IETF-118 IPMON Side Meeting

Basic Support for IPv6 Networks Operating over 5G Vehicle-to-Everything Communications

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draft-jeong-6man-ipv6-over-5g-v2x-02

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Mobile Objects (MO) for 5G V2X

- **Urban Air Mobility (UAM), Drone, Vehicle, Motorcycle, Scooter, Pedestrian, Unmanned Aerial Vehicle (UAV),Train & Ship.**

UAM (e.g., Flying Car)

Drone

Train

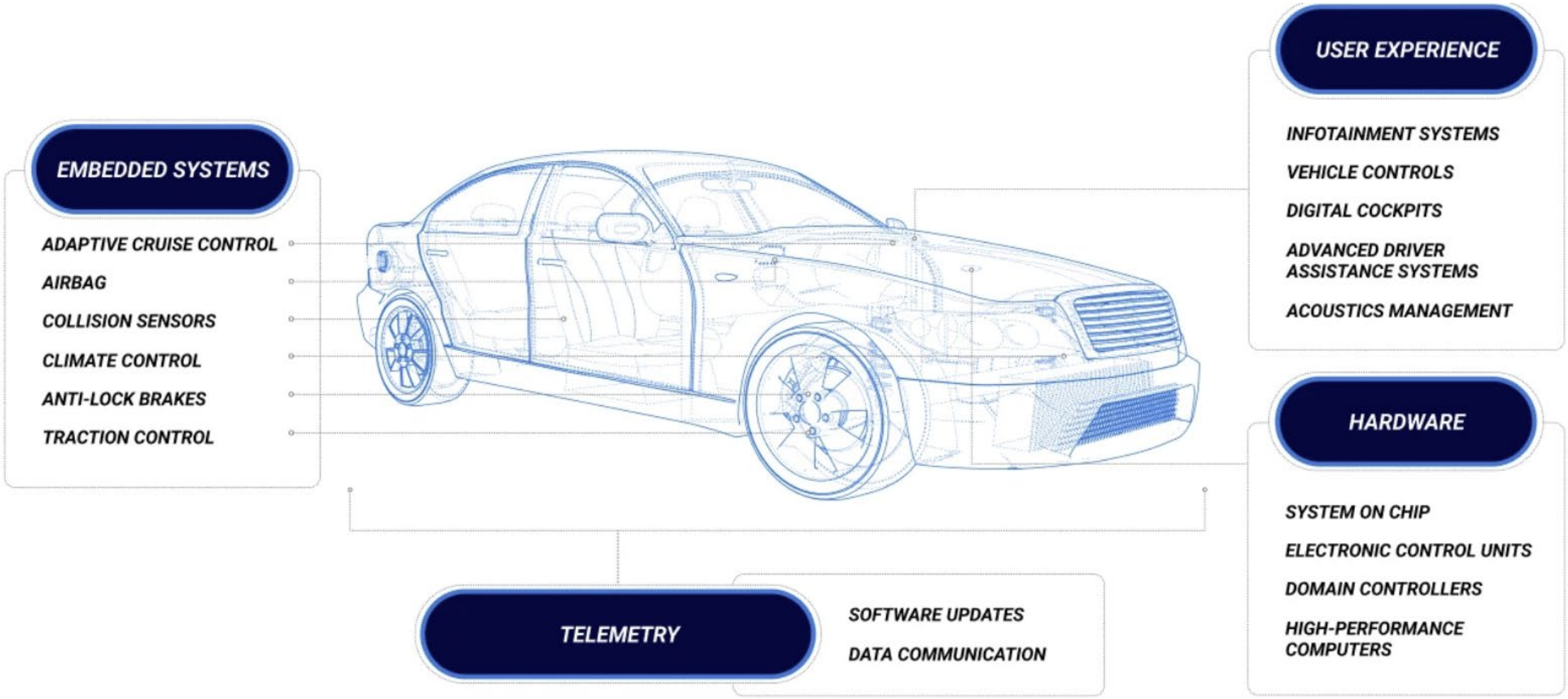
Motorcycle

Vehicle

Pedestrian

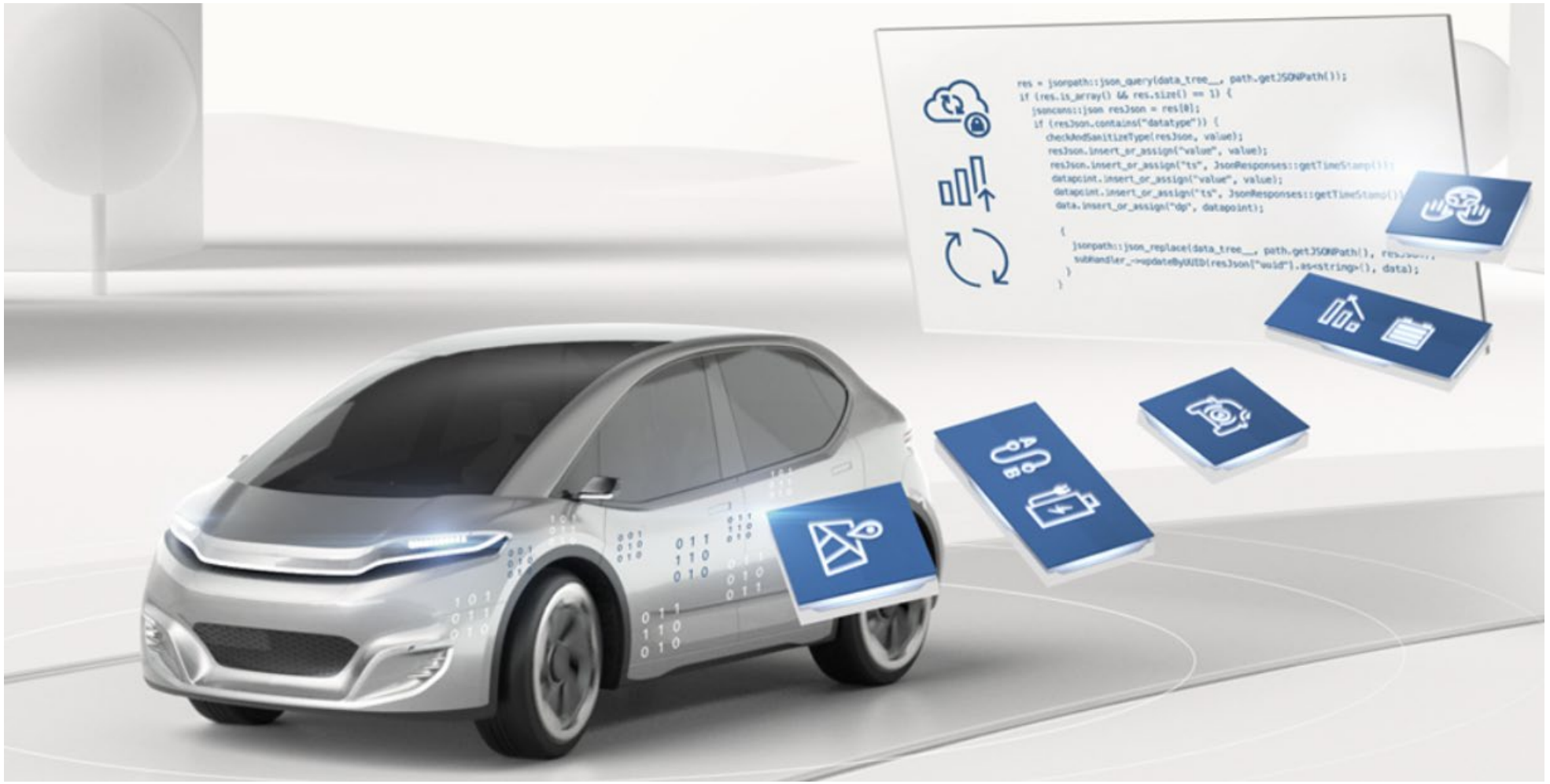
Scooter

Software-Defined Vehicle (SDV) (1/2)



