Interface Selection in 5G Vehicular Networks

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DIPARTIMENTO
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Introduction

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With the introduction of 5G cellular networks, vehicular networks will be used for safety and infotainment applications.

- **Safety Applications :** applications to increase vehicle safety on the roads and to reduce the number of accidents.
  Mainly Vehicle-to-Vehicle communication at low datarates.
- **Non-Safety Applications :** applications to provide road users with information, advertisements and entertainment during their journey.
  Mainly Vehicle-to-Infrastructure communication at extremely high datarates.

Introduction

Applications with different requirements have to be handled by different technologies.

Nowadays technologies cannot support the performance required by Non-Safety Applications

mmWaves work above 10 GHz and can ensure very high throughput and low latency, but suffer from high blockage sensitivity

Interface selection techniques using other technologies (such as LTE) are needed to support mmWaves when they did not work.

Introduction

Contribution: Comparison of mmWaves with LTE and IEEE 802.11p/WAVE through NS3 End-to-End full stack simulations to enable interface selection techniques in future 5G vehicular networks

Two type of communication have been compared:

- Vehicle-to-Vehicle (V2V) communication using IEEE 802.11p/WAVE
- Vehicle-to-Infrastructure (V2I) using LTE and mmWaves

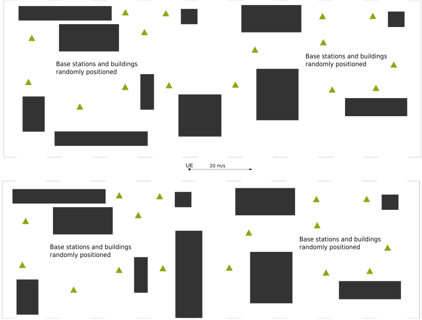
Simulation settings and scenarios

V2V Scenario

- IEEE 802.11p has been used given its major use in unstructured and self organized networks
- 2 vehicles in Line-of-Sight share data using UDP
- The vehicles are not moving
- Constant distance ranging from 2 meters to 160 meters
- Datarates simulated: 0.01 *Mbps*, 1 *Mbps*, 10 *Mbps*, 100 *Mbps*, 1000 *Mbps*

V2I Scenario

- LTE and mmWaves have been used separately
- Buildings and base stations are randomly deployed in the simulated area
- A vehicle receives data from a base station using UDP
- The vehicle speed is 20 m/s
- Base stations density ranges from 4 to 30 base stations/km^2
- Datarates simulated: 1 $Mbps$, 10 $Mbps$, 100 $Mbps$, 1000 $Mbps$



Results

Metrics analyzed

- **Experienced throughput:** the throughput perceived by the user during the simulation
- **PDCP latency:** the average latency of the only successfully received packets at the PDCP layer
- **Packet Reception Ratio (PRR):** the number of correctly received packets divided by the total number of transmitted packets

V2V Results - Throughput

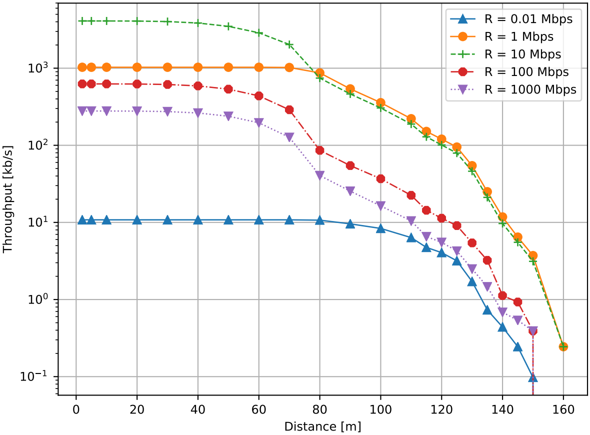


Figure 1: Average throughput vs. inter-vehicle distance d for different values of the application rate R.

V2V Results - PRR

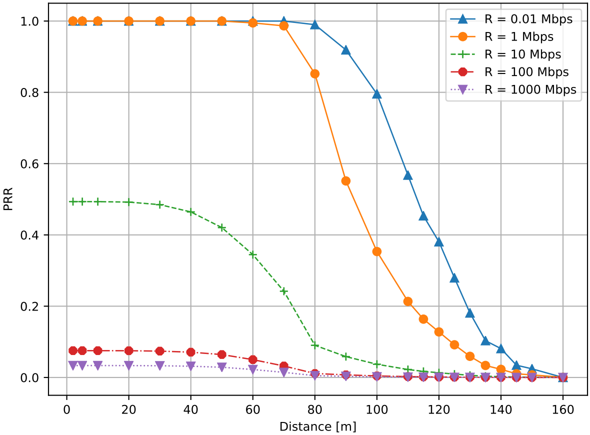


Figure 2: PRR vs. inter-vehicle distance d for different values of the application rate R.

