Accuracy and Efficiency in Simulating VANETs

Enrique Alba, Sebastián Luna, and Jamal Toutouh

Universidad de Málaga

UNIVERSIDAD
DE MÁLAGA

Outline

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Introduction and Motivation

- The performance evaluation of the different VANET protocols and applications is done by using both outdoor experiments and simulations

- The evaluation through **outdoors experiments** has several drawbacks:
  - neither easy nor cheap
  - difficult to analyze in an inherently distributed and complex environment
  - reproduction of all kinds of situations where they must act is not possible

- The **simulation** avoid the previous drawbacks. Nevertheless it presents the following one:
  - the fidelity of the simulated results versus the real ones

- We present here a comparison between simulations and real tests

- The goal is to better know the actual VANET used in **CARLINK** and the data/delay rates affecting the final applications

VANET Simulation

Three kinds of approaches in VANET simulation have been initially considered:

- Using an specially-designed VANET simulator
  Alternatives: *TraNS*, *MOVE*, *CARISMA*, and *STRAW*

- Integrating a vehicular mobility model generator into an existing network (MANETs) simulator
  - Mobility model generator: *SUDO* and *VanetMobiSim*
  - Network simulators: *Ns-2*, *GlomoSim*, *QualNet*, and *OpNet*

- MANET applications programming framework which allows the developer to test the applications via simulations.
  Alternative: *JANE*

VANET Simulation. VanetMobiSim/Ns-2

- **VanetMobiSim/Ns-2** [mobility model generator + network simulator]

- VanetMobiSim:
  - Freely available
  - Different kind of outputs
  - Generates realistic models
    - Macro-mobility features
    - Micro-mobility features

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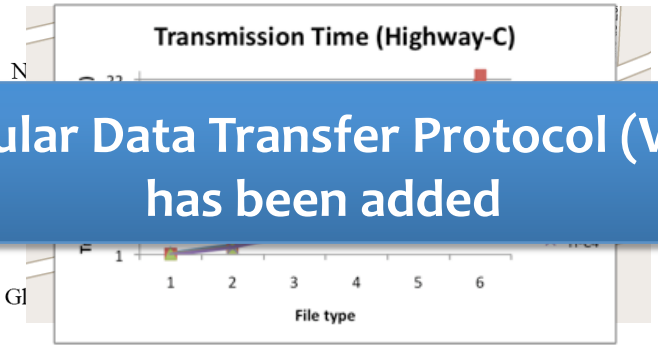
- Ns-2:
  - Freely available
  - Easily adding features
  - Widely used
  - Numerical output



Vehicular Data Transfer Protocol (VDTP) has been added

- TARGET: making precise simulations of the real systems

VANET Simulation. JANE

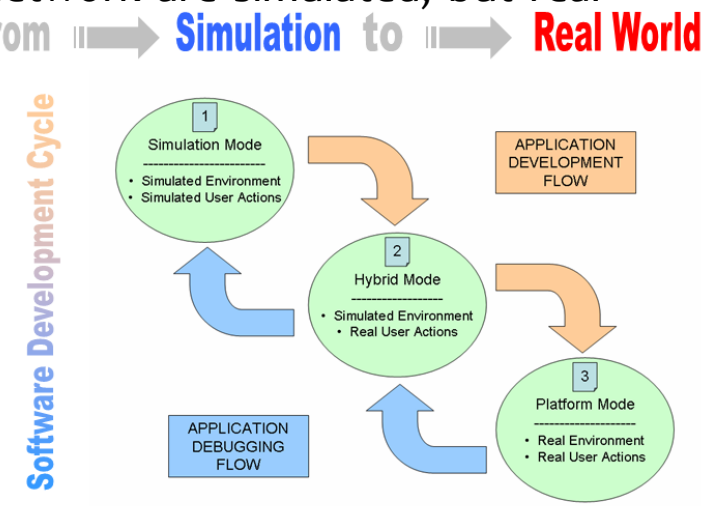
- **JANE:** Java Ad hoc Network Environment

  - Open source Java-based middleware platform which is intended to assist ad-hoc network researchers in application and protocol design

  - Three different execution modes:
    1. *Simulation Mode*: the complete environment is simulated
    2. *Hybrid Mode*: the devices and the ad-hoc network are simulated, but real users can interact with the simulation
    3. *Platform Mode*: the whole setting is real

