Motivation for new WI proposal:
Enhancements on LTE-based V2X Services
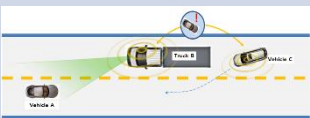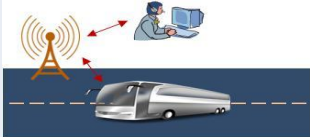
Huawei, HiSilicon

Evolution of LTE-V2X

- The Rel-14 LTE-V2X feature completed in March provides a solid foundation of Cellular based V2X communications.

- It is important to build a strong and stable ecosystem around LTE-V2X, for the sake of competition with 802.11p in the market.

- Evolution of LTE-V2X in Rel-15 timeframe is important, which can avoid sending a wrong message to the automotive industry that LTE-V2X will be out-of-date and be replaced by NR technology in a foreseeable future.

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SA1 eV2X requirements

- SA1 identified 25 use cases for eV2X services and they are categorized into 4 use case groups.
- Rel-15 LTE-V2X evolution will satisfy a certain level of eV2X requirements, which corresponds to a certain degree of automation (e.g. LTE-PC5 cannot support 1Gbps data rate which needs NR design on mmWave).

Use case	Illustration	Description	Payloads (Bytes)	Latency (ms)	Data rate (Mbps)	Range (meters)	Reliability (%)
Vehicles platooning		Vehicles dynamically form a platoon travelling together. Vehicles in the platoon obtain information from the leading vehicle to manage this platoon.	50 - 6500	10 – 25	0.012 - [65]	80 - 350	90 - 99.99
Advanced driving		Vehicle/RSU shares its own perception data obtained from its local sensors with vehicles in proximity and that allows vehicles to coordinate their trajectories.	300 - 12000	3 – 100	10 - 53 (including UL: 50 DL: 0.5)	[360] - [700]	90 - 99.999
Extended sensors		Exchange of data gathered through local sensors or live video images among vehicles, RSUs, Pedestrian and V2X server.	[1600]	3 - 100	10 - 1000	50 - 1000	90 – 99.999
Remote driving		Enables a remote driver or a V2X application to operate a remote vehicle.	-	5	UL: 25 DL: 1	-	[99.999]

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Vehicles Platooning
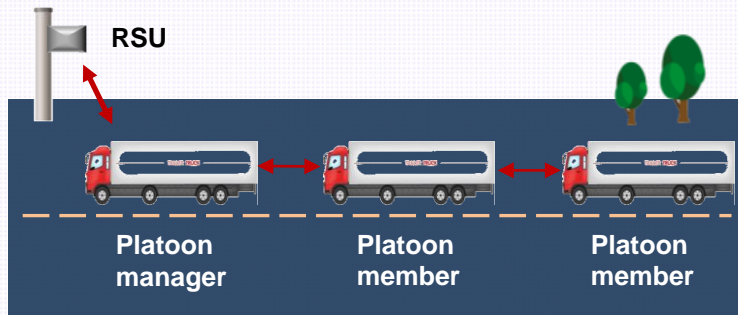
Platooning is an important ITS use case and has received substantial attention from both academia and industry.
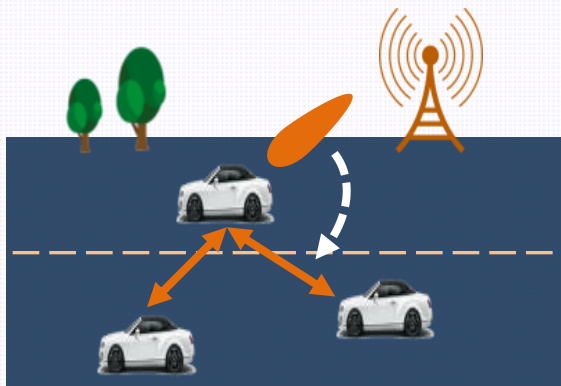
Motivation:
- Truck platooning is one use case that has the most potential to be commercialized in the near future, because it has low requirements on LTE-V2X penetration.

