Survey on IP-based Vehicular Networking for Intelligent Transportation Systems
(draft-jeong-ipwave-vehicular-networking-survey-02)

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Updates from the Previous Versions

- The previous versions are:
  - draft-jeong-ipwave-vehicular-networking-survey-00
  - draft-jeong-ipwave-vehicular-networking-survey-01

- Changes from the previous versions
  - In Section 4.4, <u>cross-layer identities management in ITS stations</u> is added for the IP address autoconfiguration of ITS stations (e.g., vehicles) in vehicular networks using multiple access network technologies.
  - In Section 9, <u>standard activities about vehicular networks</u> are added in the standards developing organizations (SDOs), such as IEEE, ETSI, and ISO.

Introduction to Vehicular Networking

- Objective of this Draft
  - To survey the <u>activities of academia, SDOs, and industry</u> of IP-based vehicular networks for Intelligent Transportation Systems (ITS).

- Assumptions for Vehicular Networks
  - **IEEE 802.11p** is considered as MAC protocol.
  - **IPv6** is considered as a Network-layer protocol.
  - **Road-Side Unit (RSU)** is connected to the Internet as an access point for vehicles.
  - **Traffic Control Center (TCC)** is a central node for managing vehicular networks as vehicular cloud.

Categories for Vehicular Networking

1. IP Address Autoconfiguration
   - **Cross-layer Identities Management in ITS Stations (new subsection)**

2. Vehicular Network Architecture

3. Vehicular Network Routing

4. Mobility Management in Vehicular Networks

5. Vehicular Network Security

6. **Standard Activities for Vehicular Networks (new section)**

IP Address Autoconfiguration

- **Cross-layer Identities Management in ITS Stations**
  - Cross-layer Identity Management in Vehicular Networks using <u>Multiple Access Network Technologies</u>
    - An <u>ITS station</u> (e.g., vehicle) should be <u>correctly identified even with multiple identities</u> for its multiple network interfaces.

  - Consideration in ETSI GeoNetworking
    - For security and privacy constraints, the <u>IPv6 address of a vehicle</u> should be <u>derived from a pseudonym-based MAC address</u> and <u>renewed correspondingly</u>.
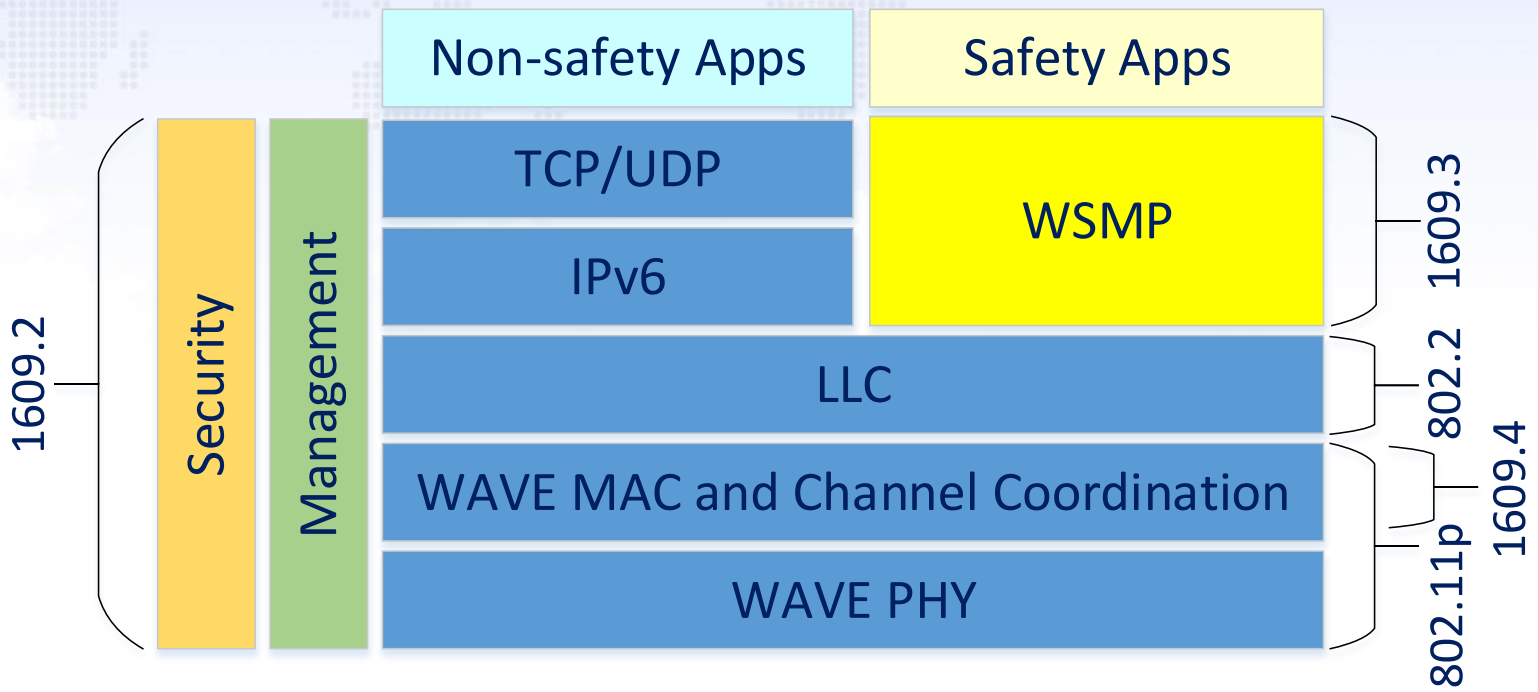
- **IEEE Guide for Wireless Access in Vehicular Environments (WAVE) - Architecture (1/2)**
  - IEEE 1609 is a suite of standards for WAVE developed in the IEEE, which define
    - An architecture and a complementary standardized set of services and interfaces for V2V and V2I communications.

