

# AnaVANET: an experiment and visualization tool for vehicular networks

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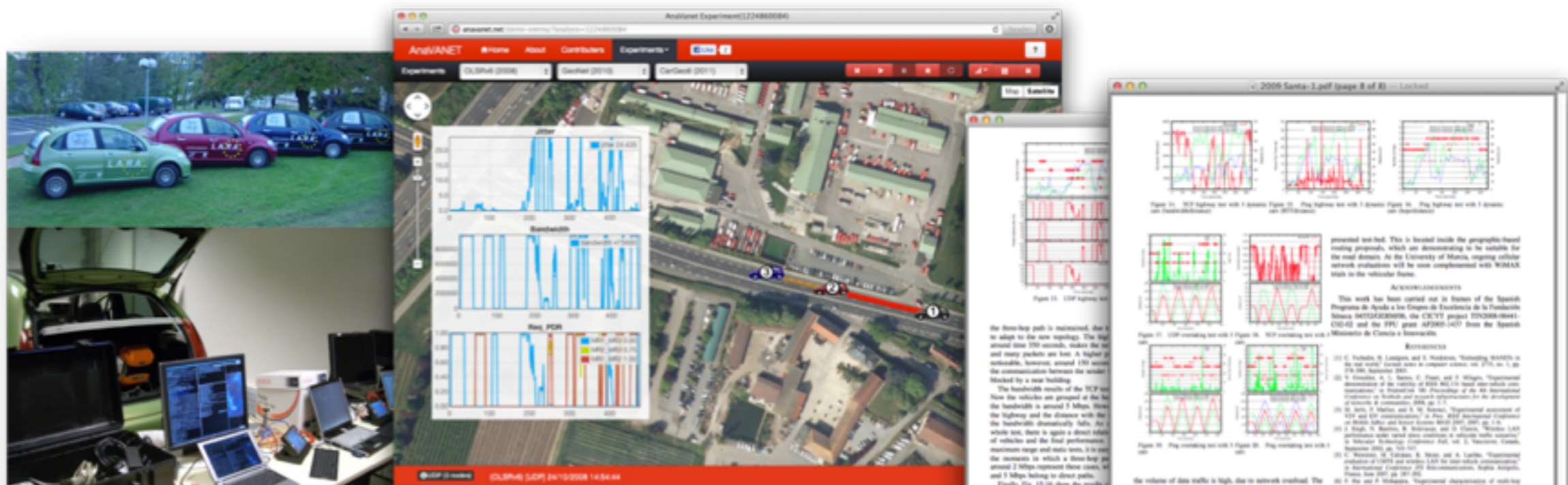
# Outline

- Background
- Issue and requirements for VANET evaluation
- Evaluation methodology
- AnaVANET
- Evaluation of NEMO over IPv6 GeoNetworking

Do experimentation. →

Visualize it. →

Publish papers.



# Vehicular Networking

- Intelligent Transportation Systems (ITS)
  - Systems to achieve road safety, traffic efficiency and comfort
- Cooperative ITS
  - Systems where multiple ITS Stations share information to achieve better road safety, traffic efficiency and comfort
  - Vehicle, Roadside, Central and Personal ITS Stations

