



3GPP TSG RAN Meeting #75  
Dubrovnik, Croatia, March 6 - 9, 2017  
Agenda Item: 10.1.4

RP-170285

# Motivation for SI proposal: Study on Advanced Receivers for LTE V2X

**Intel Corporation**

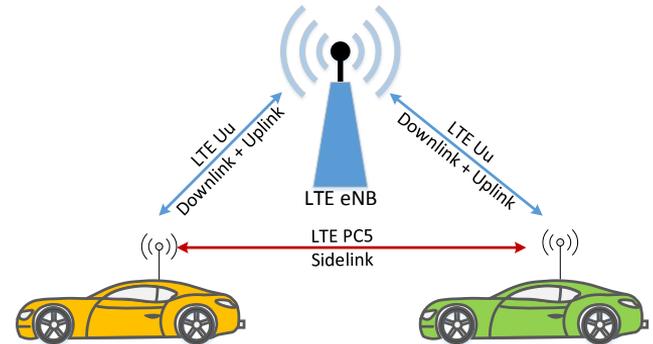
# Study Item Justification

## LTE Vehicular Communication

Work on Rel-14 LTE V2V & V2X WIs is progressing towards completion

LTE V2V/V2X defines enhancements for two complementary air-interfaces: PC5 and Uu

- LTE PC5 (Sidelink-SL) V2X enhancements
  - eNB controlled mode: SL SPS scheduling + Reporting of location information
  - UE autonomous mode: Sensing & resource selection + Geo-zoning
  - Enhancements of L1 structure for robust performance at high speeds
  - GNSS synchronization (GNSS as sync reference for time/frequency)
- LTE Uu (downlink-DL/uplink-UL) V2X enhancements
  - MBMS and SC-PTM Downlink transmissions
  - Uplink SPS enhancements to efficiently handle quasi-periodic V2X traffic



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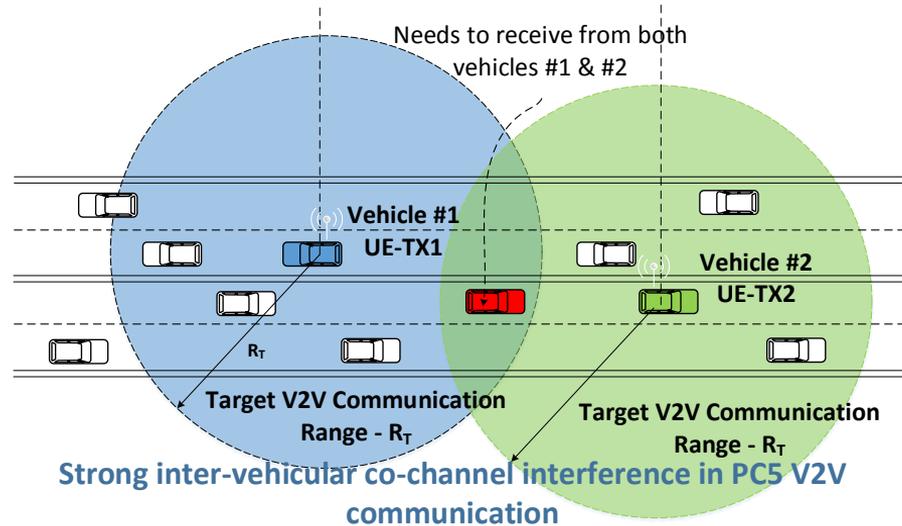
## PC5 V2X Receiver Enhancements

SL V2X transmissions are broadcast and RX nodes should attempt to receive all incoming signals

In the dense environments V2X transmissions (PSSCH/PSCCH) may collide in the same time/frequency resources leading to interference-limited RX conditions

Rel-14 SL V2X design assumes that UE would perform only **single packet decoding** in case of multiple PSCCH/PSSCH collisions

Rel-14 SL V2X performance requirements are based on the **interference unaware** MMSE-MRC processing



*Advanced UE receivers can be applied to improve SL V2V communication performance and enable joint reception of broadcast V2X PSSCH/PSCCH signals coming from different sources*

