

Impacts of C-ITS Communication Technologies on Safety

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4th September 2019

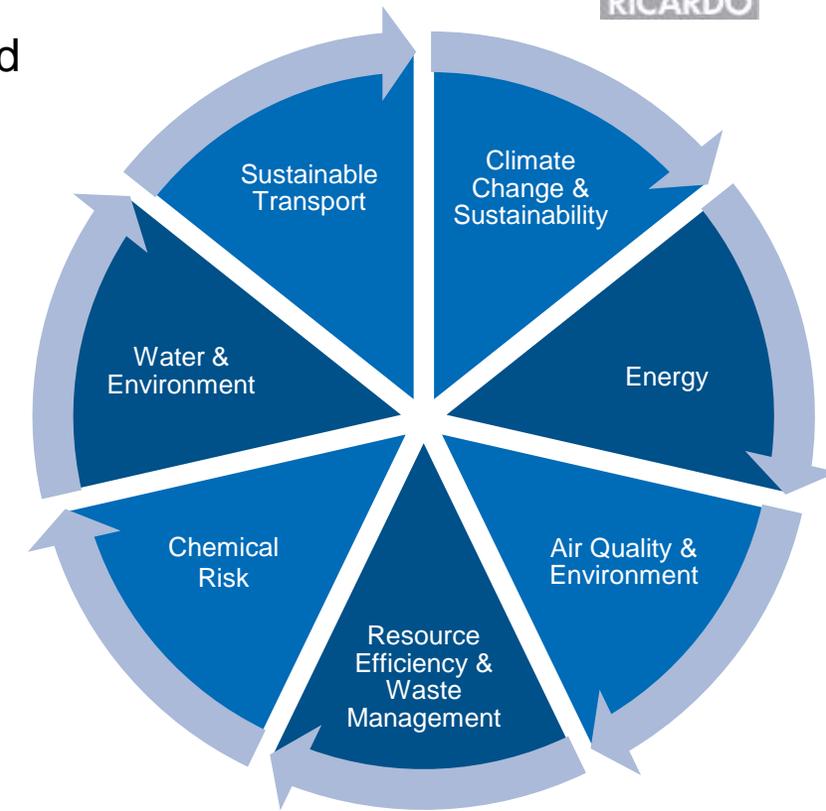
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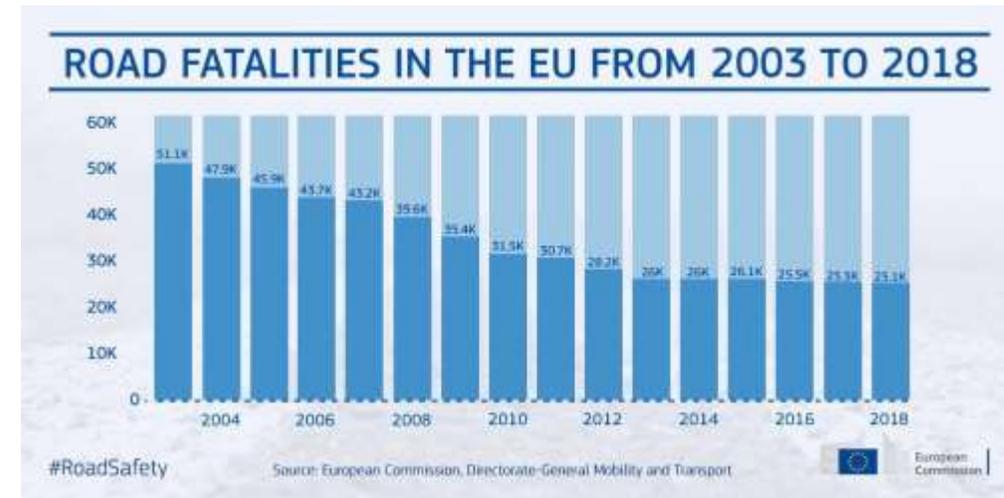


