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OpenCV2X Mode 4: Simulation extension for Cellular Vehicular Communication Networks

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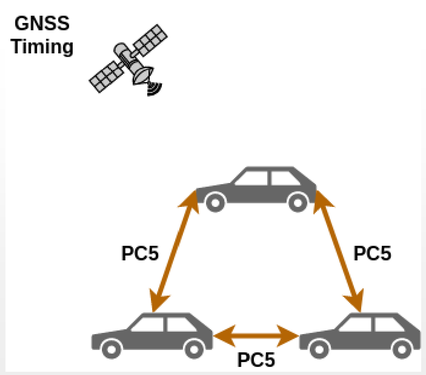
Cellular vehicular communication allows for vehicles to communicate information between each other. Two technologies cellular and DSRC are the means by which vehicles communicate. While DSRC has been heavily explored in the literature, little work has been done in identifying challenges and issues for efficient and reliable communication over cellular networks. Mode 4 is the standard for V2V communication over the cellular networks defined in 2016. This standard defines autonomous resource allocation by vehicles without the need for an eNodeB.



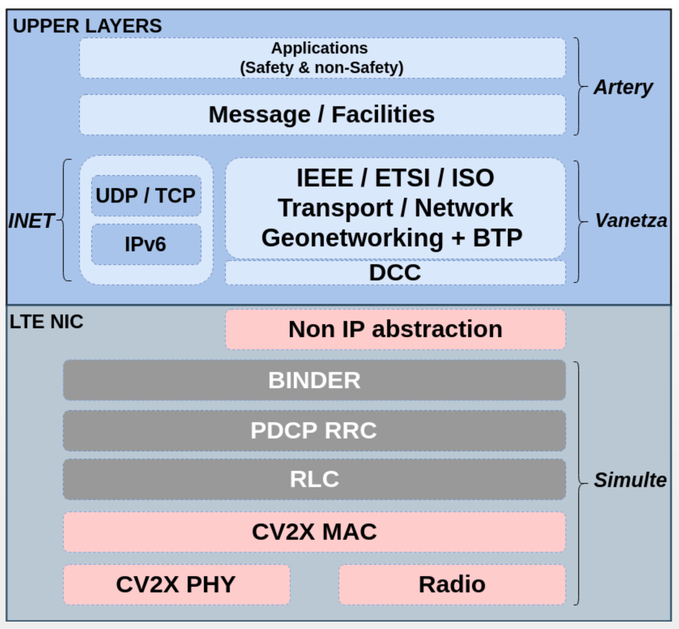
Related Work	Summary of Work
Cecchini et al. IEEE MT-ITS	MATLAB implementation of CV2X Mode 4, focused on resource allocation as opposed to general simulation environment.
Molina-Masegosa et al. IEEE Vehicular Technology Magazine'17	Investigation of a CV2X Mode 4 OMNeT++ Model, primarily focused on a parameter study with a minor extension for scheduling resources.
Mansouri et al. WONS'19	First investigation of congestion control for CV2X Mode 4, looking into DCC and how it interacts with Mode 4.
Toghi et al. IEEE VTC'19	Further investigation of congestion control, as well as specifically looking into DCC, though contradicts the above.

Motivation for our work:

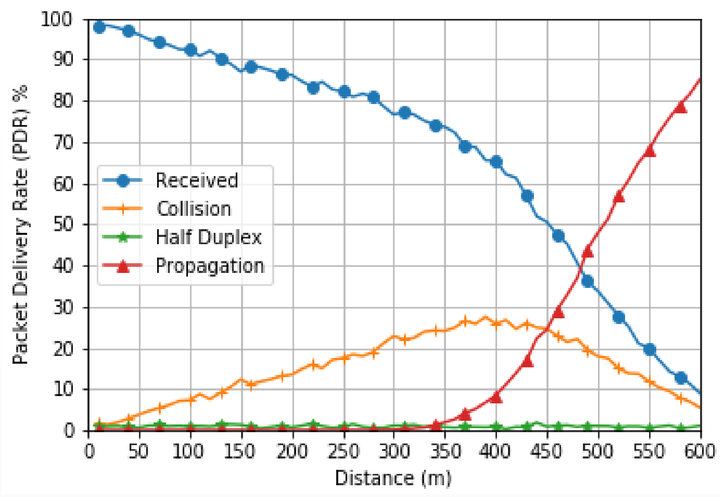
Previously outlined models are either unavailable or do not fully integrate the ITS-G5 standard for vehicular communication, limiting their application to a subset of scenarios I.e. link layer analysis and non-realistic traffic scenarios, e.g. synthetically generated packet sizes, which have low correlation with packet sizes generated in operational networks. The need for more extensive and realistic findings in this area drove our motivation to implement our open source CV2X mode 4 model and to integrate it with the ITS-G5 standard.

