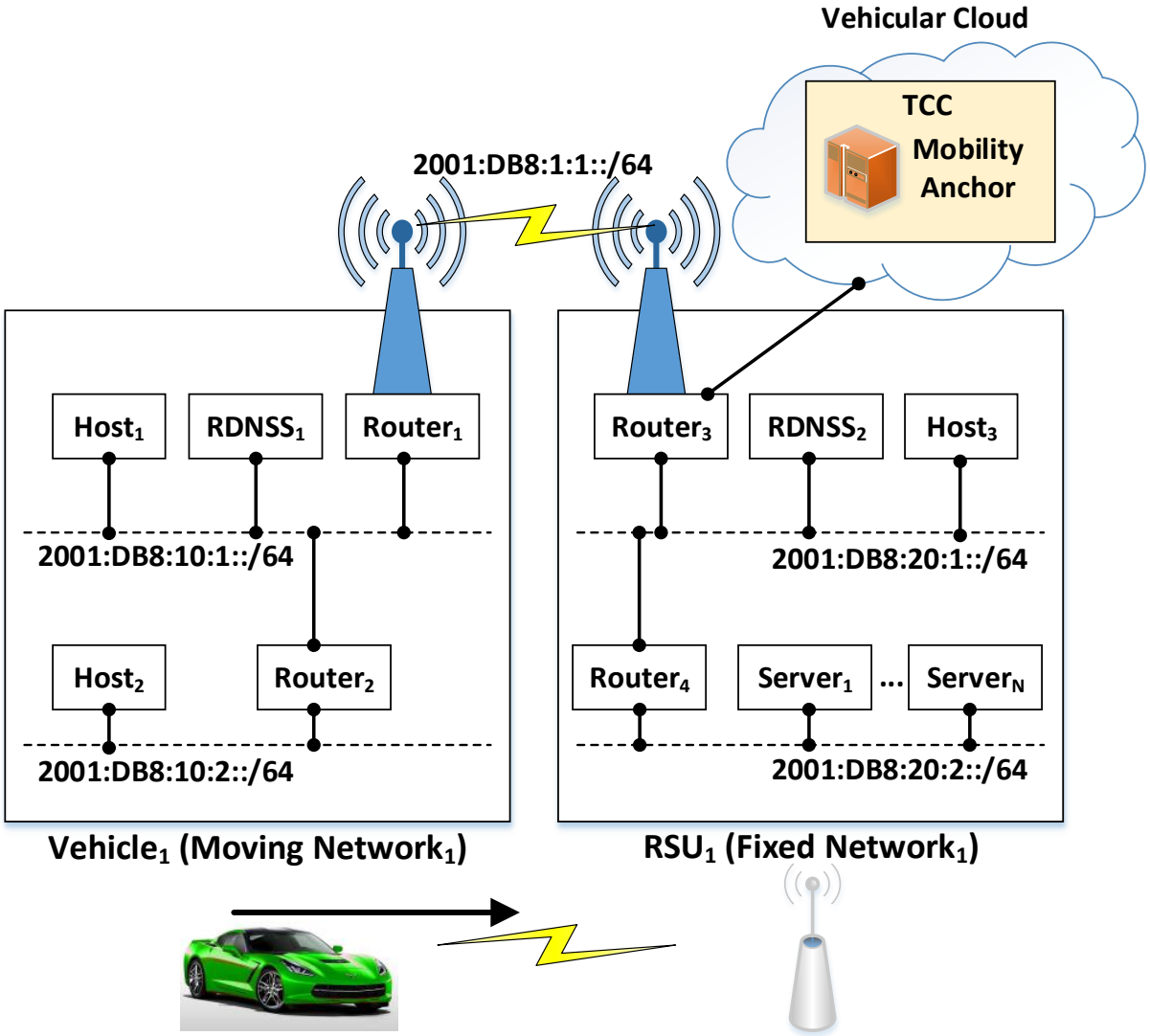

Figure 2: **Internetworking** between **Vehicle Network** and **RSU Network**

V2V Communication

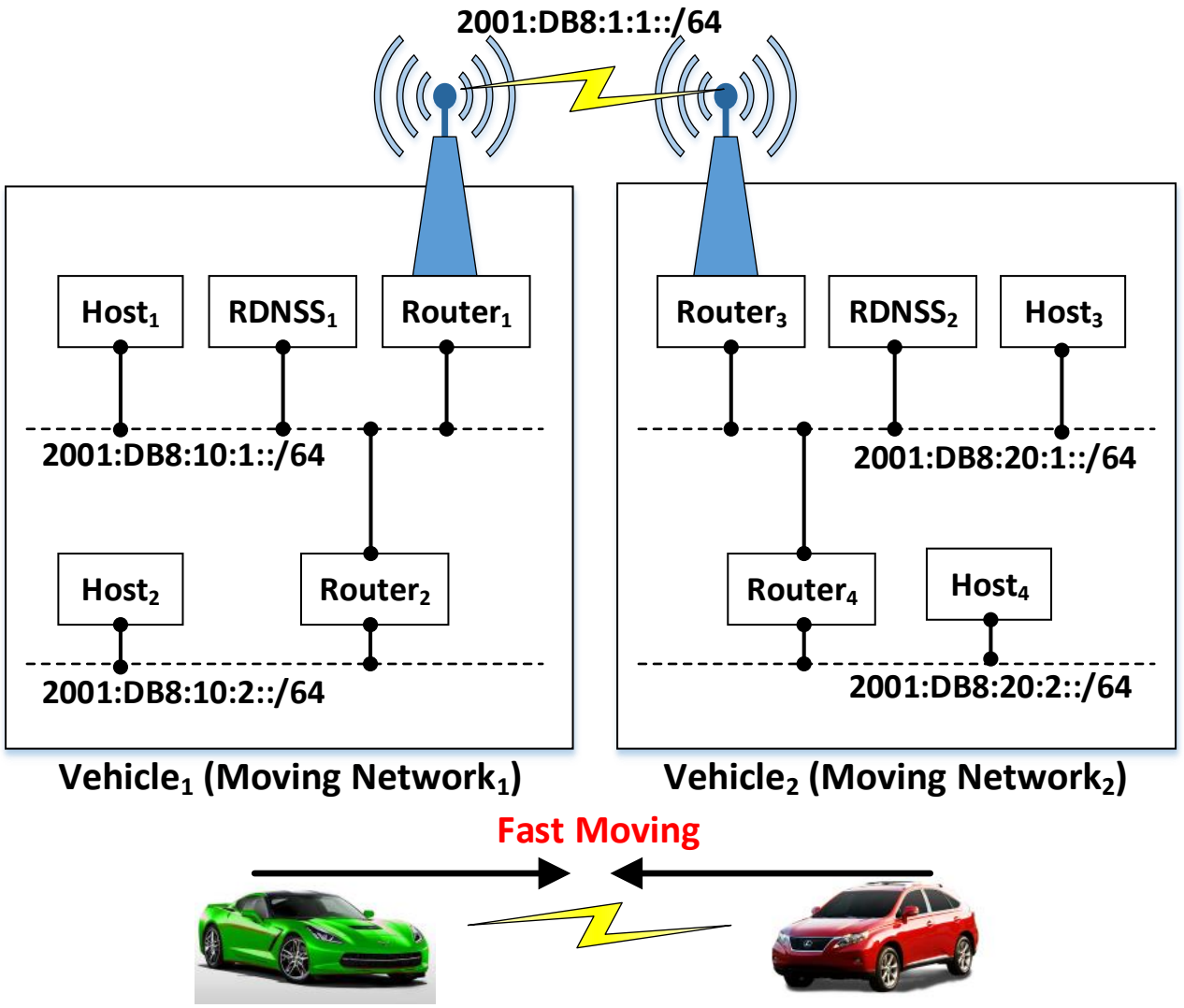

Figure 3: **Internetworking** between **Two Vehicle Networks**

Neighbor Discovery (ND) (1/3)

- **Link Model**
  - The legacy IPv6 ND protocol is not suitable for vehicular wireless links.
    - The IPv6 legacy link model's assumption for symmetry in connectivity between neighboring interfaces.
    - The existence of unidirectional links due to interference and different Tx power levels.
    - Unreachability between two nodes with the same prefix due to node mobility and highly dynamic topology in VANET.
    - Reachability between two nodes in a multi-link subnet having multiple wireless links with the same prefix.
  - IPv6 ND should be extended to support the concept of a Vehicular Link Model in a multi-link subnet.

Neighbor Discovery (ND) (2/3)

- **New Features for Vehicular ND (VND)**
  - Lightweight Duplicate Address Detection (DAD)
    - ND Optimization for 6LoWPAN [RFC 6775]
      - RS-trigger-unicast RA for ND control traffic reduction
      - Unicast-based Multihop DAD with a router
    - RSU and MA can perform the Multihop DAD for a vehicle.
  - A single address configuration in a multi-link subnet
    - A handover among RSUs and MA can support this (draft-jeong-ipwave-vehicular-neighbor-discovery-04).
  - Communication in a dynamic-topology VANET
  - Multihop forwarding in a multi-link subnet
    - VND can play the role of routing in a connected VANET.

Neighbor Discovery (ND) (3/3)

- **MAC Address Pseudonym**