[Source] https://blackberry.qnx.com/en/ultimate-guides/software-defined-vehicle

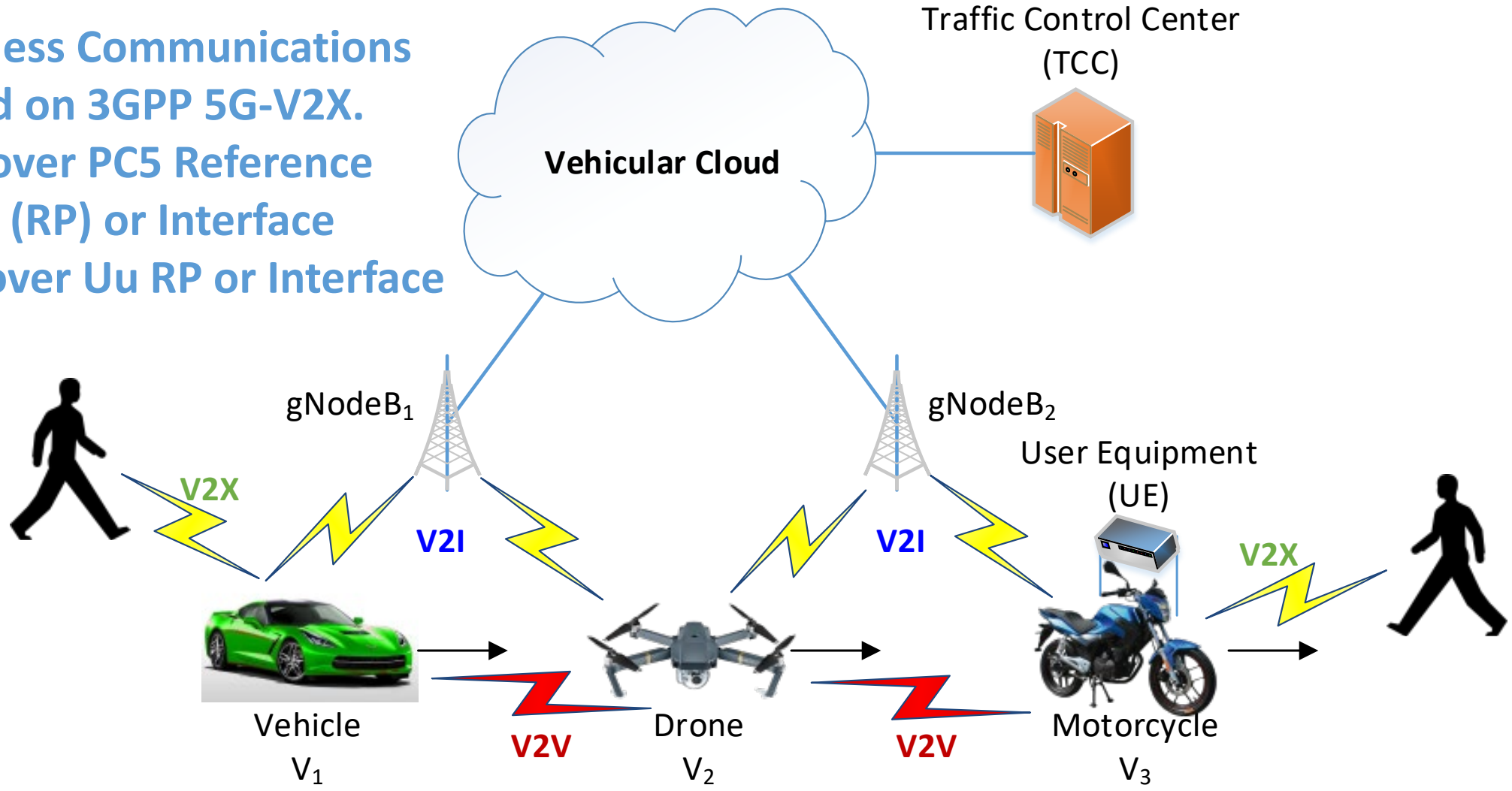
Software-Defined Vehicle (SDV) (2/2)



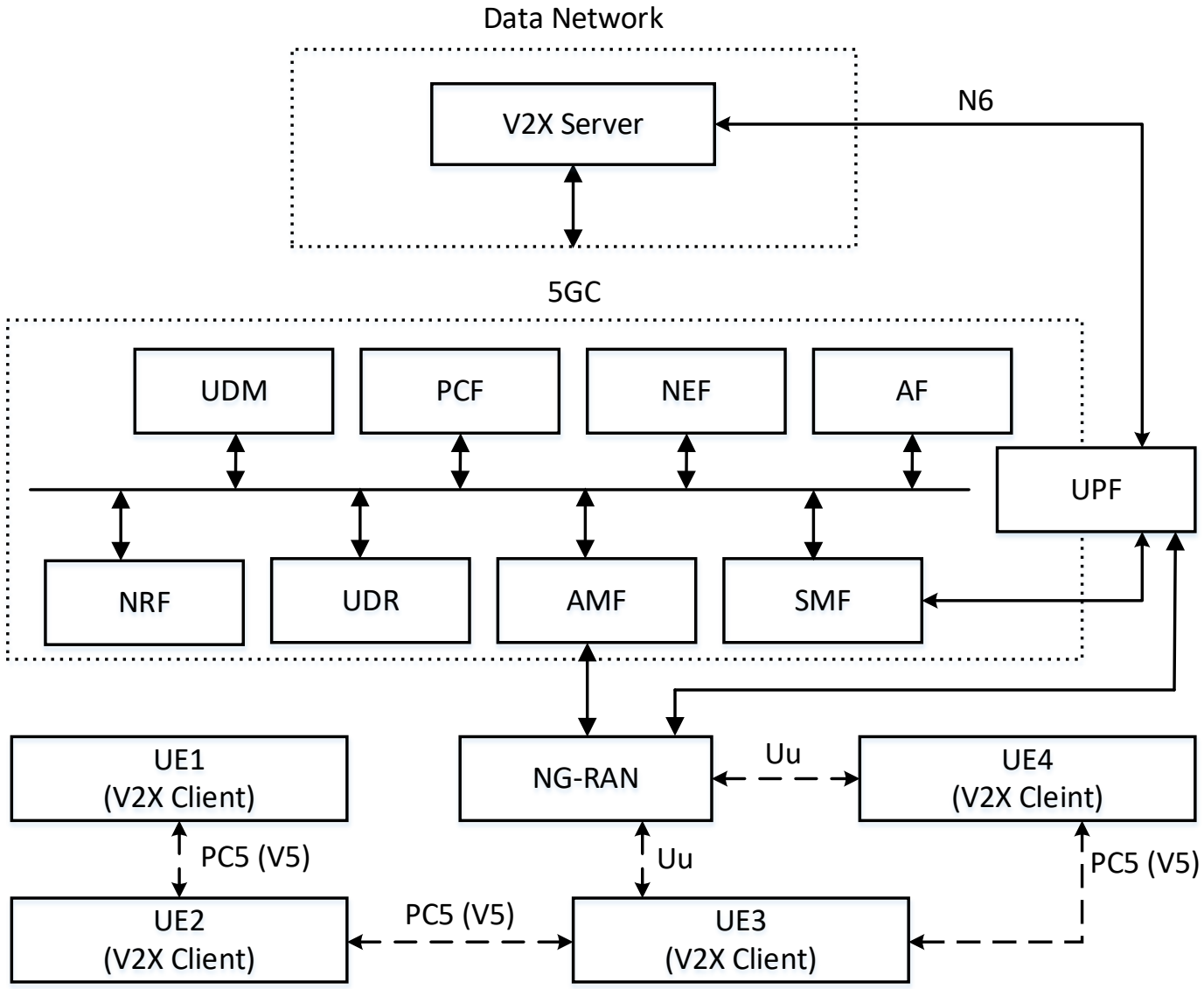
[Source] https://www.bosch-mobility.com/en/solutions/software-and-services/automotive-device-driver-library/