Scope:
- Small SA2/RAN2 changes are expected in order to facilitate the operation of vehicles platooning, as below:
  - Necessary modifications to facilitate the group operations (e.g. platoon announcing/ joining/ leaving, etc) in coordination with SA2, if any;
  - (MAC layer based) Unicast communication over PC5 (Groupcast already supported);

Smooth path switch between Uu and PC5 under the control of RAN

**Path switch from UU to PC5
in case UU is congested**

Motivation:

- RAN network can play a crucial role in improving V2X transmission reliability/efficiency/flexibility by controlling the transmission path based on:

  - The congestion situation of UU/PC5 (e.g. offload to PC5 link if UU is congested)

  - The Importance/QoS of the V2X messages (e.g. choose UU link for more reliable V2X messages delivery)

  - The reliability of PC5 link (e.g. shift to UU link on intersection scenarios where PC5 link may suffer blockage)

Scope:

- Support of non-IP based V2X transmission over Uu interface;

- Minimize the interruption time and data loss upon path switch;

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PC5 KPI performance improvements
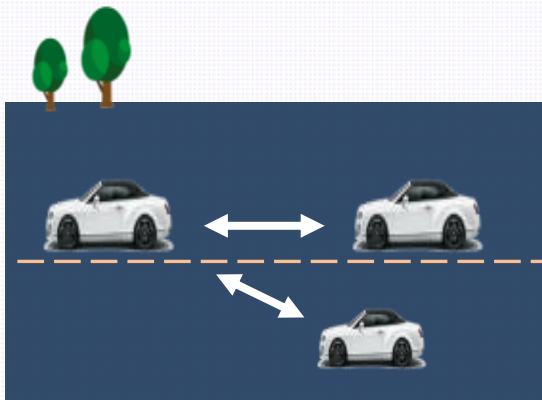
Motivation:
- Improve the PC5 KPI performance to meet the eV2X requirements

Scope:
- Reliability improvement：
    - Transmit diversity
    - Short TTI (to address the half-duplex issue)
- Data rate improvement :
    - Carrier aggregation, 64QAM
- Latency reduction:
    - Short TTI, Enhanced scheduling

WI Objectives

- Specify solutions to facilitate the operation of vehicles platooning, including: [RAN2, RAN3]
    1. Necessary modifications to facilitate the group operations (e.g. platoon announcing/joining/leaving, etc) in coordination with SA2, if any;
    2. Support of MAC layer based unicast transmission over PC5;

    Note: the discovery and pairing mechanism are subject to the application layer.
- Specify solutions for the following PC5 functionalities, which can co-exist in the same resource pools as Rel-14 functionality and use the same scheduling assignment format (which can be decoded by Rel-14 UEs), without causing significant degradation to Rel-14 PC5 operation: [RAN1, RAN2, RAN3, RAN4]
    1. Carrier aggregation;
    2. 64QAM;
    3. Transmission latency reduction (e.g. reduced time between packet arrival at Layer 1 and transmission on the radio);
    4. Radio resource sharing between UEs using mode 3 and UEs using mode 4;
- Study the feasibility and gain of the following PC5 functionalities, assuming those PC5 functionalities would co-exist in the same resource pools as Rel-14 functionality, and specify those PC5 functionalities if justified: [RAN1, RAN2, RAN3, RAN4]
    1. Transmit diversity;
    2. Short TTI;
- Specify solutions to support smooth path switch between Uu link and PC5 link under the control of RAN, including: [RAN2, RAN3]
    1. Support of non-IP based V2X transmission over Uu, with necessary coordination with SA2;
    2. Mechanism to minimize the interruption time and data loss upon path switch;
- Specify necessary RF requirements [RAN4]
- Specify necessary RRM core requirements [RAN4]

Summary

- Evolution of LTE-V2X in Rel-15 timeframe is important, which will allow building a strong and stable ecosystem around LTE-V2X.

- It is proposed to approve the Rel-15 LTE-V2X evolution Work Item at RAN#75.

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Thank you !