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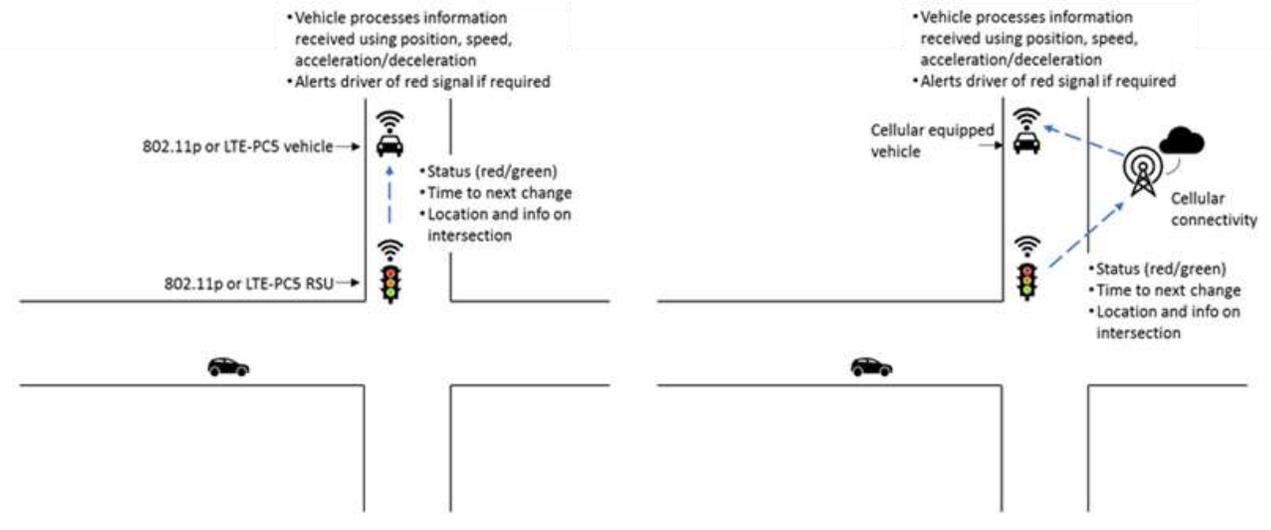
Project background and outline

- Project commissioned by the 5G Automotive Association
- Aim: **To explore the impact of different technical solutions for Cooperative Intelligent Transport Systems (C-ITS) communication solutions on EU road safety over time**
- 25,100 road fatalities in the EU in 2018 (26,000 in 1013)
- Solution 1: Cellular vehicle-to-everything (C-V2X) technologies:
 - a) LTE-PC5
 - b) LTE-Uu (cellular)
- Solution 2: Vehicle-to-vehicle (V2V) and Vehicle-to-Infrastructure (V2I) technologies
 - IEEE 802.11p (DSRC / ITS G5)



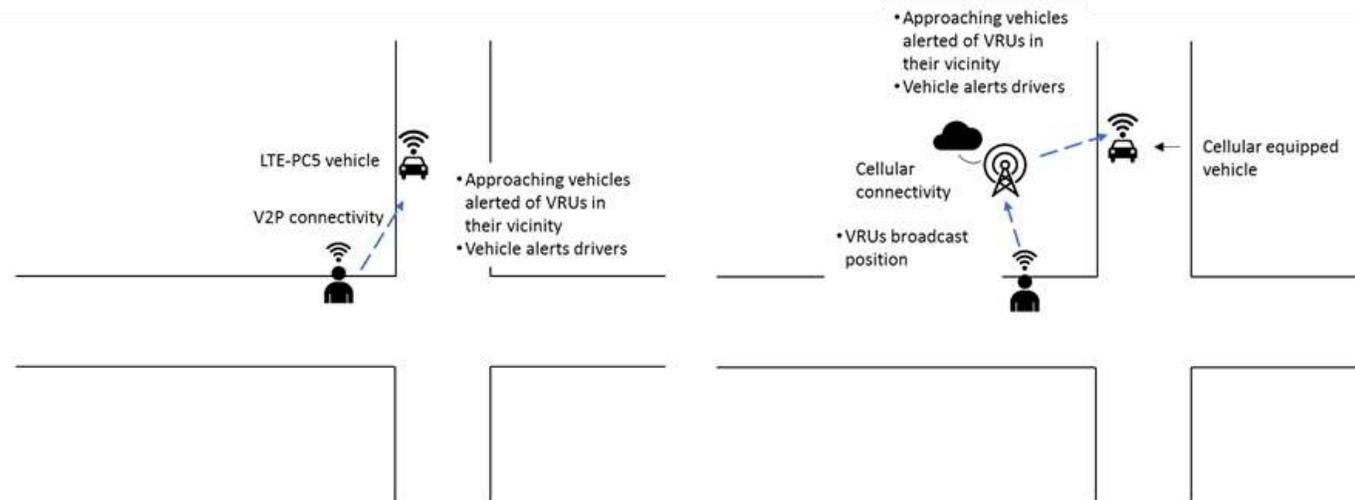
Red signal violation/intersection safety