IPv6-Over-5G-V2X Networks for SDVs

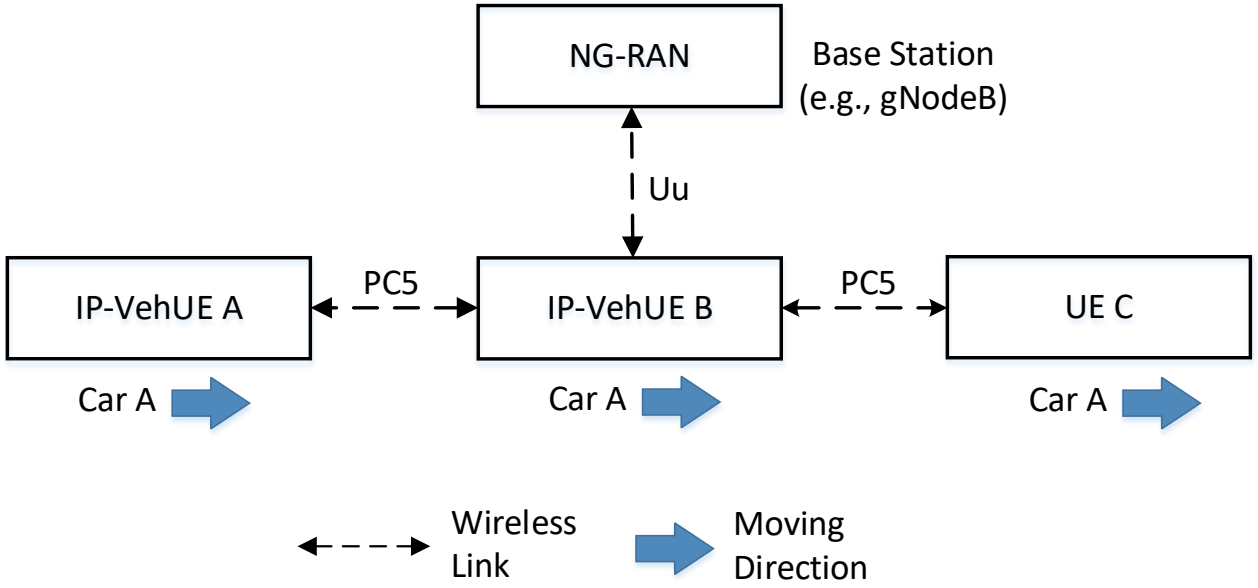
- Wireless Communications based on 3GPP 5G-V2X.
- V2V over PC5 Reference Point (RP) or Interface
- V2I over Uu RP or Interface



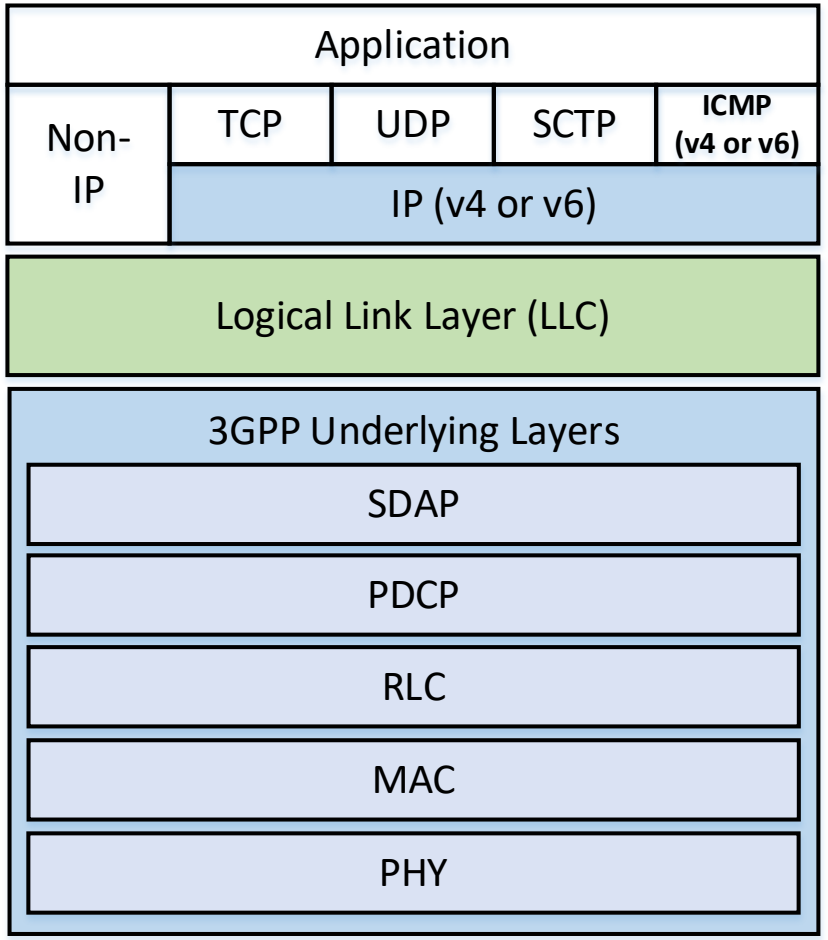
Vehicular Networks with 5G V2X [TS 23.287]



5G V2X Architecture and Protocol Stack

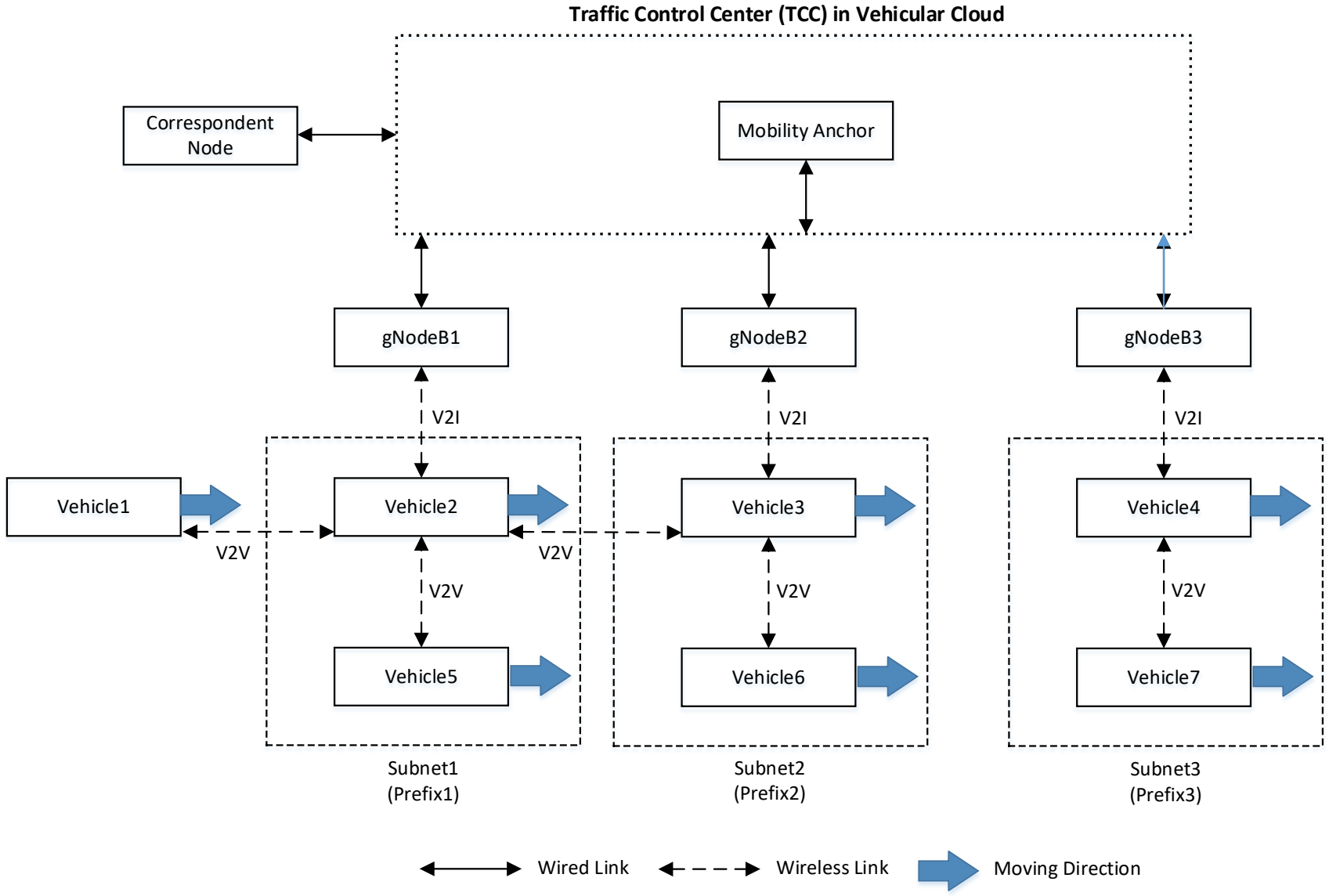


3GPP 5G V2X Architecture



UE's 5G V2X Protocol Stack (Data Plane)