V2V Results - Latency

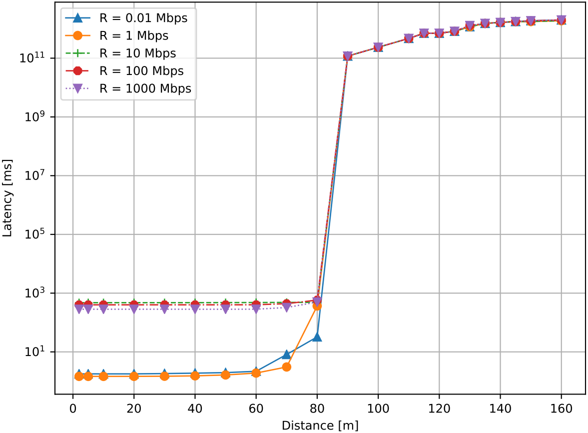


Figure 3: Average latency vs. inter-vehicle distance d for different values of the application rate R.

V2I Results - Throughput

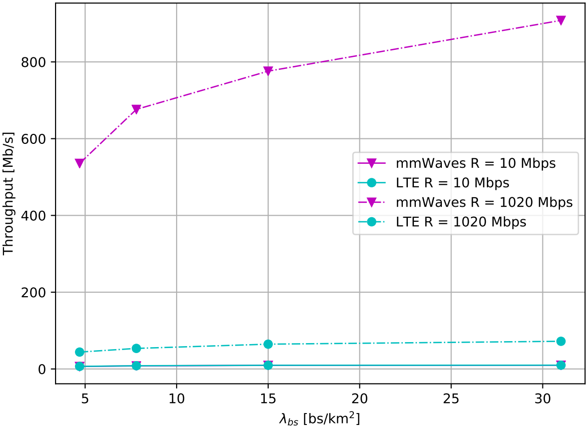


Figure 4: Throughput vs. base station density λ_{bs} for different values of the application rate R.

V2I Results - PRR

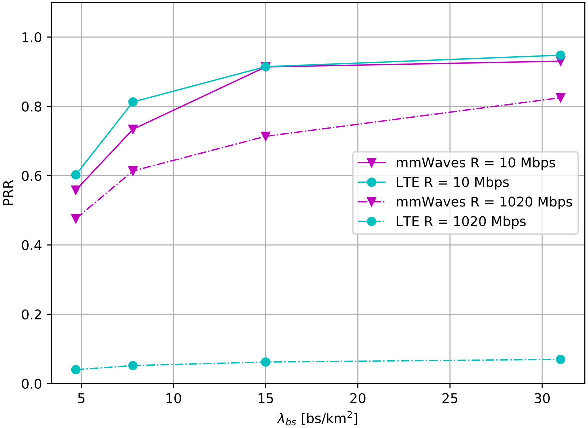


Figure 5: PRR vs. base station density λ_{bs} for different values of the application rate R.

V2I Results - Latency

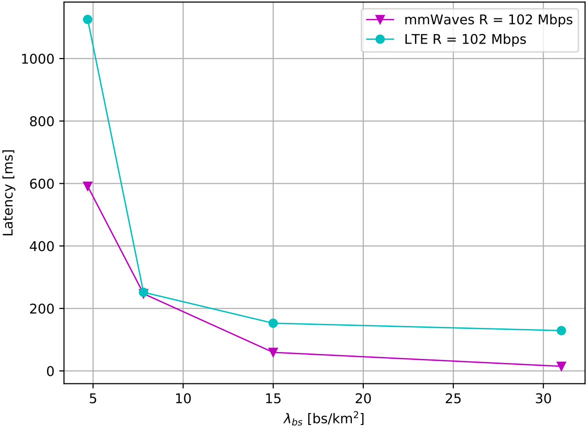


Figure 6: Latency vs. base station density λ_{bs} for different values of the application rate R.

Conclusions

Conclusions

IEEE 802.11p/WAVE

- Low-rate and short-range connectivity
- Reliable communication and low latency
- Suitable for safety applications in 5G vehicular networks

LTE

- Good connectivity for datarates under 100 Mbps
- Capillar network of infrastructures available
- Suitable for some non-safety applications and as support technology

mmWaves

- High blockage sensitivity
- Extremely high throughput and low latency
- Suitable for the most demanding non-safety applications if supported by LTE

Acknowledgements

Thank you for your attention!