Departament d'Enginyeria Telemàtica
UNIVERSITAT POLITÈCNICA DE CATALUNYA

7th ACM PE-WASUN 2010

Performance Evaluation of a Hybrid Sensor and Vehicular Network to Improve Road Safety

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October 2010

Outline

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I. **Introduction**

II. Related work

III. Basics of a HSVN (Hybrid Sensor and Vehicular Network) framework

- Mobility models in VANETs (Vehicular Ad hoc Network)
- Proposal of a communication protocol between WSNs (Wireless Sensor Networks) and VANETs

IV. Simulation results

V. Conclusions and future work

Introduction

- Research on short range wireless technologies has been evolving very fast in the last years. In addition, ad hoc networks are receiving much attention due to the easy deployment they require.

- In the framework under consideration, there are two kind of ad hoc networks: WSNs (Wireless Sensor Networks) and VANETs (Vehicular Ad hoc Networks).

- HSVNs (Hybrid Sensor and Vehicular Networks) are introduced as a new concept of road sensor deployment, and they can be seen as a new kind of next generation network architecture.

Outline

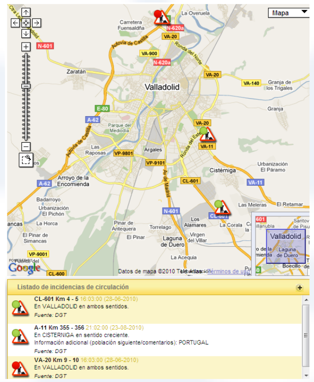
Related work (I)

- Recently, different consortiums have been created in Europe, EEUU, Japan... which aim to make safer vehicles and roads.

- The CAR 2 CAR communication consortium is a non-profit industrial driven organization initiated by European vehicle manufacturers supported by equipment suppliers, research organizations and other partners.

- CARLINK seeks to develop intelligent service platforms for vehicles.

- INFOTRANSIT has been developed by the RACC (*Reial Automòbil Club de Catalunya*) Spanish foundation which provides data to make a safer road.



Related work (II)

- Regarding HSVNs, several research studies have been made whose principal challenge is the architecture design.

- HSVNs need to include a reliable communication protocol between VANETs and WSNs, which have to interchange data from their respective nodes.

- One of the most important features is that there is no limit in the batteries lifetime of the road side devices or in the storage size as well, since nodes are vehicles.

- Also, other related work present the benefit of using multiple access technologies and multiple radios in a collaborative manner, to create an advanced heterogeneous vehicular network (AHVN) architecture.

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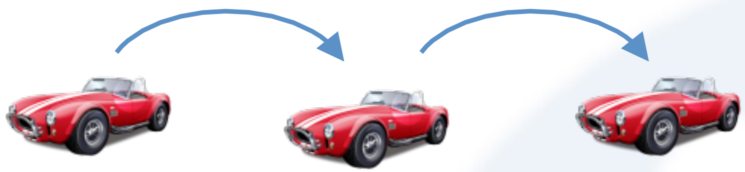
Basics of a HSVN framework

- The main feature offered by vehicular networks is the capability to distribute traffic road information among the vehicles of a road.



- In VANETs, it is typically assumed that each node in the network is equipped with some navigation system and also with a GPS.

- A simple, fast and efficient communication protocol has to be designed to allow communication between VANETs and WSNs.

- The data interchange has to be very fast, since the interval in which the vehicle is under the transmission range of the WSNs is very short.

- The cooperation between WSNs and VANETs makes it possible to extend the transmission range in a VANET to a larger region with the cooperation of both networks.

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Mobility models in VANETs

- In a vehicular scenario, cars do not move freely throughout the whole area.

  - They follow streets and roads
  - They are aware of the other vehicles
  - They follow road segments and signals lights

- In order to achieve realistic results, all these features have to be taken into account when designing a HSVN framework.

- A mobility model describes the movement pattern followed by the nodes in a specific scenario.

- Choosing proper simulation settings and mobility model is crucial to obtain accurate results. For instance, in an urban scenario it is important to include obstacles, roads, traffic lights and signals.