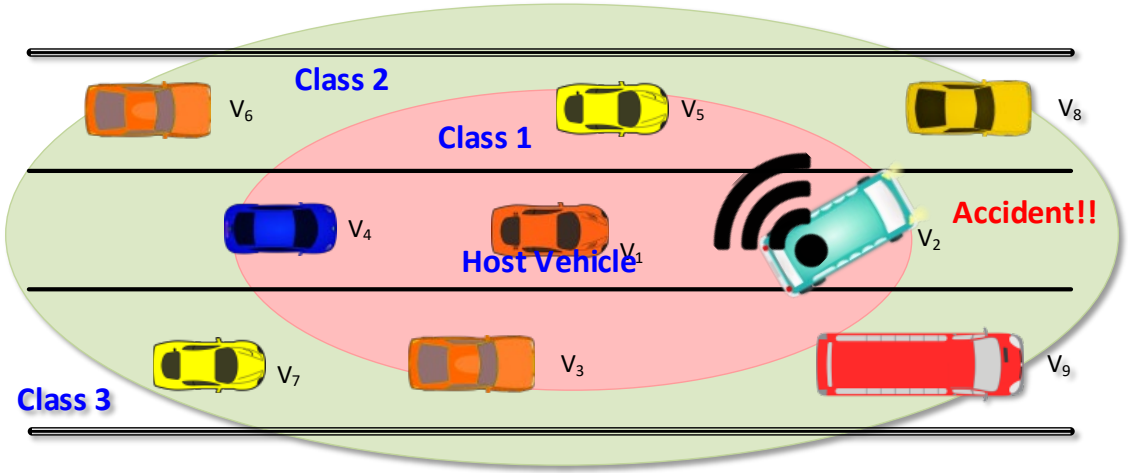
IPv6 Vehicular Networks with 5G V2X



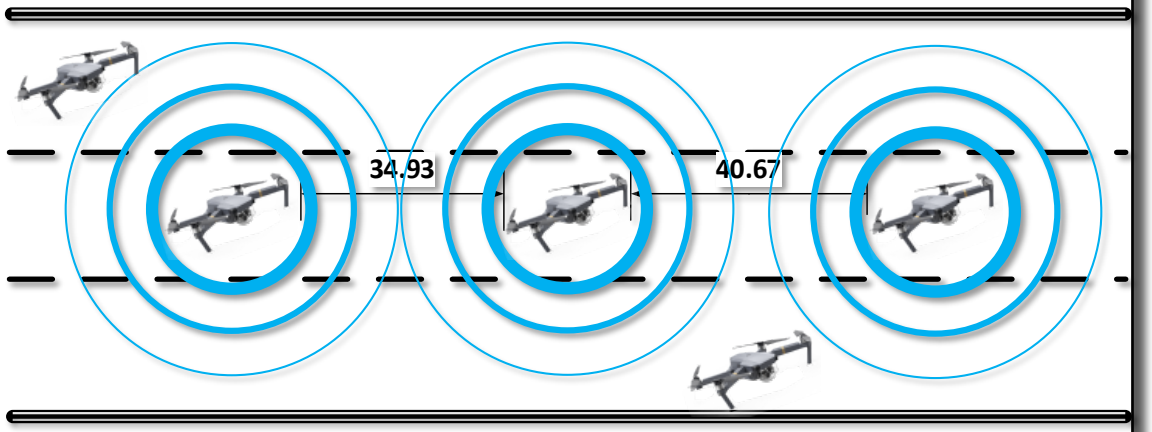
Use Cases of IPv6-Over-5G-V2X

- **V2V Use Cases**
  - Context-Aware Navigation Protocol (CNP) for driving safety
  - Collision avoidance service for Urban Air Mobility (UAM) vehicles
  - Cooperative Adaptive Cruise Control (CACC) on the road
  - Platooning on the highway
  - Cooperative Environment Sensing (CES)
- **V2I Use Cases**
  - Road navigation service
  - Accident notification service
  - Energy-efficient speed recommendation service
  - Vehicle charging service
- **V2X Use Cases**
  - Pedestrian safety service
  - Scooter safety service