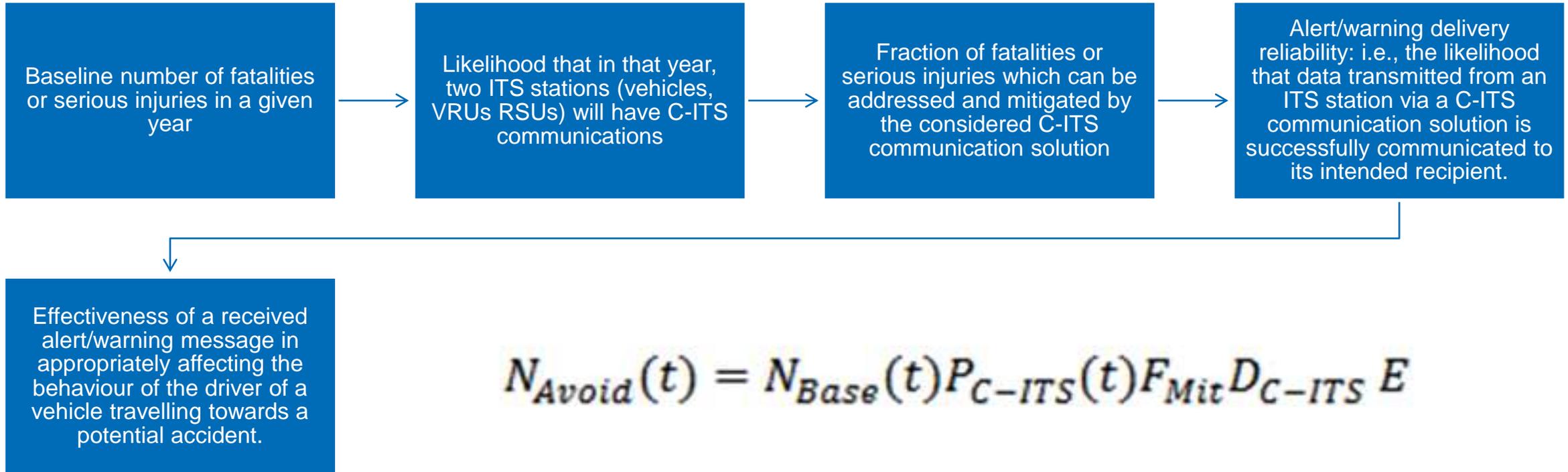
- The status of the signal and the time to next change to red are transmitted to all vehicles in the vicinity
- In-vehicle sensors and processing determine if the vehicle is likely to arrive at a red light too fast to stop
- The vehicle alerts its driver to start reducing speed



Vulnerable Road User (VRU) protection

- VRUs are assumed to be equipped with (i.e. will carry) smartphones with C-ITS communication solutions
- Approaching vehicles will be alerted of VRUs in their vicinity
- Having been alerted, drivers may be able to avoid collisions with VRUs





- Model was developed to look at High and Low scenarios for all C-ITS communication solutions
- The approach to modelling the ability of a vehicle to avoid an accident, and the timing and range of an alert signal to enable this to happen, is based on the 3GPP model from the previous studies
- Only 4G-LTE network coverage and availability was considered (i.e. not 3G or 5G)
- “Retrofitting” in vehicles was assumed to be possible with smart phones
- Factor for inability to react to warning messages through driver impermeant was used