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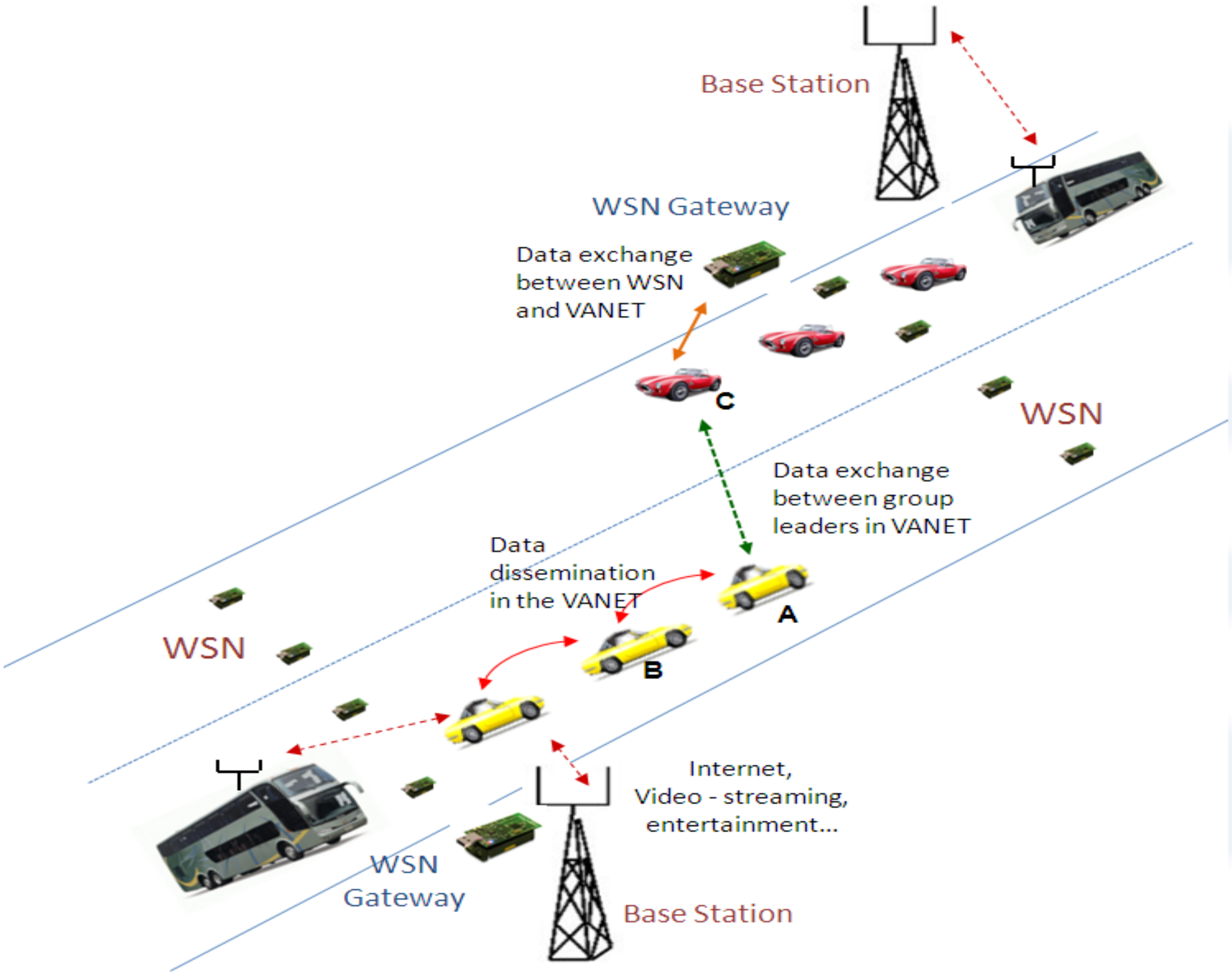
Proposal of a communication protocol between WSNs and VANETs