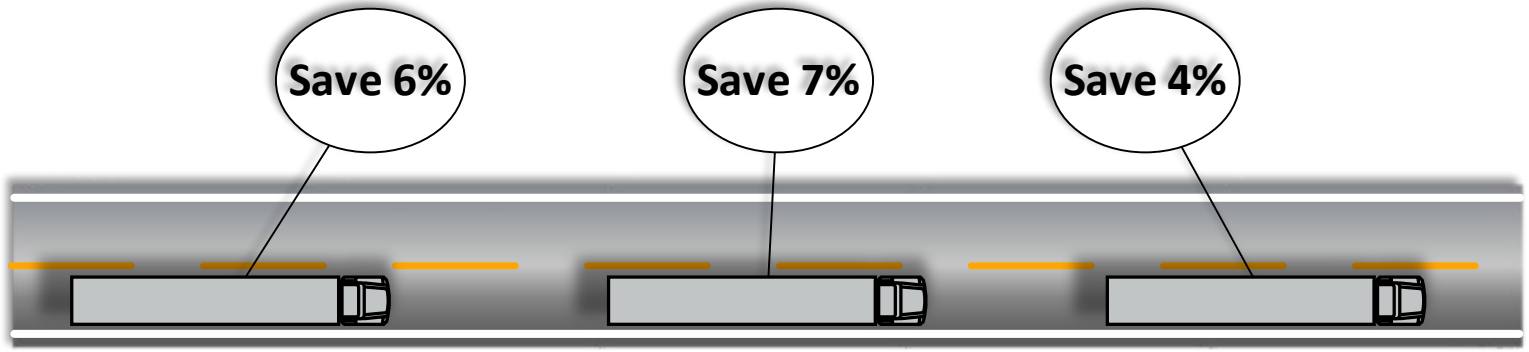
V2V Use Cases



Safe Driving in Road Networks



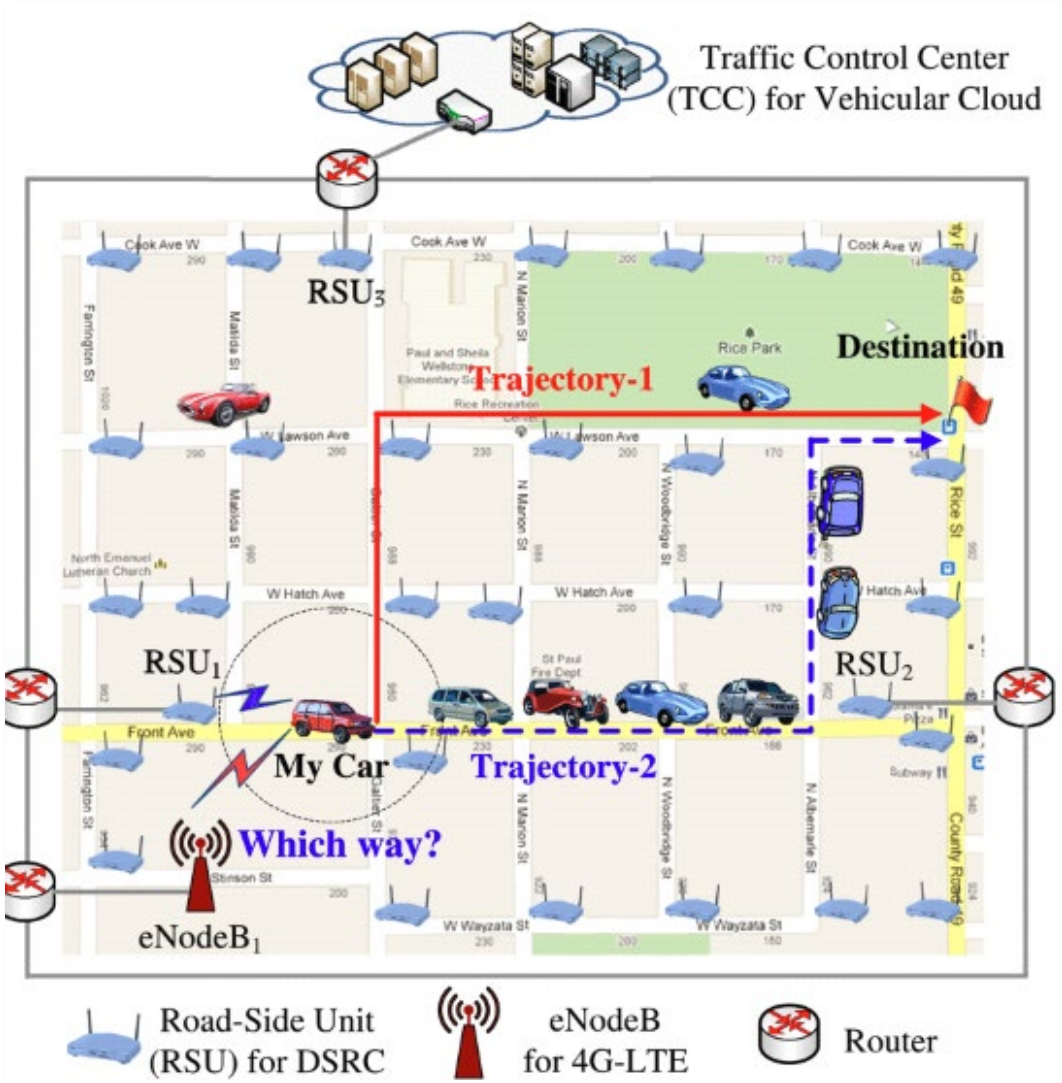
Safe Flying in Drone Networks



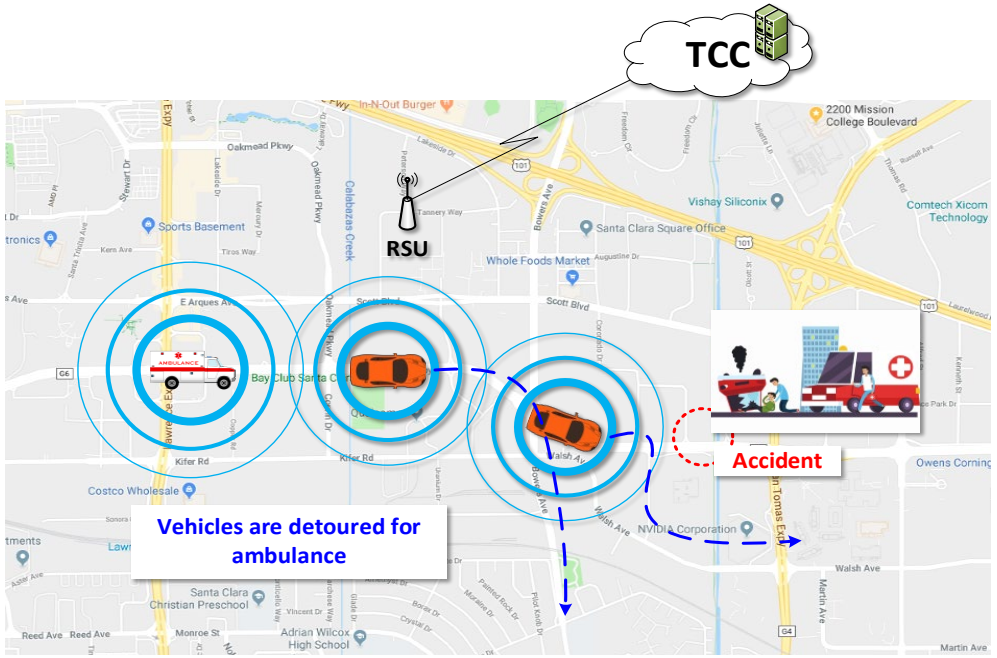
Total energy consumptions are saved by platooning.