Results - Red signal violation/intersection safety

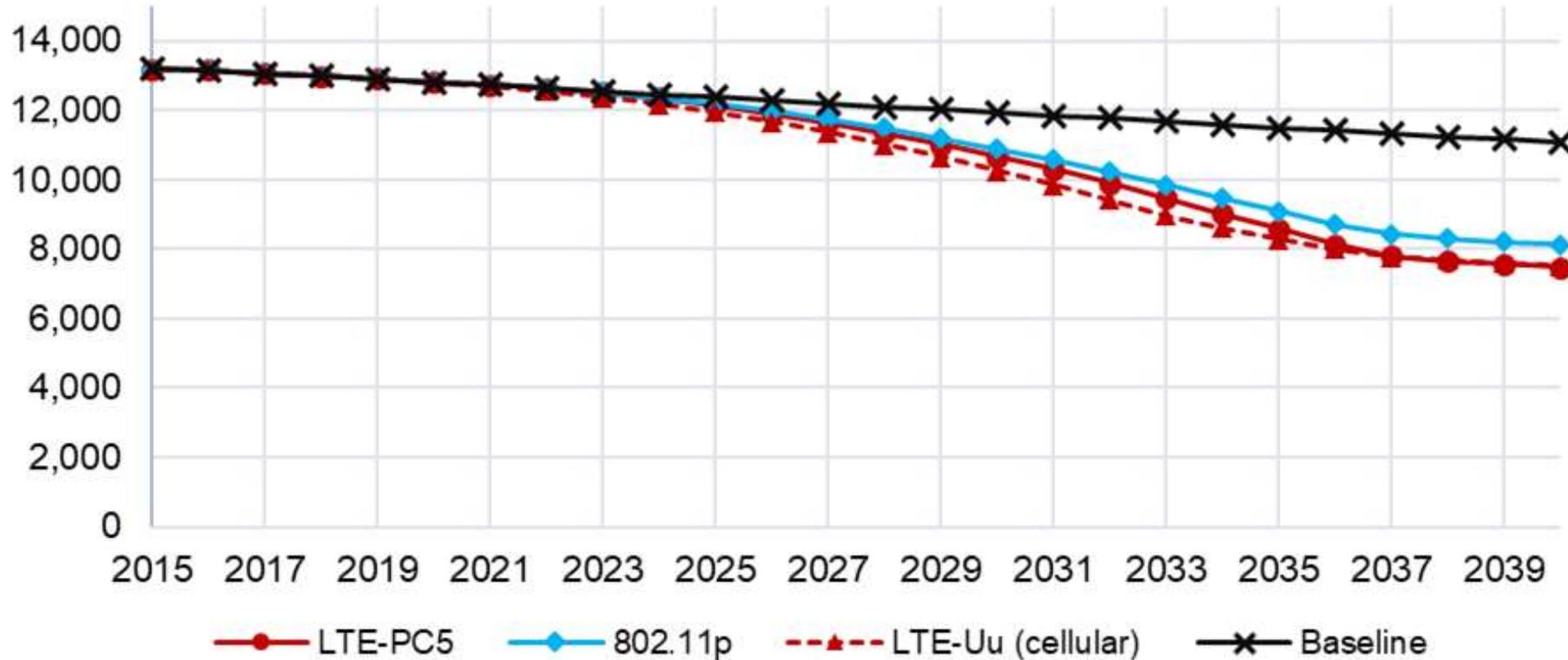


Figure 18: Red signal violation - Total annual fatalities and serious injuries in the high scenario for the three C-ITS communication solutions in comparison to the baseline.