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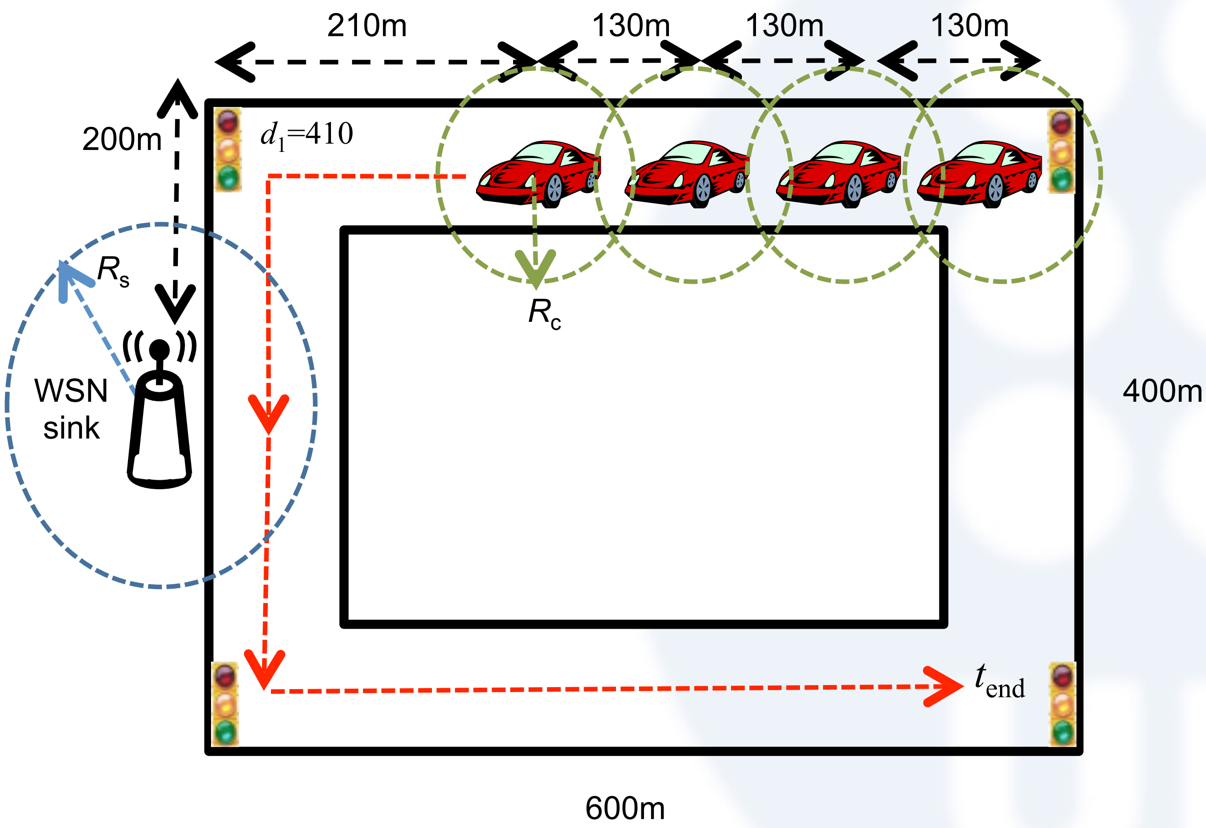
Scenario