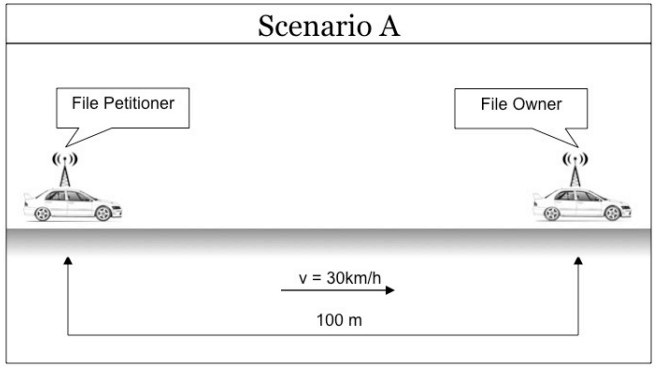
  - Drawback: It is not specialized for VANETs
    - not provide realistic mobility models for the simulation of vehicular networks

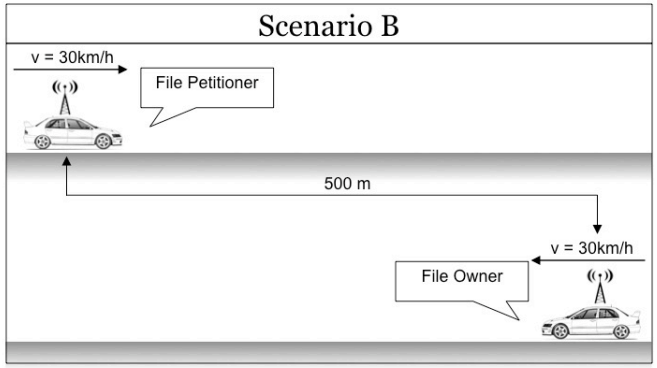
  - TARGET: programming high level applications



The CARLINK-UMA scenario

- The scenarios are defined by their specific mobility models:





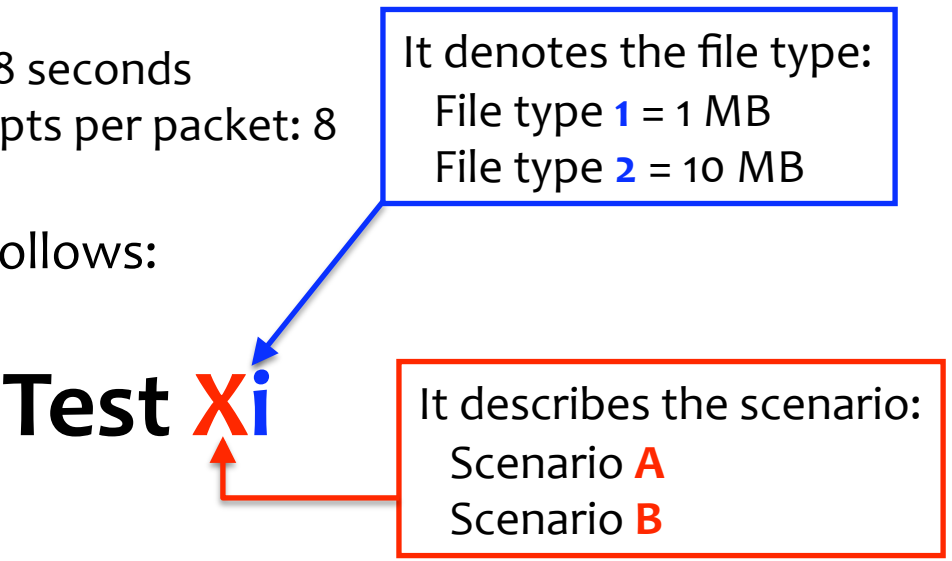
- File transfers between two cars by using ad-hoc operation mode of the *IEEE 802.11b MAC Layer Standard*
  - PROXiM ORINOCO PCMCIA transceiver
  - Range extender antenna gain: 7 dBi

The CARLINK-UMA scenario

- Each experiment is composed of different tests
- The tests consist in repeatedly transferring a file in specific scenarios:
  - File type 1: 1 MB (traffic information documents)
  - File type 2: 10 MB (multimedia files)