Platooning for Efficient Driving

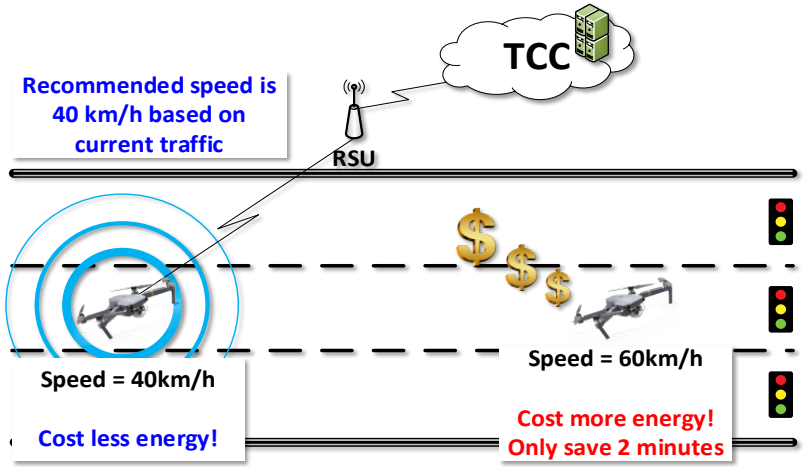
V2I Use Cases



Efficient Navigation for Road Networks

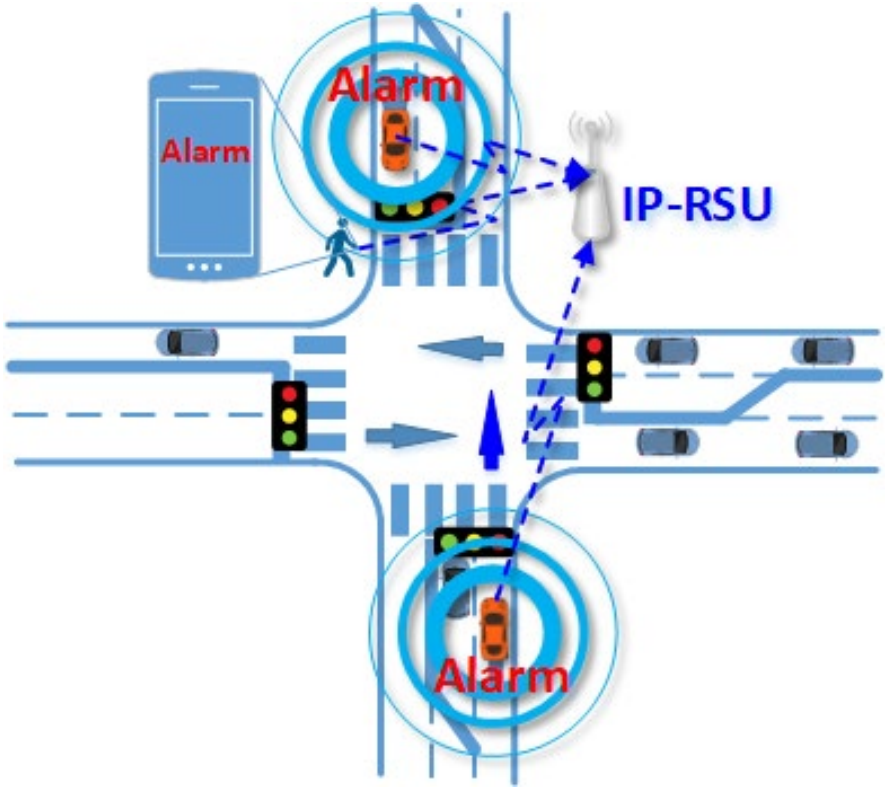


Effective Navigation for Emergency

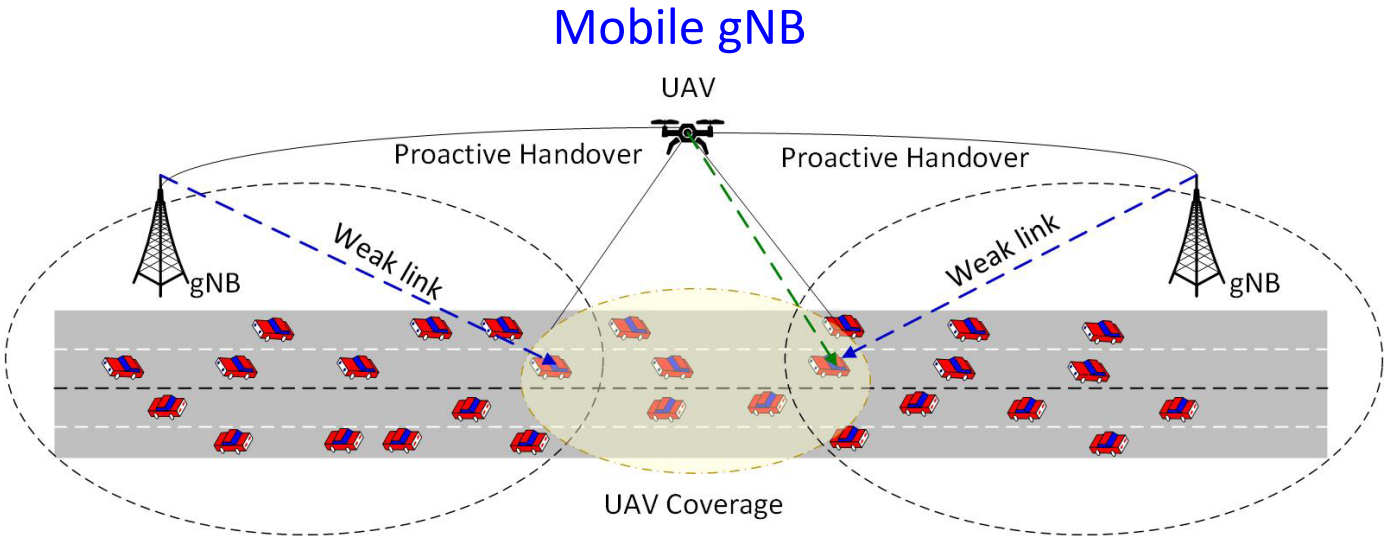


Speed Recommendation for Energy Efficiency

V2X Use Cases



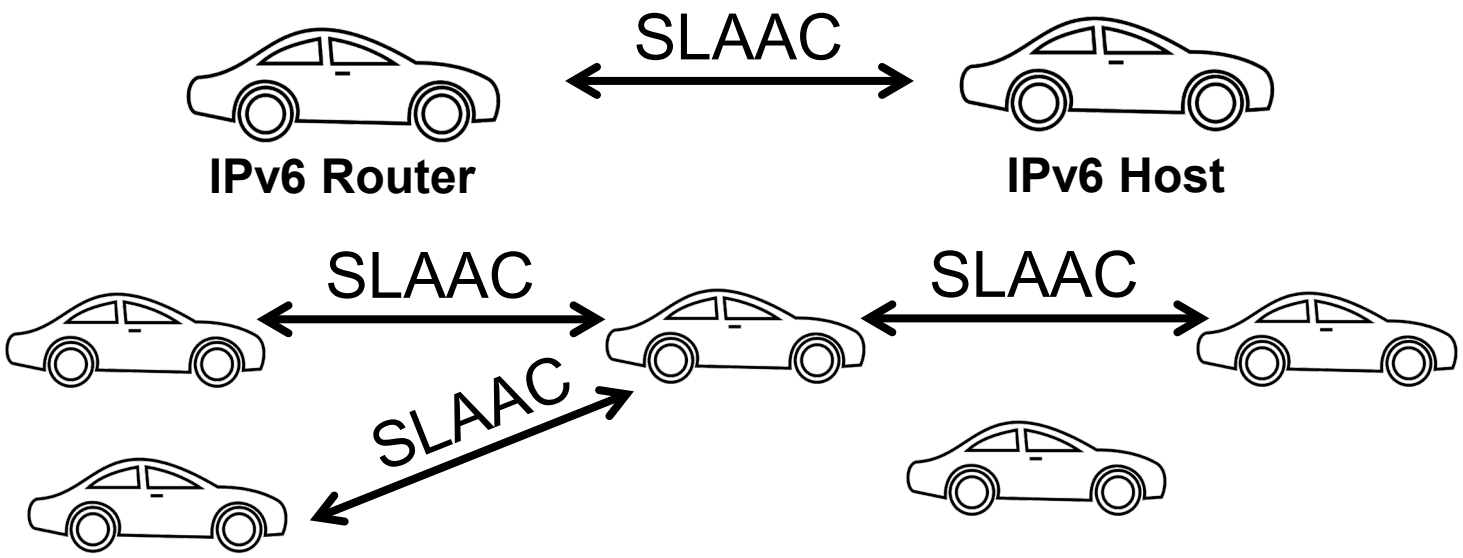
Pedestrian Protection



Blind Spot Coverage in Road Networks with Drones

Observation 1

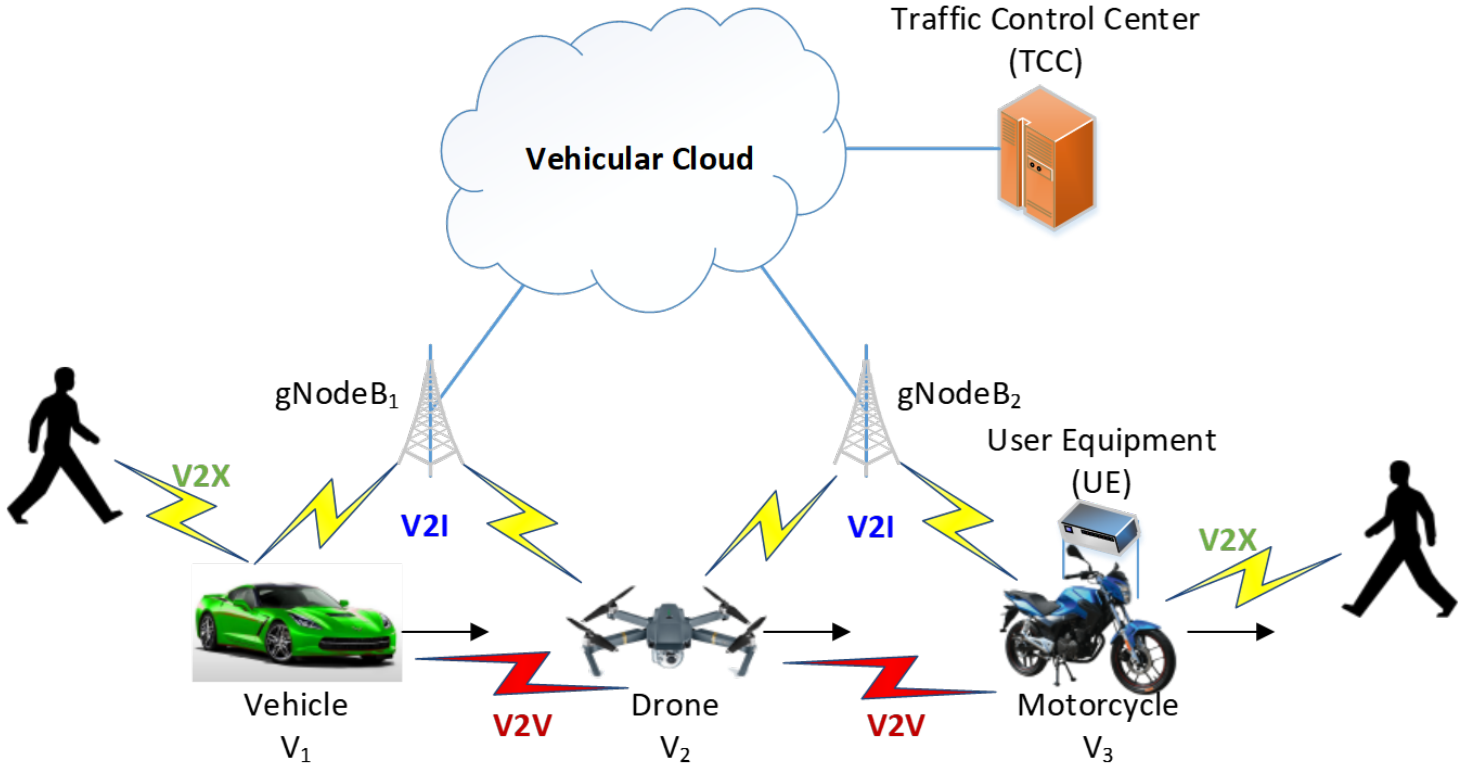
- For 5G V2V by PC5 in **unicast mode**, one vehicle UE (**VehUE**) needs to be an **IPv6 router** for **SLAAC**.