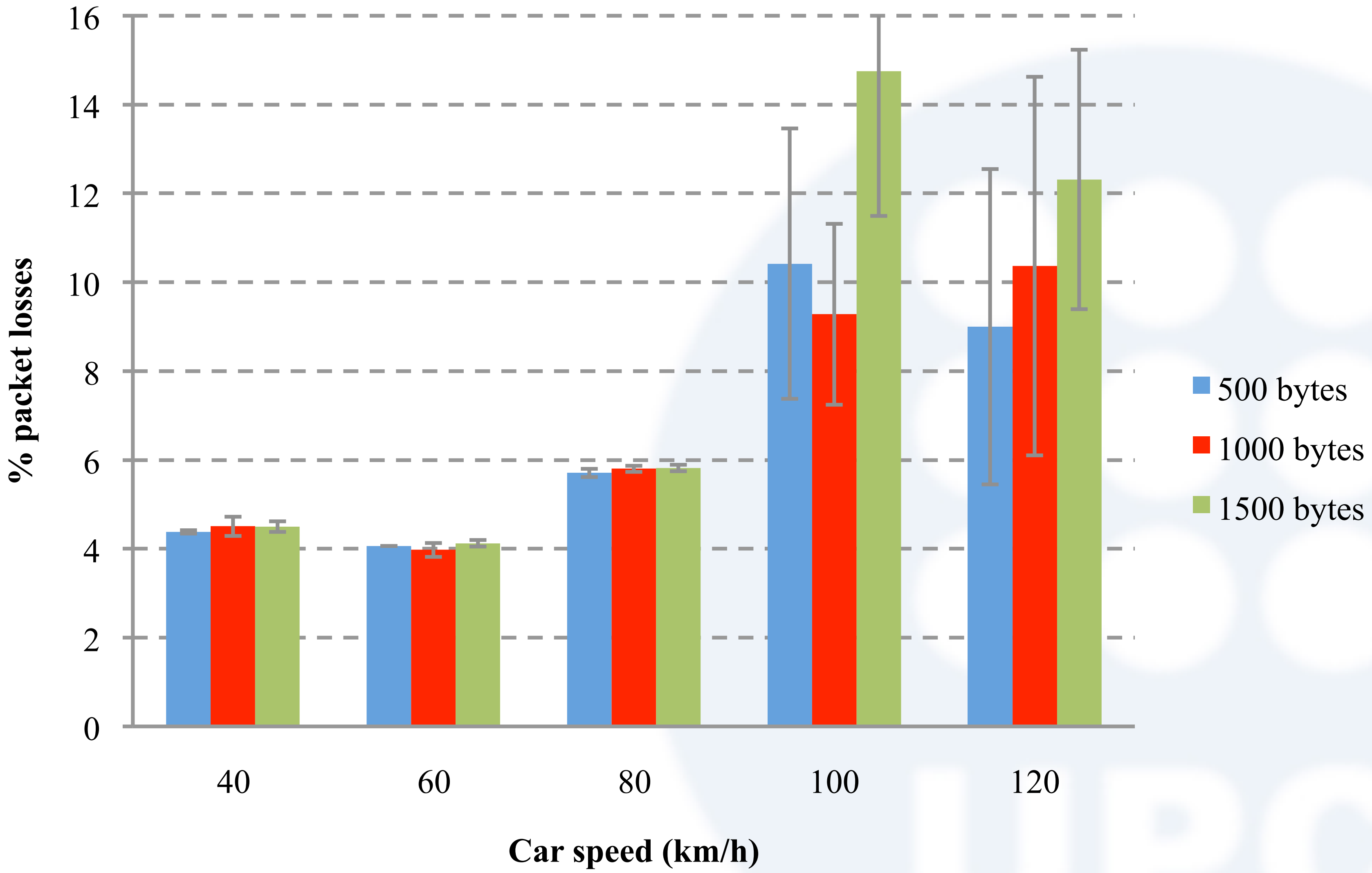
- To analyse the performance of the proposed communication protocol between WSNs and VANETs, we have carried out several simulations of data transmissions between different nodes in a HSVN, using the freeware simulator NCTuns6.0 (National Chiao Tung University Network Simulator).