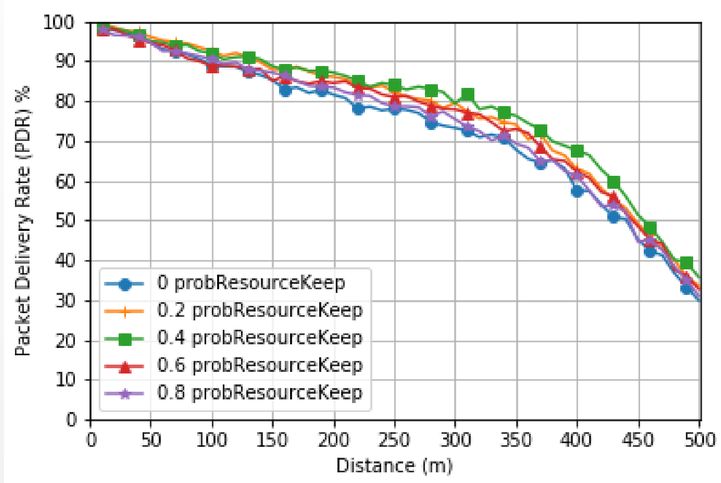
Model Implementation:

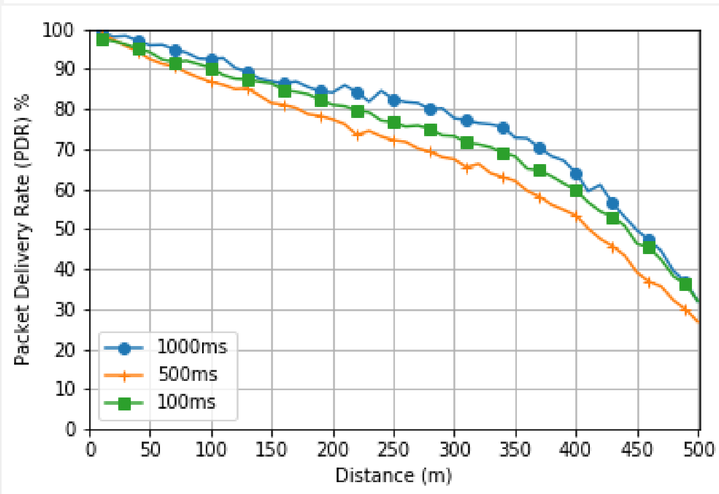
- **OMNeT++:** This is the simulation framework used most extensively by the vehicular community.
- **SimuLTE:** Implements the LTE stack for OMNeT++. This has been extensively extended to allow for Mode 4 simulations.
- **INET:** Implements many common Network protocols.
- **Artery:** Artery implements the ITS-G5 standard protocols used as the current standard for CAM and DENM messages.
- **SUMO:** Our road network and traffic simulation engine.



Initial Results:







Results explanation:

- The first figure shows the causes for packet loss for a simulation run.
- Second figure shows the impact of the parameter *probResourceKeep* which determines the likelihood of maintaining a reservation.
- Final figure shows the impact of the length of the sensing window on PDR.

Future work:

- Extensive parameter study looking at some of the major parameters for Mode 4 and replicating some of the papers already available.
- Investigation of the performance of Mode 4 for Non-Periodic traffic.
- Investigation of congestion control mechanisms e.g. Decentralized Congestion Control (DCC) ITS-G5 standard mechanism, Adaptive MCS schemes, adaptive transmission power.
- Alternative scheduling schemes to improve performance of the standard e.g. Methods to solve the issue of multiple UEs reserving the same resource, means of preventing wastage of resources when a grant is broken, mechanisms for dynamically sized grants to better utilize resources.

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