3GPP TSG RAN Meeting #74
Vienna, Austria, December 5 - 8, 2016
Agenda Item: 10.1.1

RP-162163

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

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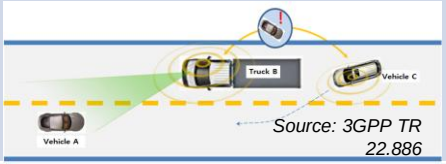
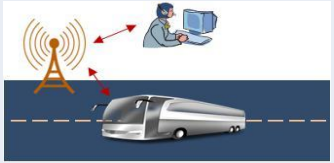
Progress of Rel-14 LTE-V2X

- To expand the LTE platform to the automotive industry, the initial standard on support of V2V services was completed in Sep 2016.

- Further enhancements that focusing on additional V2X operation scenarios leveraging the cellular infrastructure, also for inclusion in Release 14, is targeting completion in March 2017.

SA1 identified eV2X use cases and KPIs

SA1 had identified 25 use cases for advanced V2X services and they are categorized into 4 use case groups. The consolidated requirements for each use case group are captured in TR 22.886.

Use case	Illustration	Description	Payloads (Bytes)	Latency (ms)	Data rate (Mbps)	Range (meters)	Reliability (%)
Vehicles platooning		Enables the vehicles to dynamically form a platoon travelling together. All the vehicles in the platoon obtain information from the leading vehicle to manage this platoon.	50 -1200, Up to [6500]	10 ~ 25	0.012 ~ [65]	200 ~ 300 (Note 1)	90 ~ 99.99
Advanced driving	*Source: GM*	Enables semi/full automated driving. Each vehicle and/or RSU shares its own perception data obtained from its local sensors with vehicles in proximity and that allows vehicles to synchronize and coordinate their trajectories or manoeuvres.	450 ~ [6500]	[3] ~ [100]	[10] ~ [53] (including UL: [50] DL: [0.5])	[5] ~ [10] sec * max relative speed	[99.99] ~ [99.999]
Extended sensors	 *Source: 3GPP TR 22.886*	Enables the exchange of raw or processed data gathered through local sensors or live video images among vehicles, road site units, devices of pedestrian and V2X application servers.	[1600]	3 ~ 100	[25] ~ 1000 Mbps	50 ~ 1000	90 ~ 99.999
Remote driving		Enables a remote driver or a V2X application to operate a remote vehicle for those passengers who cannot drive by themselves or remote vehicles located in dangerous environments.	[X]	5 ~ [20]	UL: 20 ~ 25 DL: 1		[99.999]

Note 1: Estimated distance between the leading and last vehicle in the platoon of up to 5 vehicles.

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General view of Rel-15 LTE-eV2X

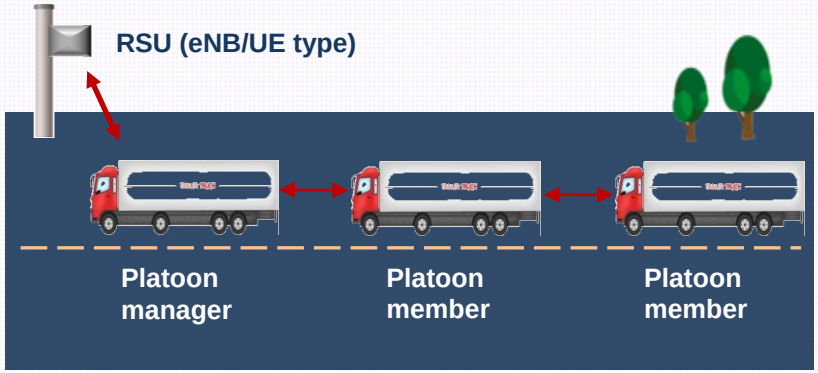
- TR 22.886 specifies multiple levels of requirements (i.e. a range of KPI values) for each advanced V2X service, which corresponds to different level of automation.