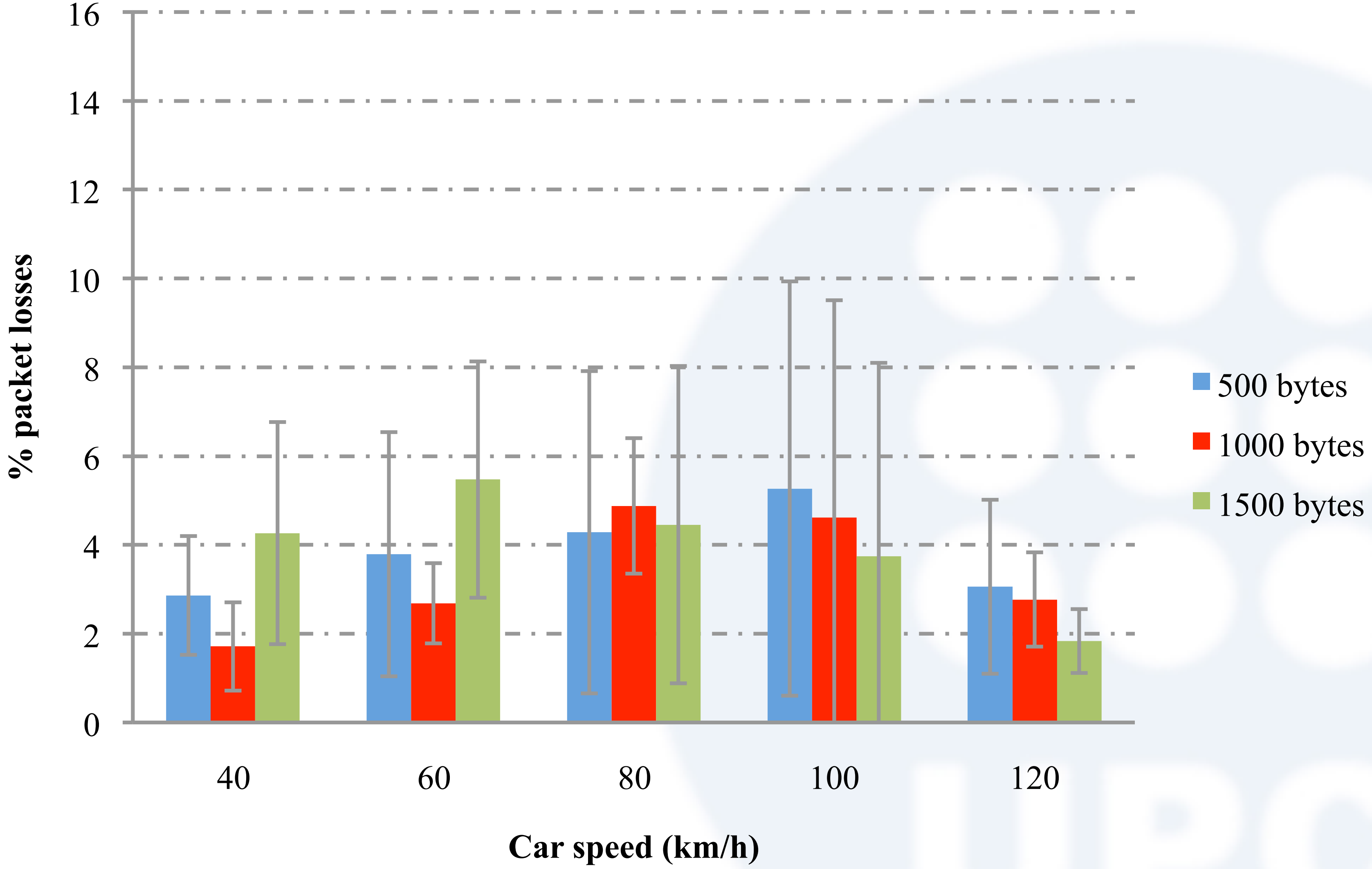
Simulation settings

Setting	Value
Average speed of the nodes	μ=40 to 120 km/h
Number of road lanes	4 (two in each direction)
Road length	2 Km
Number of Mobile nodes in the VANET	4 vehicles
Number of nodes in the WSN	1 sink node
Transmission Range of the nodes (WSN and VANET)	$R_s=R_c$=200m
Routing protocol in the HSVN	AODV, DSR
Packet size	500, 1000, 1500 bytes
Time of simulation	t_{end}=80 sec.
Data source rate (CBR)	1 Mbps
MAC	IEEE 802.11b
Nominal capacity	11 Mbps