- Impact is low in the early years due to the lack of communication infrastructure
- Higher penetration rates for LTE-Uu results in slightly higher benefits than LTE-PC5
- 802.11p has lowest benefits due to slower deployment than cellular and less favourable alert delivery rates than LTE-PC5

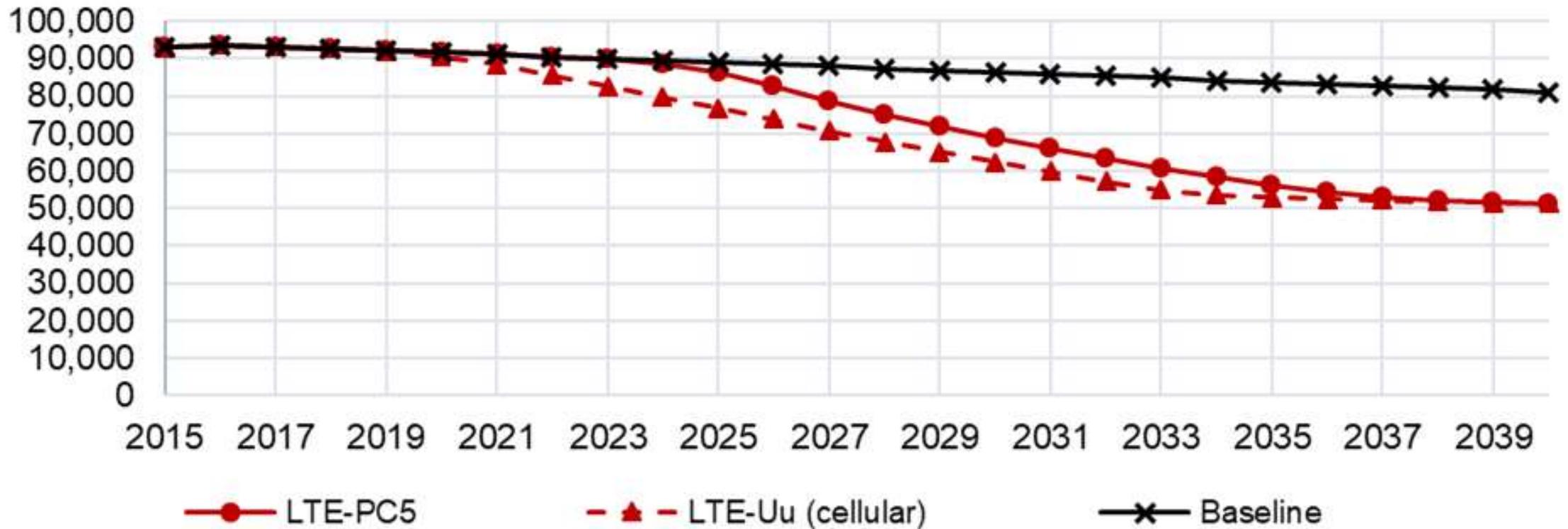
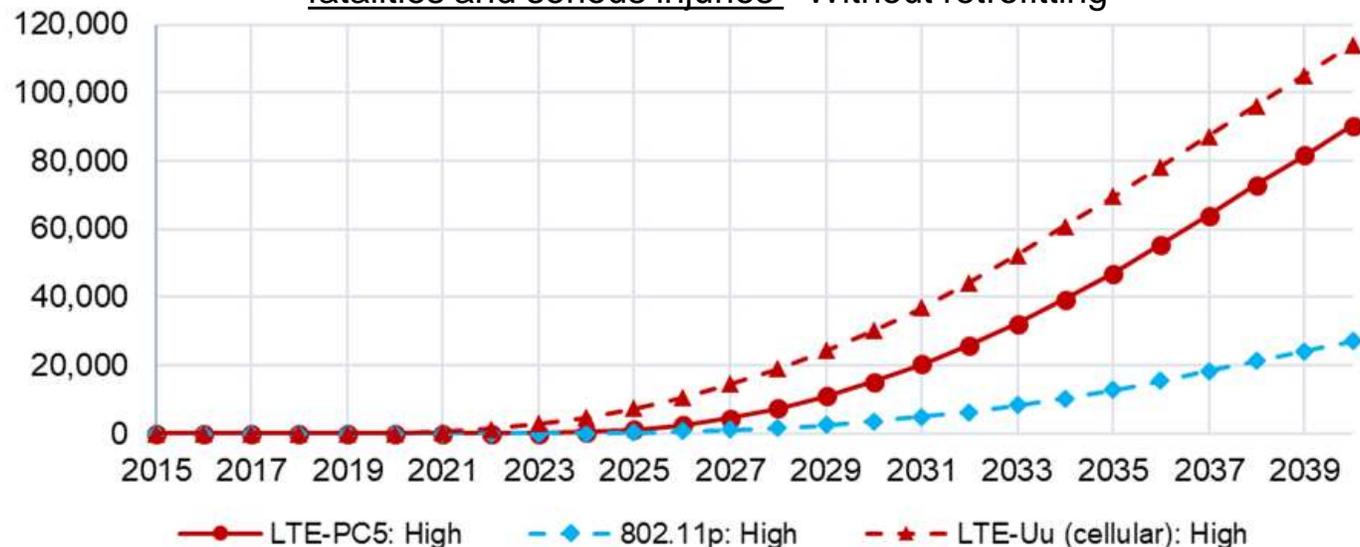