- Rel-15 LTE-eV2X can satisfy a certain level of requirements, subject to different advanced V2X services. For example, even Rel-14 LTE-V2X can already satisfy the lowest level of requirements for vehicles platooning, as below:
  - Latency = 25ms
  - Data rate = 0.012Mbps
  - Reliability = 90%
  - Range = 200m

- Rel-15 LTE-eV2X needs to be backward compatible with Rel-14 LTE-V2X.

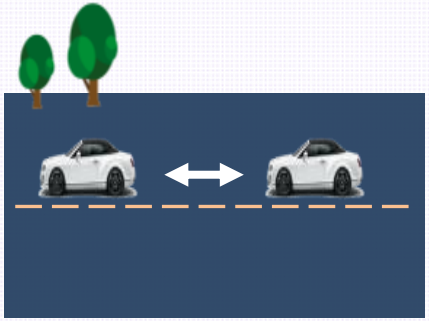
In Release 15, it is important to continue the evolution story of LTE-V2X (V2V, V2I/N, and V2P) to keep the superiority of LTE-V2X as compared to 802.11p.

Support of Vehicles Platooning

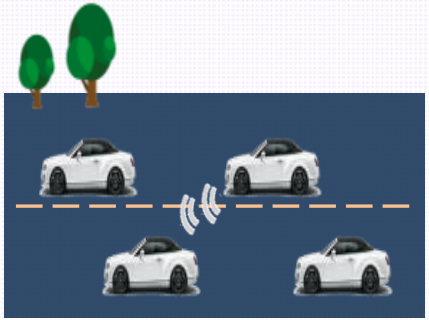


- Procedures to enable platoon group operations, such as announcing/joining/leaving one platoon or merging different platoons, etc
- Support of one-to-one communication between two platoon members
- Relay to support delivery of V2X messages between RSU and platoon members via the platoon manager
- Enhancements on radio resource allocation, synchronization and power control for vehicles in one platoon group

Efficient and reliable PC5 communication



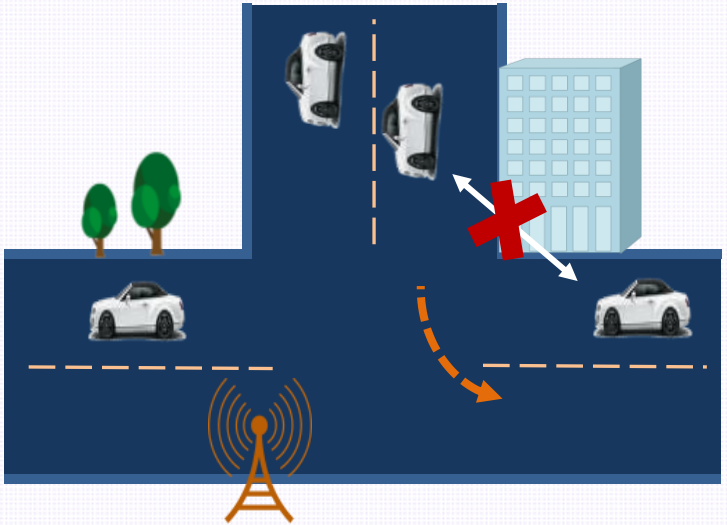
PC5 transmission (one-to-one) and feedback



PC5 transmission (one-to-many) and feedback

Consider Layer 1 or layer 2 feedback to support efficient and reliable PC5 communication between two vehicles (i.e. one-to-one communication) and between a group of vehicles (i.e. one-to-many communication)

Smooth path switch between Uu link and PC5 link



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

1. Support of non-IP based V2X transmission over PC5/Uu interface
2. Vehicles should be able to know the (potential) unreliability of PC5 link or Uu link, and to perform the path switch
3. Data loss upon path switch should be minimized