  - IEEE 1609.0 provides a description of the WAVE system architecture and operations.
    - Two data plane protocol stacks, such as <u>IPv6</u> and <u>WAVE Short Message Protocol (WSMP)</u>

- **IEEE Guide for Wireless Access in Vehicular Environments (WAVE) - Architecture (2/2)**

Non-safety Apps	Safety Apps
TCP/UDP	WSMP
IPv6	
LLC	
WAVE MAC and Channel Coordination	
WAVE PHY	

Security — Management — 1609.2

1609.3 — 802.2 — 1609.4 — 802.11p

IEEE 1609.1: Core Systems   IEEE 1609.3: Network Services

IEEE 1609.2: Security   IEEE 1609.4: Channel Management

- **IEEE Guide for Wireless Access in Vehicular Environments (WAVE) - Networking Services**
  - IEEE 1609.3 defines <u>networking services operating at the network and transport layers</u> in WAVE.
    - It provides addressing and routing services within a WAVE system with <u>multiple upper layers</u> (e.g., safety and navigation applications) and <u>multiple lower layers</u> for the network layer and transport layer.

  - It provides requirements for IPv6 configuration, such as address setting.
    - <u>WAVE Routing Advertisement (WRA)</u> provides information about infrastructure internetwork connectivity.
    - <u>WRA removes</u> the need for an <u>IPv6 Router Advertisement (RA) message</u> in IPv6 Neighbor Discovery (ND).
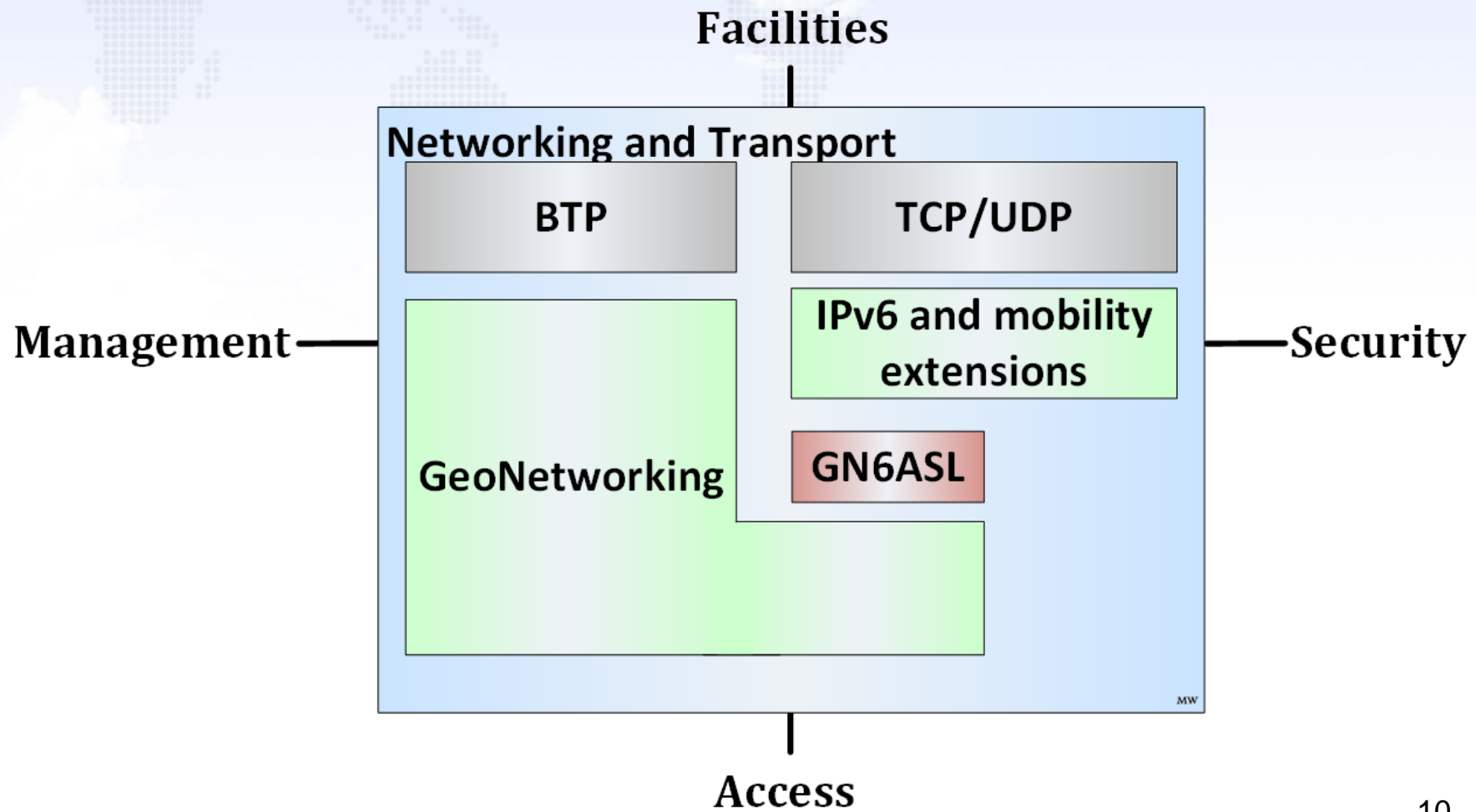
- **ETSI ITS: Transmission of IPv6 Packets over GeoNetworking Protocols (1/3)**
  - ETSI specified the <u>transmission of IPv6 packets over the ETSI GeoNetworking (GN)</u> protocol.
    - <u>GN</u> is defined in **ETSI EN 302 636-4-1**.
    - <u>IPv6 packet transmission over GN</u> is defined in **ETSI EN 302 636-6-1** using a <u>protocol adaptation sub-layer</u> called <u>GeoNetworking to IPv6 Adaptation Sub-Layer (GN6ASL)</u>.

  - The GN6ASL enables the following:
    - IPv6 on V2X communications,