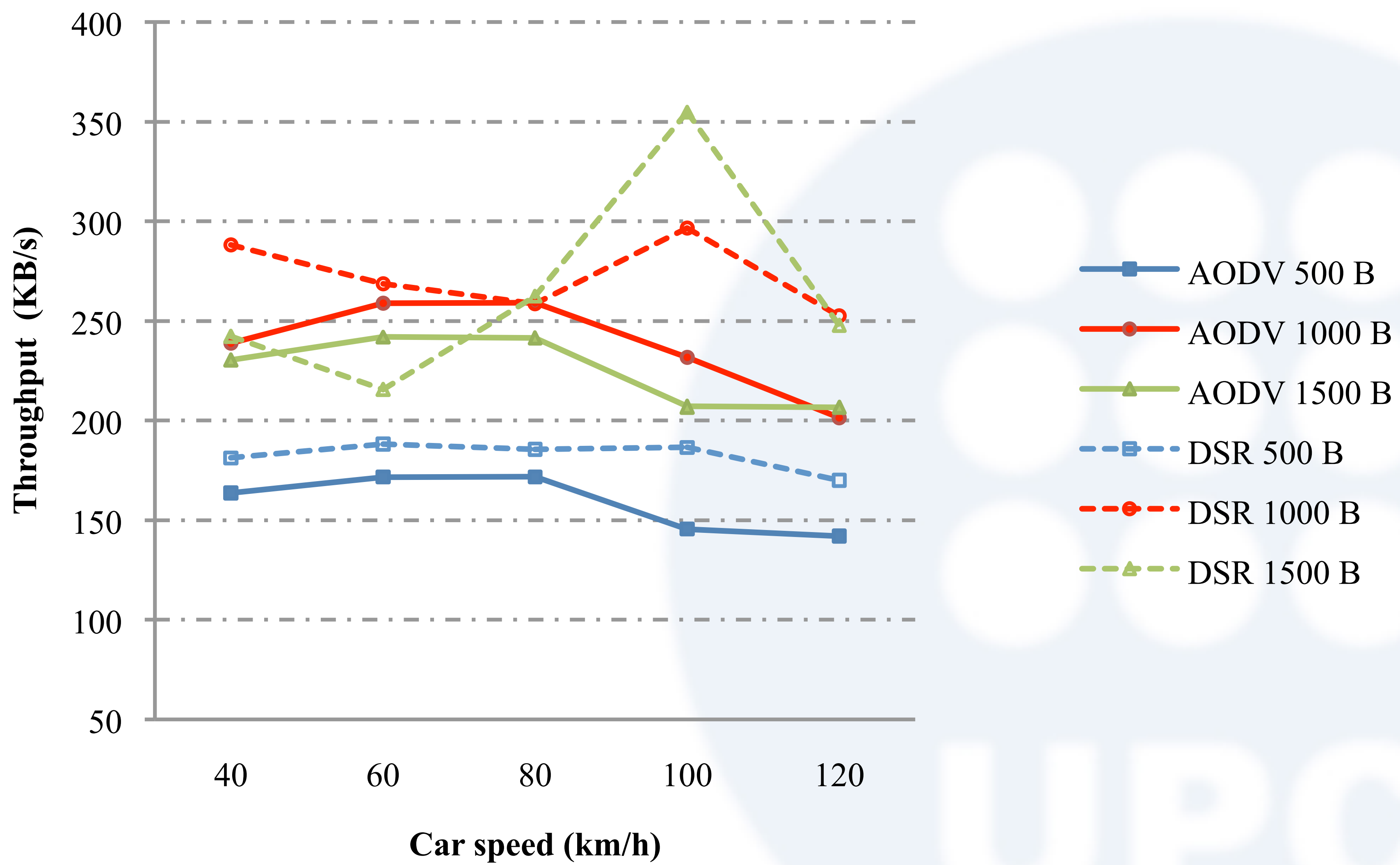
Packet losses evolution for AODV



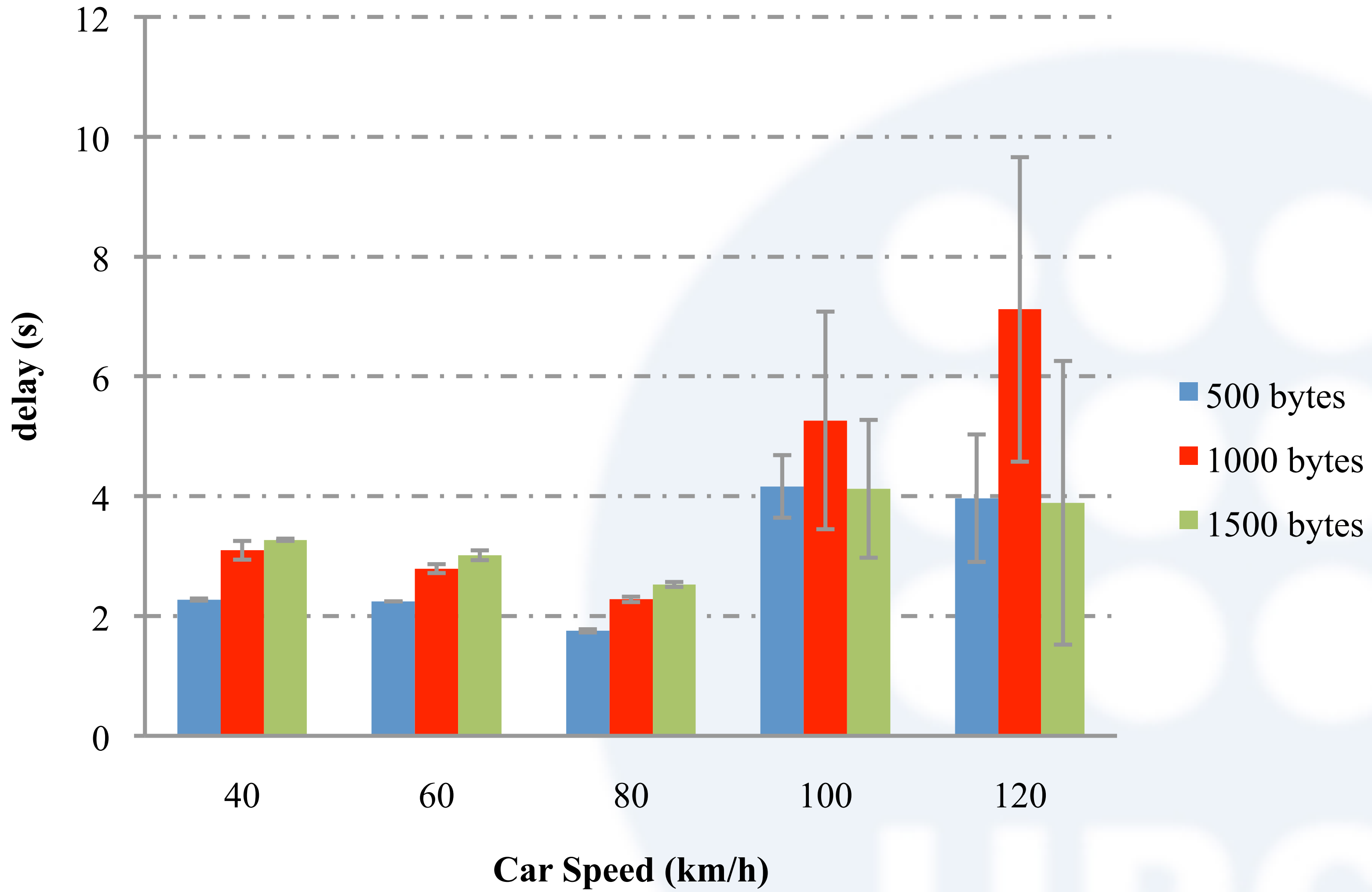
Packet losses evolution for DSR



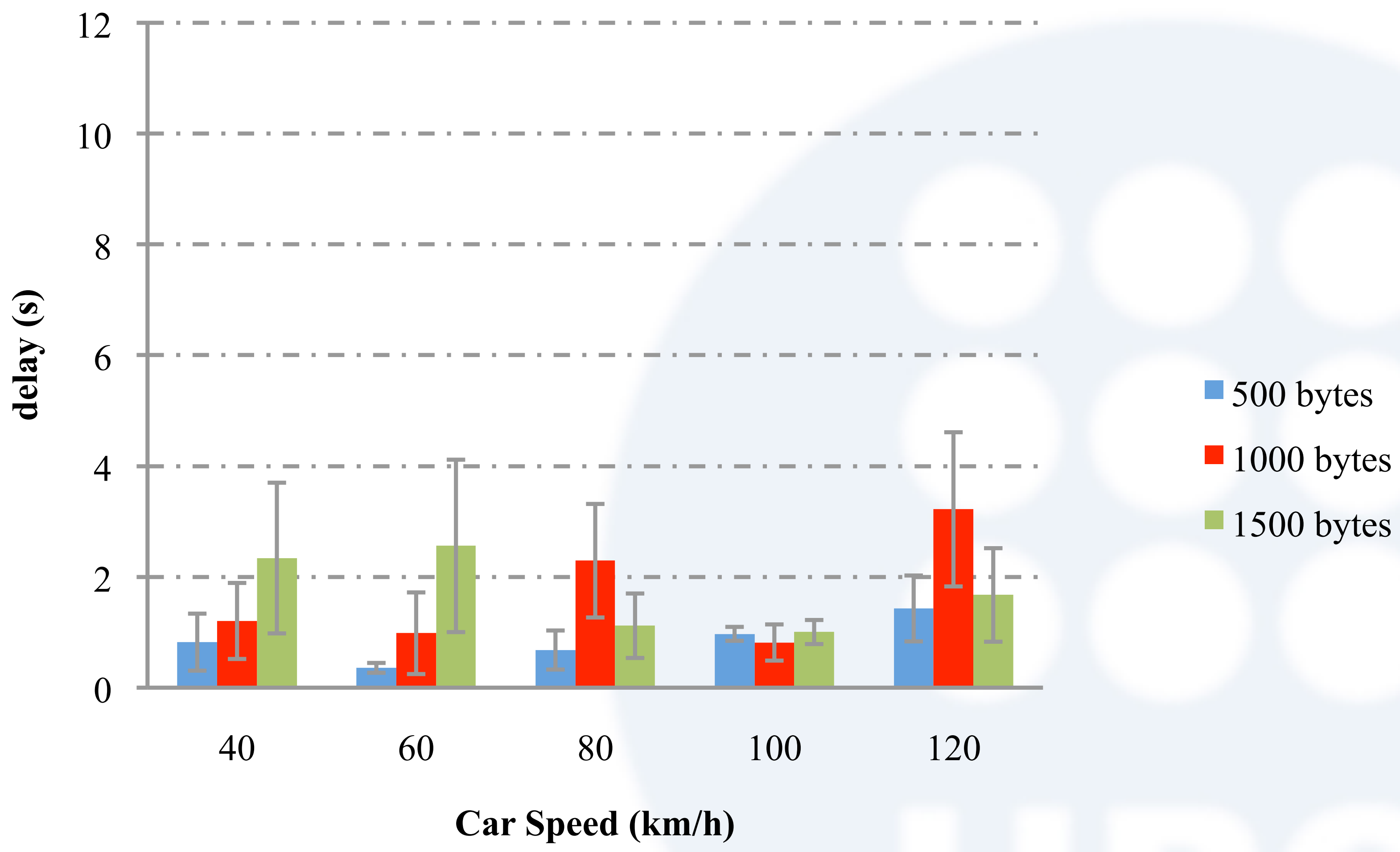
Throughput with AODV and DSR



End-to-end packet delay for AOAV



End-to-end packet delay for DSR



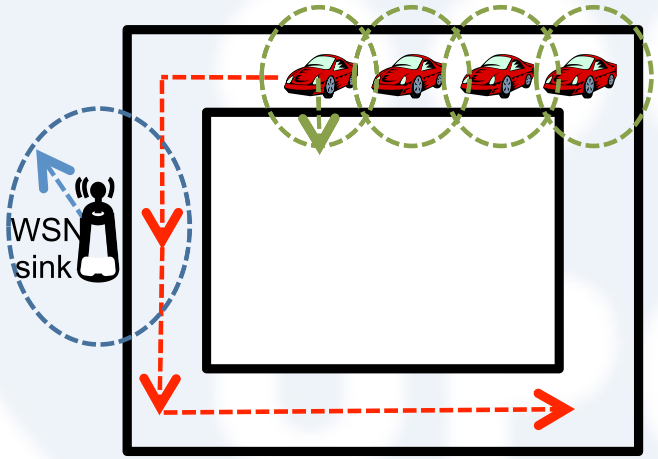
Conclusions from the simulations

- In this slide we highlight important conclusions in the performance evaluation of DSR and AODV obtained in the simulations of this particular scenario.

- After link breakages we can see this behaviour, specially at high speeds:

  - DSR takes longer to find a new path and eventually, it finds the 1-hop path
    - Lower losses.
    - Lower delays.

  - AODV finds sooner a new path, although a longer one
    - Higher losses (multihop)
    - Higher delays



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Conclusions and future work

- In this article we have shown the performance of the routing protocols AODV and DSR in a HSVN framework that includes a proposal for a communication protocol between WSNs and VANETs.

- Simulation results for the scenario under evaluation, show the effectiveness of DSR compared to AODV regarding end-to-end delays, losses and throughput.

- An immediate work we will analyse the performance of the system under other routing protocols more specific for VANETs, e.g. GSR (Geographic Source Routing), SAR (Spatial Aware Routing) and VADD (Vehicular Assisted Data Delivery).

- Other aspects will be tackled to improve the routing in HSVN, such as considering the different type of traffics (e.g. warnings, road messages) and Infotaintment services (video-streaming, Internet browsing).

Conclusions and future work

- In future work we will modify the routing protocol to include some additional features for vehicular networks, such as location and speed of the vehicles.

- In addition, we will evaluate the system performance using the MAC IEEE 802.11p specification, which is focused on VANETs.

- Also, we plan to develop an analytical model so that nodes can estimate the medium occupancy. We will include this model in the routing protocol to choose the best path.

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