  - MAC address change should consider the maintenance of end-to-end transport-layer session according to IPv6 address change.
  - With a mobility management scheme (e.g., MIPv6 and PMIPv6), the new IP address for the transport-layer session should be notified to an appropriate end point.

- **Prefix Dissemination/Exchange**
  - The communication of two vehicular nodes (e.g., vehicle and RSU) within different internal networks requires an ND extension or routing for efficient prefix dissemination/exchange.
  - VND can exchange prefixes between vehicular nodes with Vehicular Prefix Information (VPI) ND option (draft-jeong-ipwave-vehicular-neighbor-discovery-04).

Mobility Management

- **Efficient Mobility Management**
  - It should support seamless connectivity and timely data exchange between two end points.
  - A proactive handover scheme is used along with multihop DAD and tunneling among RSUs and MA.

- **Trajectory-Based Mobility Management**
  - With a GPS navigator, A vehicle's mobility information (e.g., position, speed, direction, and trajectory) is periodically reported to RSUs and MA in TCC.
  - With prediction of vehicle mobility, RSUs and MA can perform DAD, data packet forwarding, and handover in a proactive manner.
  - Link-layer parameters (e.g., Received Channel Power Indicator (RCPI)) can be used for handover timing.

Next Steps

- **WG Last Call**
  - This version is good enough for WGLC.
  - During WGLC, we will collect feedback from IPWAVE WG and reflect it on the revision.

- **IESG Submission**
  - We aim at submitting the document to the IESG before IETF-104 meeting.