- ✓ **Which one shall be the IPv6 router for SLAAC?**
- ✓ **How many IPv6 addresses/prefixes will a vehicle have in this case?**

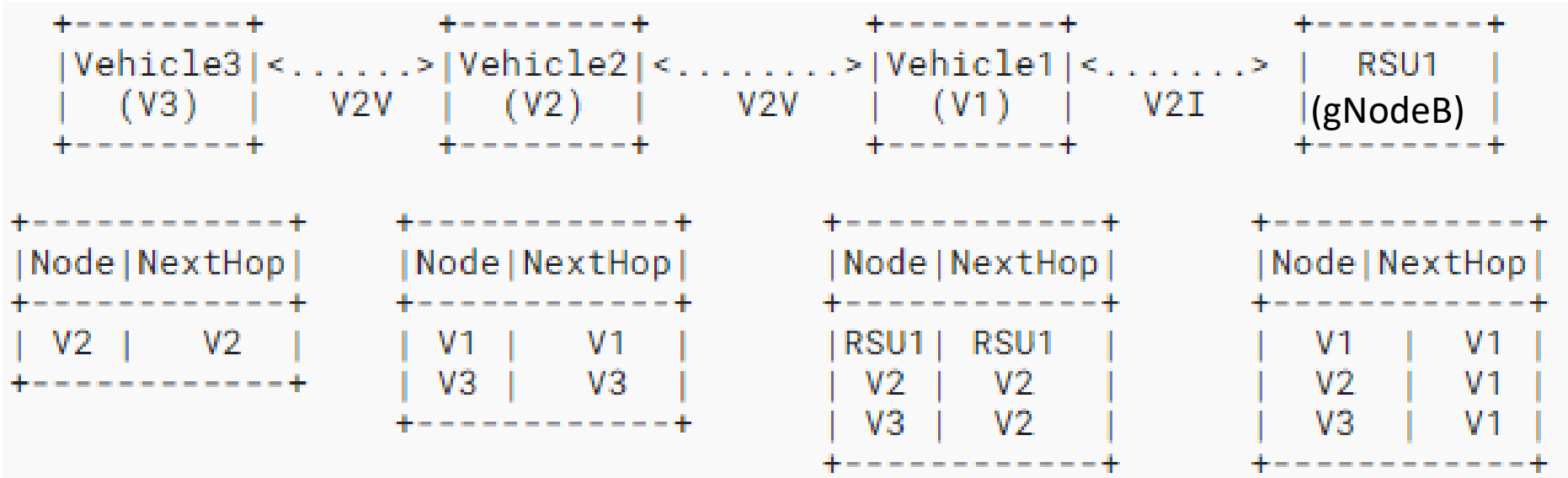
Observation 2

- **For V2V and V2I communications in general, will they use the same IPv6 configuration?**
  - Using the same prefix?
  - Using the different prefixes?



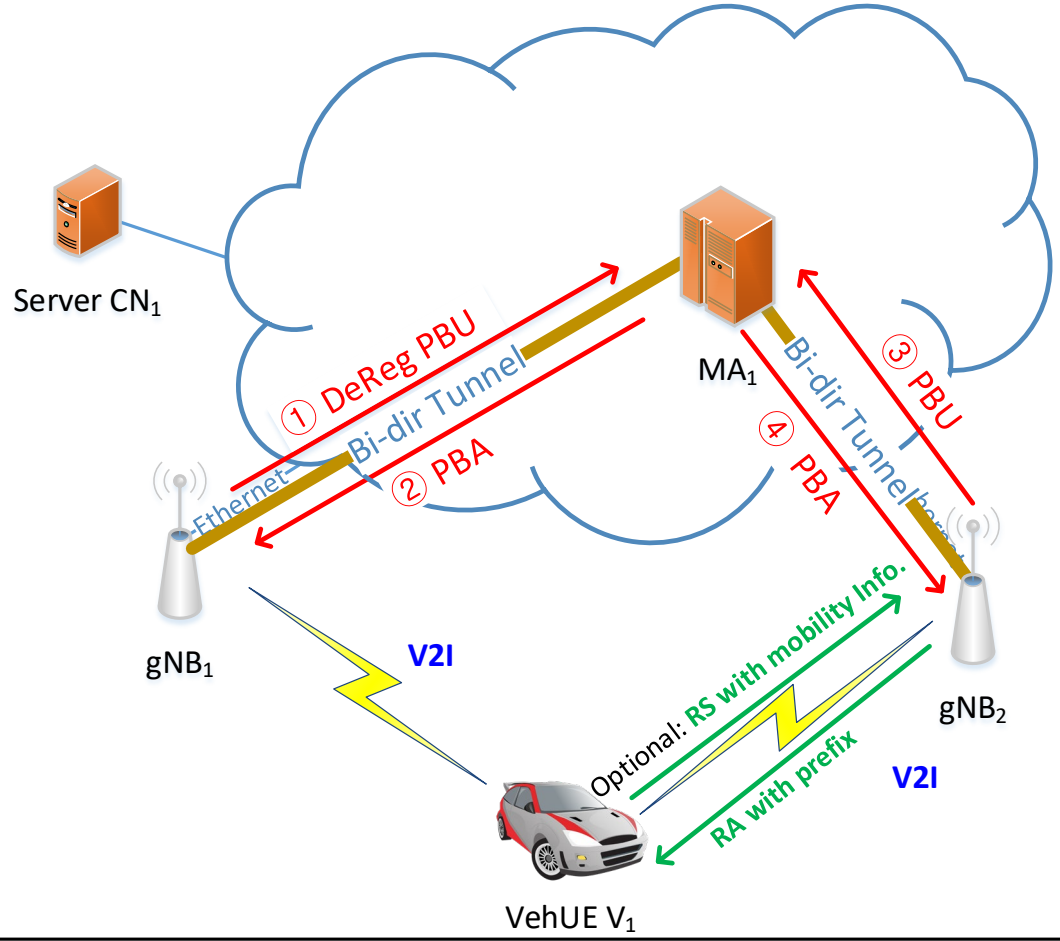
Observation 3

- **For multihop V2V and V2I, existing routing protocols are costly to maintain routing table.**
  - How to minimize control traffic overhead for both routing and IPv6 ND?