Figure 22: VRU protection - Total annual fatalities and serious injuries in the high scenario for the two C-ITS communication solutions in comparison to the baseline.

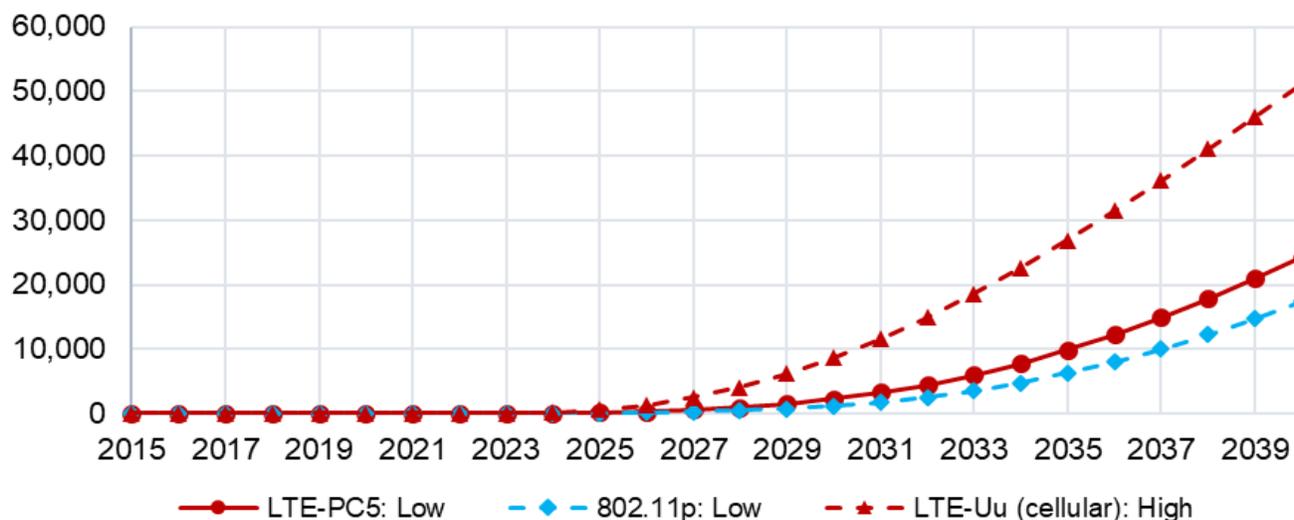
- Compared to the red signal violation use case the advantages of LTE-Uu over the other two technical solutions is higher in the VRU use case, due to the advantages in smartphone penetration in the high scenario
- Since for 802.11p is not assumed to be implemented in smartphones, the impacts for that technical solution are zero

Aggregated results for both use cases in the high and low scenarios - Cumulative avoided fatalities and serious injuries - Without retrofiting



High Scenario

- LTE-Uu shows the highest benefits in terms of the number of avoided fatalities and serious injuries.
- By 2040 the number of fatalities and serious injuries avoided
 - LTE-Uu: 114,066
 - LTE-PC5: 90,380
 - 802.11p: 27,144.