    - Global IPv6 address acquisition (or configuration), and
    - Operating as a mobile router.

- **ETSI ITS: Transmission of IPv6 Packets over GeoNetworking Protocols (2/3)**

Facilities

Networking and Transport

| BTP | TCP/UDP |

GeoNetworking

IPv6 and mobility extensions

GN6ASL

Management — Security

Access

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- **ETSI ITS: Transmission of IPv6 Packets over GeoNetworking Protocols (3/3)**
  - IPv6 over GN protocol introduces three types of virtual links for
    - Symmetric reachability by means of stable geographically scoped boundaries,
    - The support of Neighbor Discovery (ND) protocol including Stateless Address Autoconfiguration (SLAAC),
    - The dynamic definition of a broadcast domain, and
    - The support of the change of pseudonym, i.e., changing IPv6 addresses when the GN address is changed.

Standard Activities for Vehicular Networks (7/7)

- **ISO ITS: Communications Access for Land Mobiles (CALM) Using IPv6 Networking**
  - ISO specified a standard to support the following IPv6 networking:
    - The global reachability of ITS stations (ITS-S),
    - The continuous Internet connectivity for ITS-S, and
    - The handover functionality required to maintain such a connectivity.

  - The standard defines the following IPv6 functional modules that are necessary in an IPv6 ITS-S
    - IPv6 forwarding,
    - Interface between IPv6 and lower layers (e.g., LAN, WLAN interfaces),
    - IPv6 address configuration of static nodes and mobile nodes,
    - Mobility management, and
    - IPv6 security.

Next Steps

- Request for the adoption of this draft as **a WG document** for **"ITS General Problem Area"** in IPWAVE WG with
    - Industry Activities for Vehicular Networking (e.g., GMC, Toyota, Honda, and BMW), and
    - Definitions of General Problem Areas for V2X.

- We will welcome comments from IPWAVE WG.