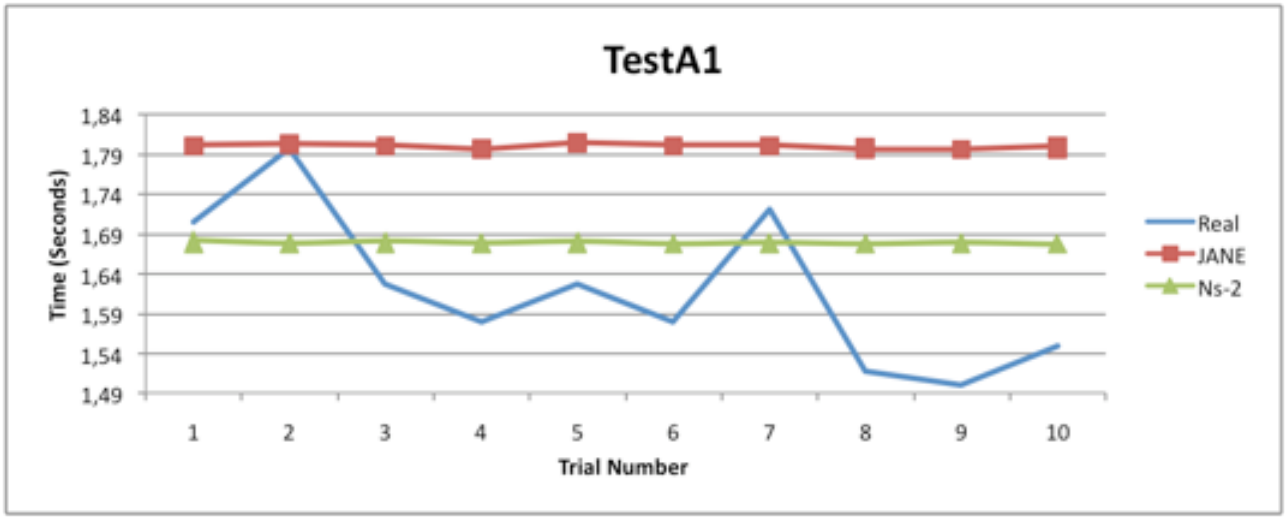
- The file transfers are carrying out by using the Vehicular Data Transfer Protocol (VDTP):
  - Chunk size: 25Kbytes
  - Retransmission time: 8 seconds
  - Max number of attempts per packet: 8

- The test are named as follows:
  - **Test A1**
  - **Test A2**
  - **Test B1**
  - **Test B2**



Results

- **Test A1** (same sense, 1 MB files)



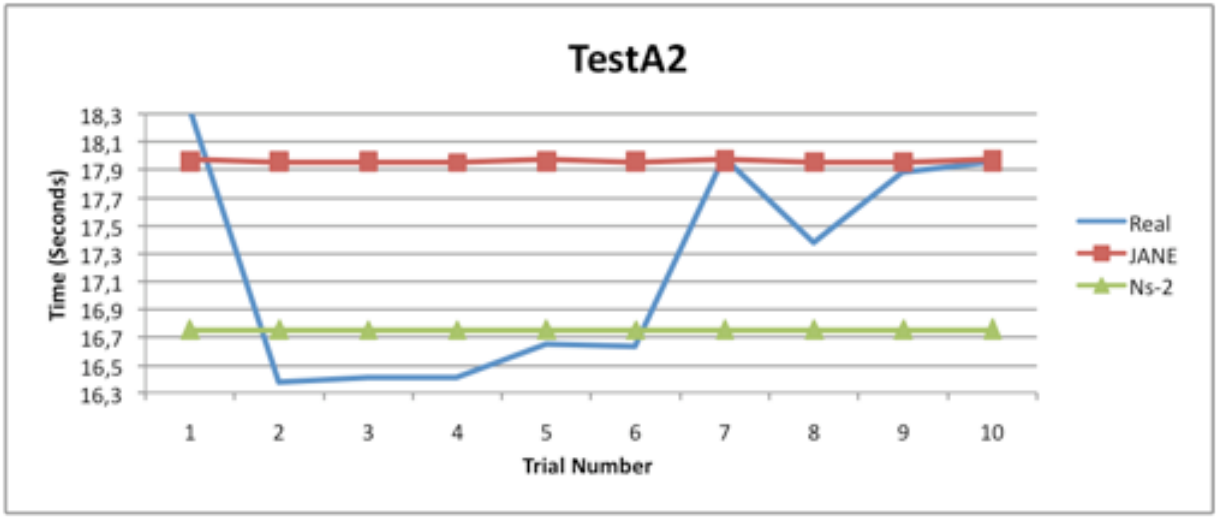
- Average values:

Accurate results

	Real Experiments	JANE	VanetMobiSim/Ns-2
Transmission Time	1.6 secs	1.8 secs	1.6 secs
Data Rate	626.9 KB/s	563.8 KB/s	609.7 KB/s

Results

- **Test A2** (opposite sense, 1 MB files)



- Average values:

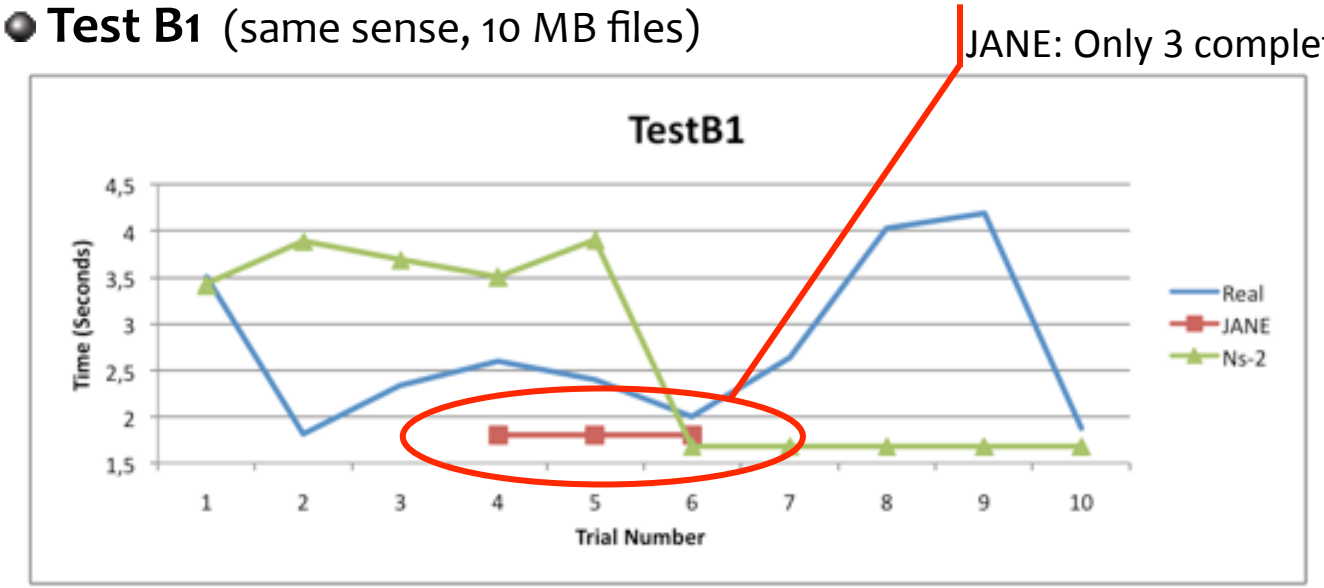
Difference 0.6 secs

	Real Experiments	JANE	VanetMobiSim/Ns-2
Transmission Time	17.3 secs	17.9 secs	16.7 secs
Data Rate	585.1 KB/s	564.4 KB/s	611.1 KB/s

Difference 0.6 secs

Results

- **Test B1** (same sense, 10 MB files)



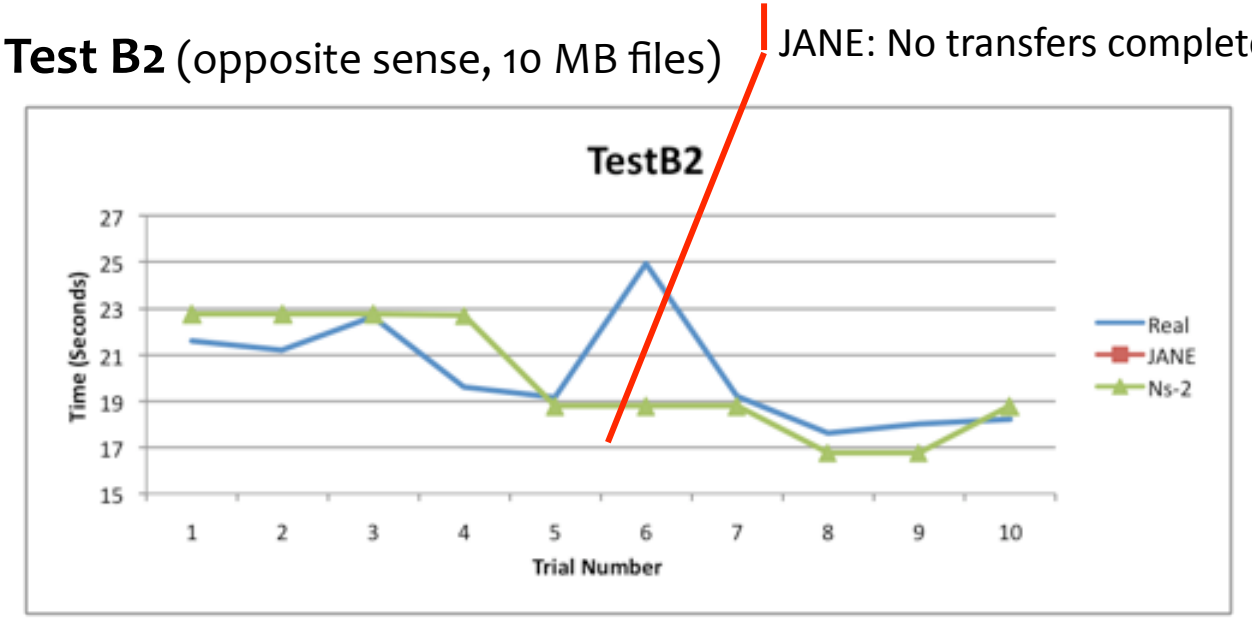
- Average values:

Accurate results

	Real Experiments	JANE	VanetMobiSim/Ns-2
Transmission Time	2.7 secs	1.8 secs	2.6 secs
Data Rate	371.4 KB/s	563.7 KB/s	391.4 KB/s

Results

- **Test B2** (opposite sense, 10 MB files)



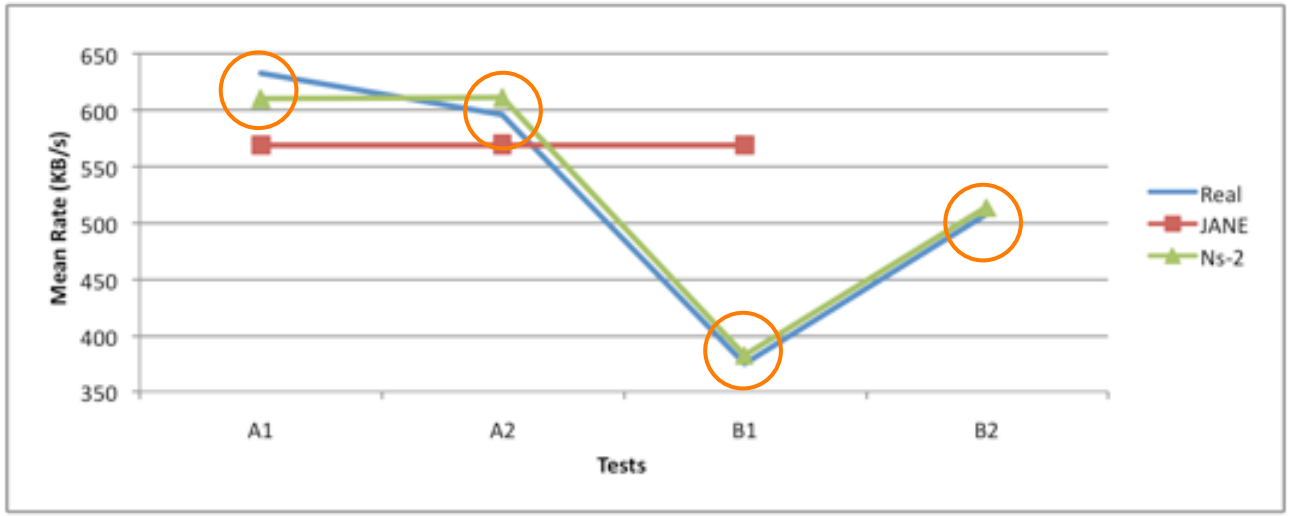
- Average values:

Accurate results

	Real Experiments	JANE	VanetMobiSim/Ns-2
Transmission Time	20.1 secs	N/A	19.9 secs
Data Rate	502.1 KB/s	N/A	513.3 KB/s

Results

Global average results



- Mean data rate differences (absolute value in KB/s) between real and simulation results

	Test A1	Test A2	Test B1	Test B2
JANE	63.1 KB/s	20.6 KB/s	192.3 KB/s	N/A
VanetMobiSim/Ns-2	17.2 KB/s	25.8 KB/s	20.0 KB/s	11.3 KB/s

Conclusions

- The real world is quite difficult to simulate in a trustworthy manner. Our simulations can be changed by including:
  - obstacles
  - signal reflections
  - etc.

- At the CARLINK-UMA Scenario an important quantity of data can be transferred with a transmission data rate always higher than 300 KB/s

- VanetMobiSim/Ns-2 is the **most realistic** simulator, if the goal is to model the VANET in a computer

- JANE is useful for **programming/testing** high-level applications

- As a future work:
  - perform simulations of other scenarios in order to predict the performance of the communications at urban and highway environments (almost finished)
  - combine the simulator (VMS/Ns-2) with *optimization techniques* in order to offer an optimal configuration of VDTP (in progress)


Thank you for
your attention.
Any question?