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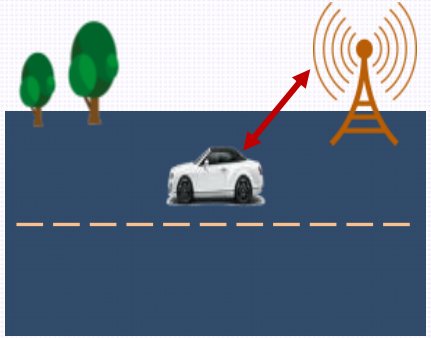
Enhancements on eV2X over Uu interface

High reliability and low latency Uu transmission



- Support of short TTI (i.e. 2 OFDM symbol length) is under specifying in Rel-14.
- Further enhancement on UU interface, by e.g. exploiting frequency/spatial/time diversity or fast HARQ, to meet the following target:
  - Reliability = $1\text{-}10^{-5}$,
  - User plane latency = 10 ms
  - Packet size = 300 bytes

NOTE: Support of High reliability and Low latency Uu transmission will be addressed by a separate SI/WI.

UL HARQ/CSI feedback for SC-PTM transmission

- By link adaptation allowed by UL HARQ/CSI feedback for vehicles in RRC_CONNECTED, efficient and reliable SC-PTM transmission for V2X messages can be achieved.

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Other potential Rel-15 LTE-eV2X enhancements

- Further enhancements on congestion control
- RAN4 RF aspects, e.g. de-prioritized MCC operation scenarios in Rel-14 LTE-V2X.

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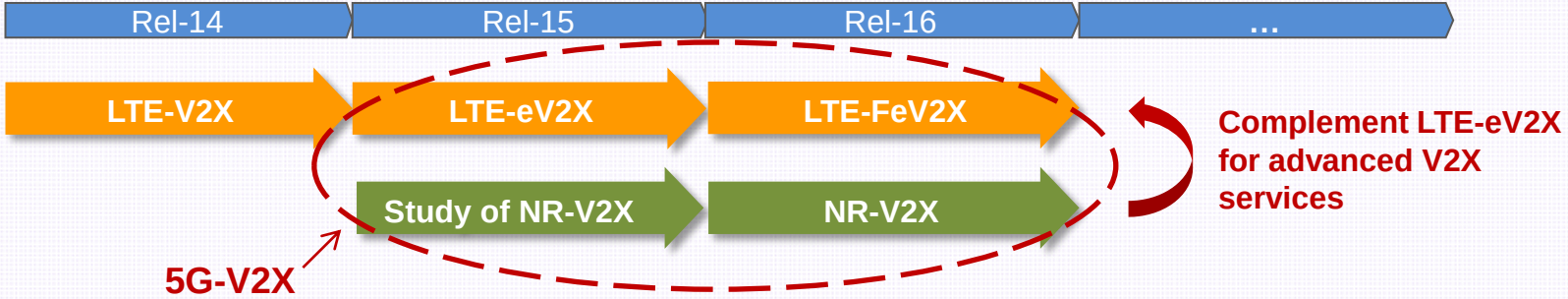
Relationship with NR-V2X

- In Rel-15, LTE-eV2X and NR-V2X study can proceed in parallel.
- NR-V2X study needs to consider how to complement LTE-eV2X for advanced V2X services, as per the following agreement in TR 38.913:

> 10.4.3 V2X communication
>
> It is not intended for NR V2X to replace the services offered by LTE V2X. Instead, the NR V2X shall complement LTE V2X for advanced V2X services and support interworking with LTE V2X.

- Postpone the decision on NR-V2X study to RAN#75 as per the agreement on “Prioritization discussion for New Radio Access Technology SI” made at RAN#73 (RP-161914).



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Conclusion and proposal

- **In Rel-15, it is important to continue the evolution story of LTE-V2X (V2V, V2I/N, and V2P) to keep the superiority of LTE-V2X as compared to 802.11p.**

- **Approve the Rel-15 LTE-eV2X Work Item at RAN#75.**

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Thank you !

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