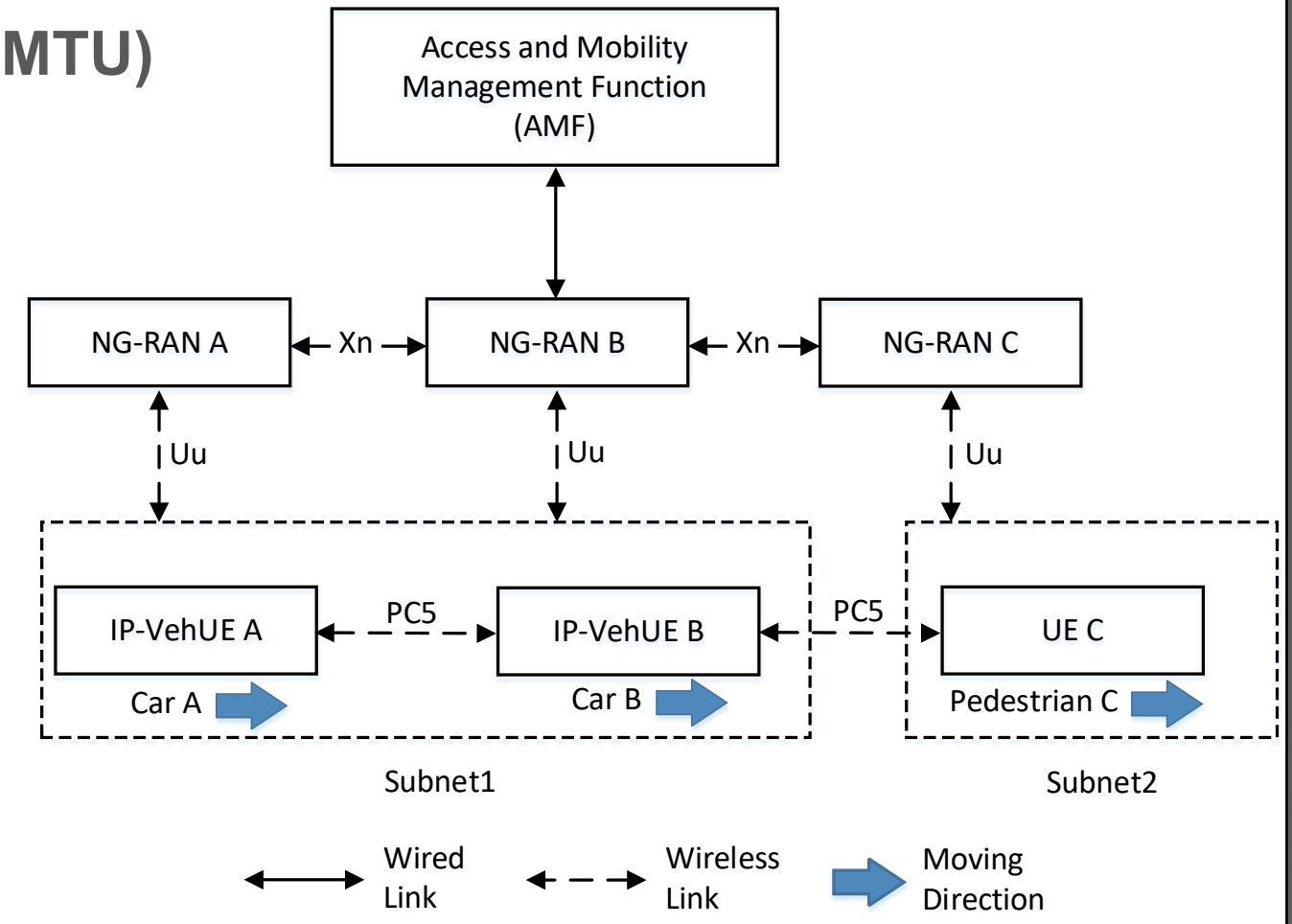
Observation 4

- **Mobility Management in 5G V2X is required for the communications between a VehUE and a Server in Internet.**
  - How to manage IPv6 mobility of vehicles while they move in roadway?



IPv6 Networking over 5G V2X Links

- Maximum Transmission Unit (MTU)
- Frame Format
- Link-Local Addresses
- Subnet Structure
- Stateless Address Autoconfiguration (SLAAC)



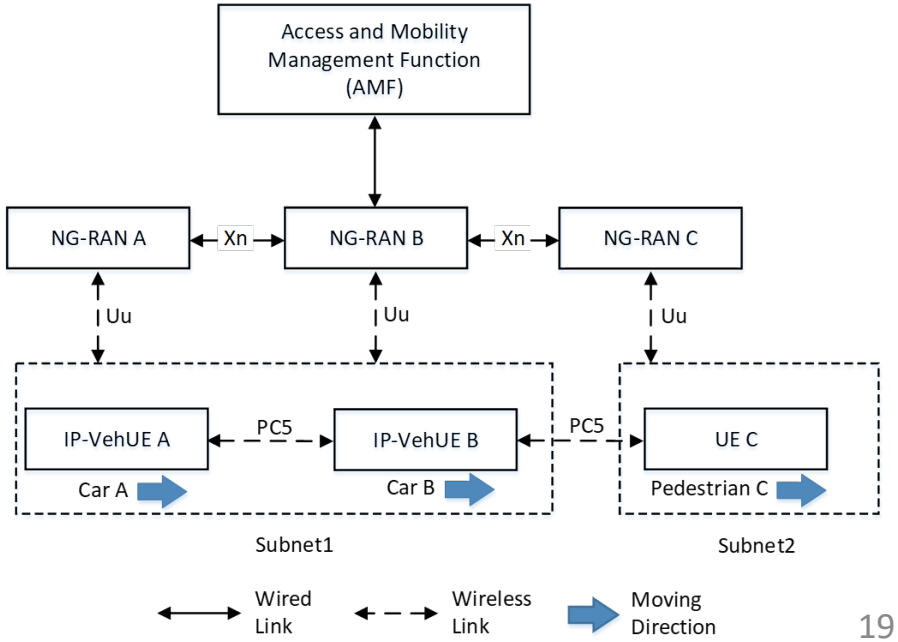
IPv6 Networking over 5G V2X Links

- **Maximum Transmission Unit (MTU)**
  - The default MTU for IP packets on 5G V2X links over both PC5 and Uu RPs is inherited from [RFC2464], which is 1500 octets.
  - As defined in [RFC8200], the 5G V2X links must offer a minimum MTU of 1280 octets to the IPv6 layer.

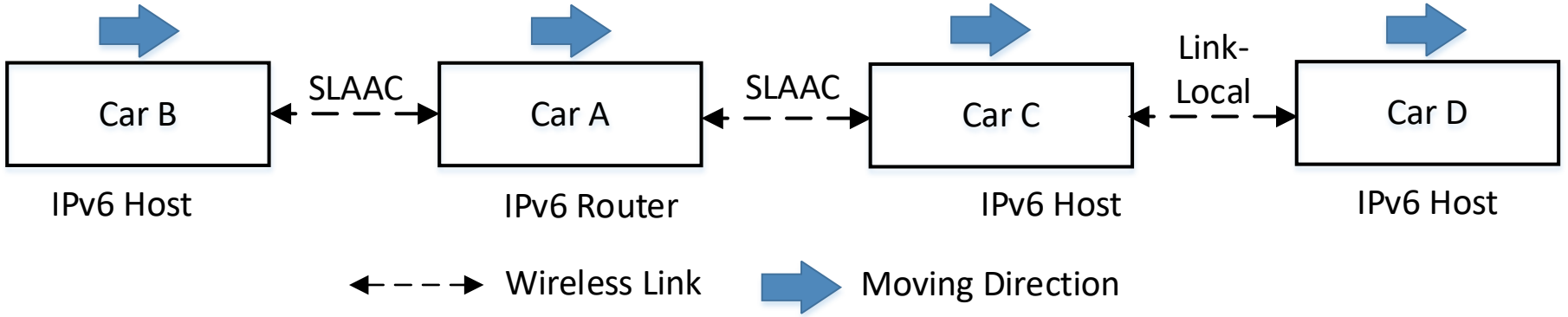
- **Frame Format**
  - IPv6 packets over 5G V2X links follow the general frame format according to the protocol stack defined by 3GPP.

IPv6 Networking over 5G V2X Links

- **Link-Local Addresses**
  - IPv6-based 5G V2X uses link-local addresses for IPv6 packets.
  - To avoid conflicts between link-local address in wireless vehicle networks, the interface identifier used by each IP-VehUE is ensured to be unique through addressing[RFC4291][RFC4193] [RFC7136].
- **Subnet Structure**
  - The 5G-V2X subnet structure supports multi-link subnets for efficient V2V and V2I communications [I-D.jeong-ipwave-vehicular-neighbor-discovery].



IPv6 Stateless Address Autoconfiguration (SLAAC) (1/2)



- When using IPv6 link-local addresses, an IP-VehUE forms the link-local addresses locally without Duplicate Address Detection (DAD) [3GPP TS23287].

- When using SLAAC, an IP-VehUE uses an IPv6 prefix sent by another IP-VehUE acting as an IPv6 default router.

IPv6 Stateless Address Autoconfiguration (SLAAC) (2/2)

- **Issues to solve for IPv6 SLAAC are as follows:**
  - Which VehUE shall be the IPv6 router for the role to assign IPv6 addresses/prefixes if multiple VehUEs can be or want to be an IPv6 router?
  - For a VehUE acting as an IPv6 router, how many IPv6 addresses/prefixes will it assign?
    How much will the role of an IPv6 router burden the IPv6 router VehUE?
  - For a VehUE receiving IPv6 addresses/prefixes from an IPv6 router VehUE, how many IPv6 addresses/prefixes will it have on the movement?
  - If a VehUE (e.g., Car D) does not have any connection with an IPv6 router VehUE, it will only use an IPv6 link-local address for communications.
    In this case, multihop routing is triggered to forward IPv6 packets.
    How will this scenario affect the IPv6 networking among VehUEs?

Next Steps

- **Is this draft valuable to work on it in 6MAN WG?**
- **If so, may this draft be adopted as a WG item now?**
  Or is it needed to develop this draft more?
- **In this IETF-118 IPMON hackathon project, we showed the feasibility for Drones' Safe Flying with IPv4-Over-5G-V2X.**
  - We will work on IPv6-Over-5G-V2X for Drones' Safe Flying for IETF 119.
- **We welcome your comments and feedback ☺**