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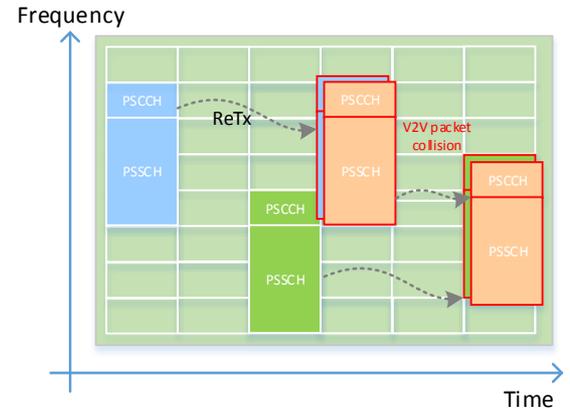
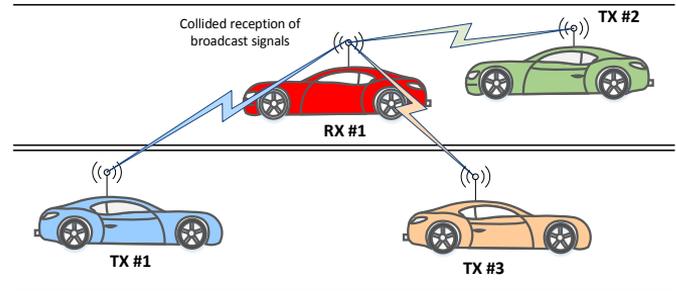
## PC5 V2X Receiver Enhancements

### MULTI-PACKET DECODING

- Rel-14 requirements imply that UE would make single packet decoding in case of multiple PSSCH/PSCCH collisions
- Advanced receivers may be capable to perform **multi PSSCH/PSSCH packet decoding** at the cost of increased complexity. 2+ decoding iterations may be considered.

### INTERFERENCE HANDLING

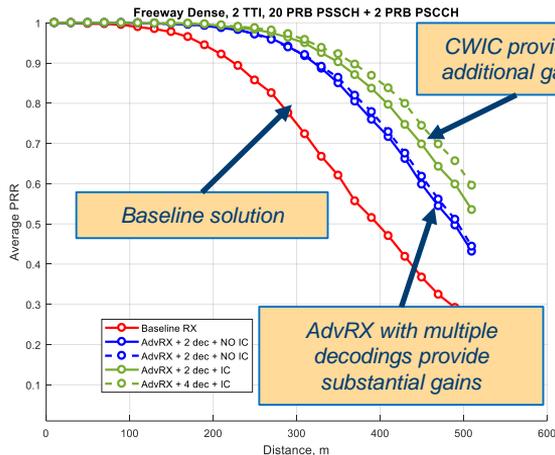
- Rel-14 requirements are based on interference unaware receivers and **IS/IC receivers** can be used to improve SL V2X performance
- SL V2X communication parameters are broadcasted via PSCCH and PSSCH interference signal parameters can be easily obtained
- Different IS/IC receiver types can be used to ensure improved UE demodulation performance including LMMSE-IRC, Symbol-level IS/IC (SLIC) and Codeword-level interference cancellation (CWIC)
- CWIC receivers are expected to provide the best performance



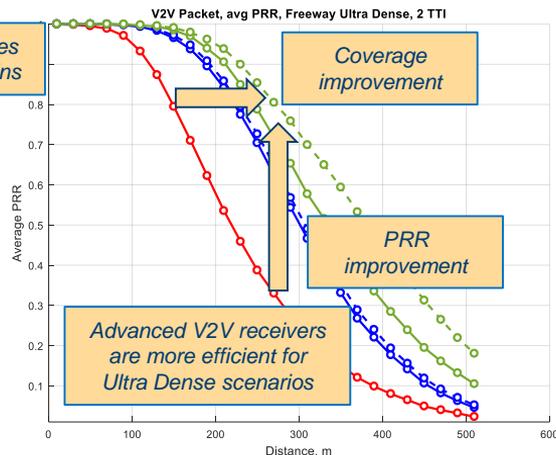
# Study Item Justification

## System-level performance

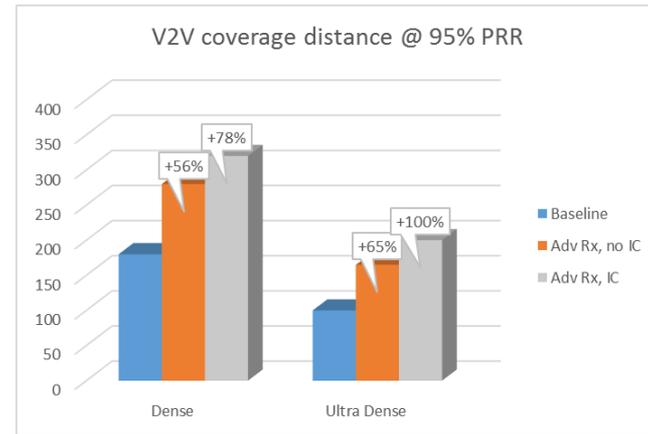
Freeway Dense (70 km/h)



Freeway Ultra Dense (35 km/h)