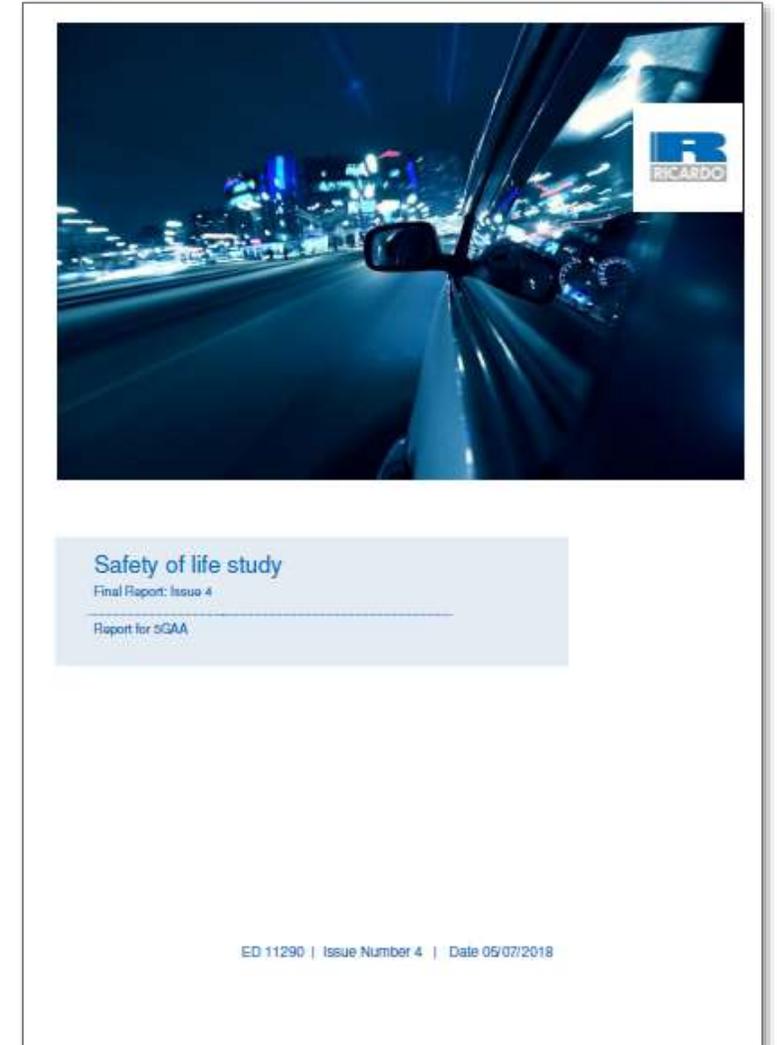


Low Scenario

- The direct communication solutions (LTE-PC5 and 802.11p) are closer together in terms of cumulative avoided fatalities and serious injuries (24,241 and 17,400 in 2040 respectively)
- LTE Uu has a cumulative number of 52,663 avoided fatalities and serious injuries in 2040.

Conclusions

- In both use cases LTE-Uu (cellular) and LTE-PC5 C-ITS communications deliver greater benefits than 802.11p, due to a higher uptake of the services through smartphones and embedded in-vehicle cellular communications.
- LTE-Uu (cellular) communication solution results in the highest benefits by 2040, due to the take up of this C-ITS communication solution happening faster than for other solutions.
- LTE-PC5 and LTE-Uu were modelled separately, in practice, the two technical solutions use very similar chip technology and device hardware and so may ultimately converge into a single (hybrid) technical solution.
- Considering retrofitting of existing vehicles through smartphones significantly improves the impacts LTE-PC5 and LTE-Uu solutions
- The absolute values are subject to various assumptions where sufficient data was not available (such as future geographic coverage and availability for LTE-Uu, alert reliability rates for direct communication in the V2I case, number of serious injuries avoided).
- Full study is published on the 5GAA website: <https://5gaa.org/news/5gaa-safety-of-life-study/>





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