V2V Communication Coverage



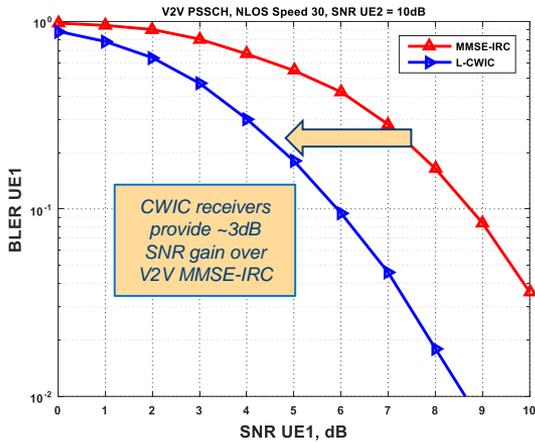
<b>Deployment</b>	Freeway Dense (70 km/h) Freeway Ultra Dense (35 km/h)
<b>V2V parameters</b>	PSSCH - 20 PRB, 2 TTIs ; PSCCH – 2 PRB
<b>Receiver</b>	Option 1: Baseline RX (1 decoding, No IC, MMSE-IRC) Option 2: Advanced RX + Multiple decodings Option 3: Advanced RX + CWIC

*Advanced V2V receivers may ensure substantial coverage gains and PRR improvement under typical V2V scenarios*

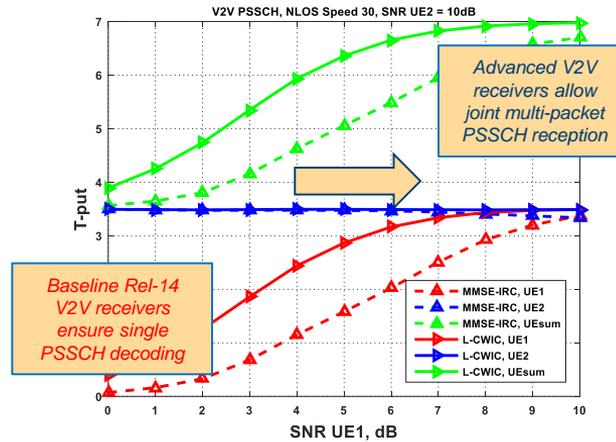
# Study Item Justification

## Link-level performance (2 UEs + 1 TTI PSSCH)

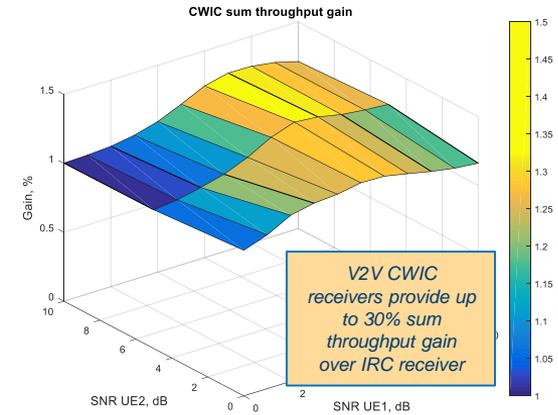
UE<sub>1</sub> BLER vs SNR  
SNR UE<sub>2</sub> = 10 dB



Throughput vs SNR  
SNR UE<sub>2</sub> = 10 dB



Sum throughput gain (CWIC/IRC)



Enhanced V2V receivers allow achieving substantial link-level performance improvement over legacy Rel-14 receivers

# Study Item Justification

## Summary

### Conclusions

- Support of efficient vehicular communication is one of the key directions of further LTE evolution
- In LTE Rel-14 initial V2V functionality was introduced. The Rel-14 LTE V2V demodulation requirements are based on the single packet decoding assumptions and non-interference aware processing.
- System- and link-level analysis show substantial benefits of supporting advanced V2V receivers based on the two key features: 1) Joint multi-packet decoding and 2) Interference cancellation

### Proposal

- Organize RAN4 Advanced V2V receivers study item to investigate the proposed enhancements

# Study Item Objectives

## Study feasibility of advanced LTE V2X receivers for Sidelink [RAN4]

- Identify and agree on the target scenarios and assumptions including
  - Realistic deployment scenarios (based on Rel-14 RAN1 work)
  - Interference models and simulation assumptions for link-level evaluations
- Identify reference advanced LTE V2X receiver structures and evaluate their performance/complexity trade-off and implementation feasibility including at least
  - Investigate feasibility of using processing (incl. decoding) of multiple overlapping PSCCH/PSSCH
  - Investigate feasibility of the following receiver structures including LMMSE-IRC and CWIC
- Evaluate advanced LTE V2V receivers performance benefits