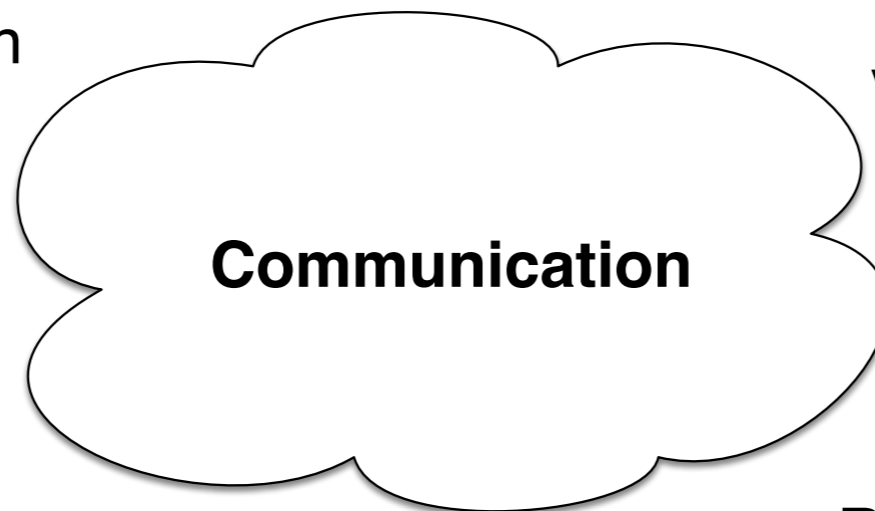


Personal ITS Station



Central ITS Station

- ✓ Road safety
- ✓ Traffic efficiency
- ✓ Comfort



Vehicle ITS Station

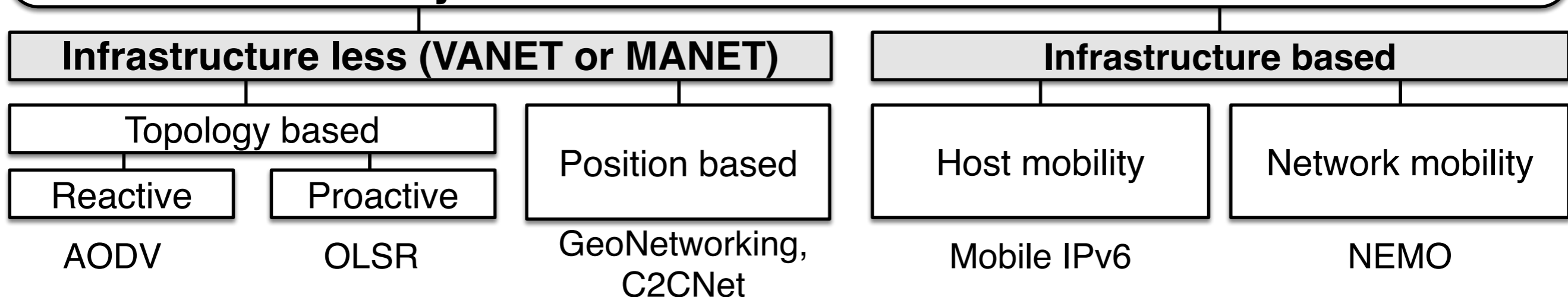


Roadside ITS Station

# Network Layer Protocols for vehicular Networking

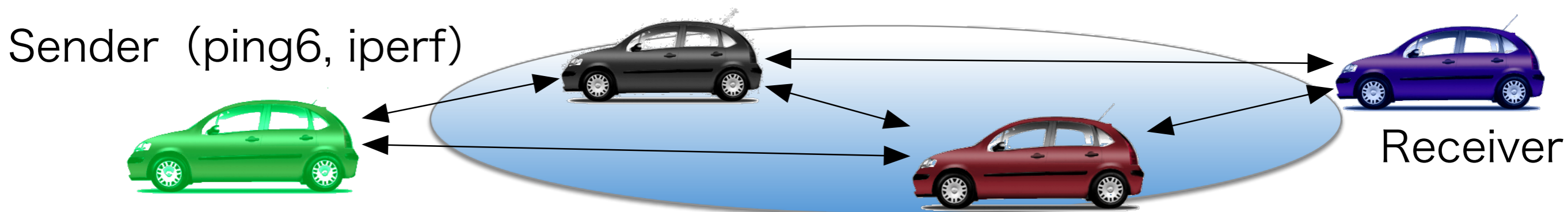
- Vehicle to Vehicle (V2V)
  - wireless communications in dynamic topologies without any infrastructure
  - VANET or MANET
- Vehicle to Infrastructure (V2I)
  - global connectivity of nodes to the Internet
  - Internet Mobility (Mobile IPv6, NEMO)

## Network Layer Protocols for vehicular communications



# Issues on vehicular networks evaluation

- Common end-to-end evaluation tools such as ping6 and iperf
  1. Unawareness of communication path
  2. Unawareness of per-hop network performance in the communication path
  3. Unawareness of vehicles' movement

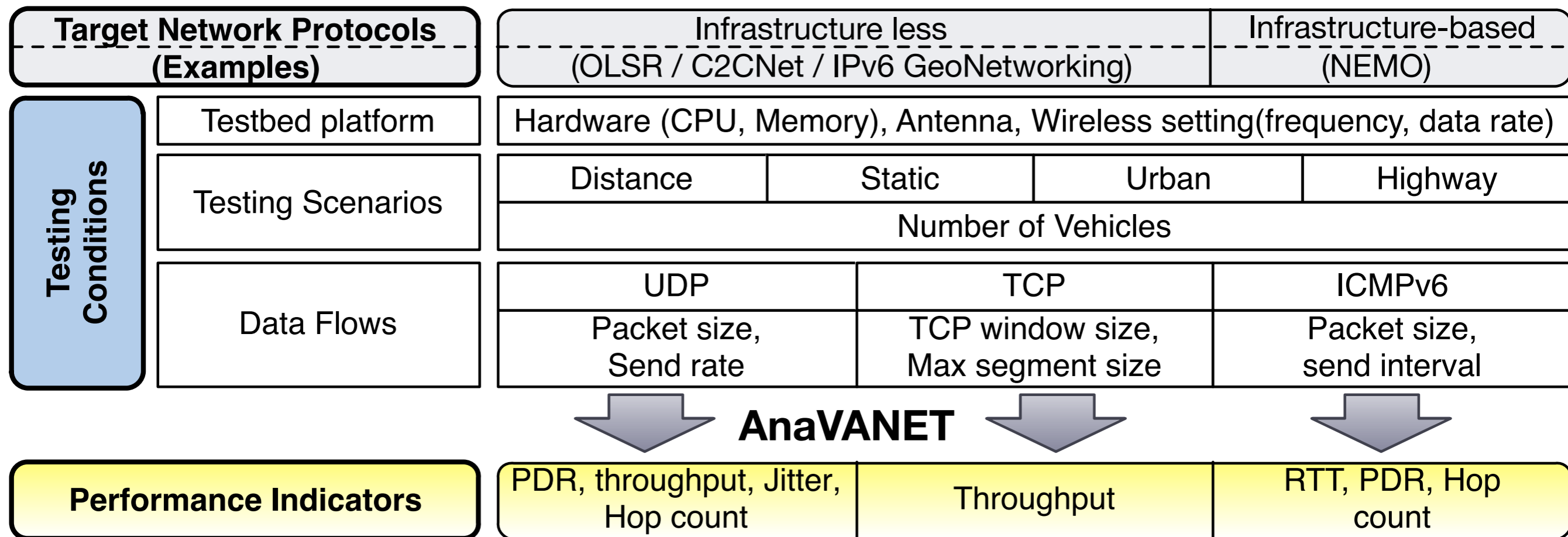


# Requirements on vehicular network evaluation

1. Path detection
2. Communication performance in links
3. Geographical awareness
4. Intuitive visualization
5. Independence from network protocols
6. Independence from devices
7. Adaptation to various scenarios
8. Easiness for data collection

# Overview of Evaluation Methodology

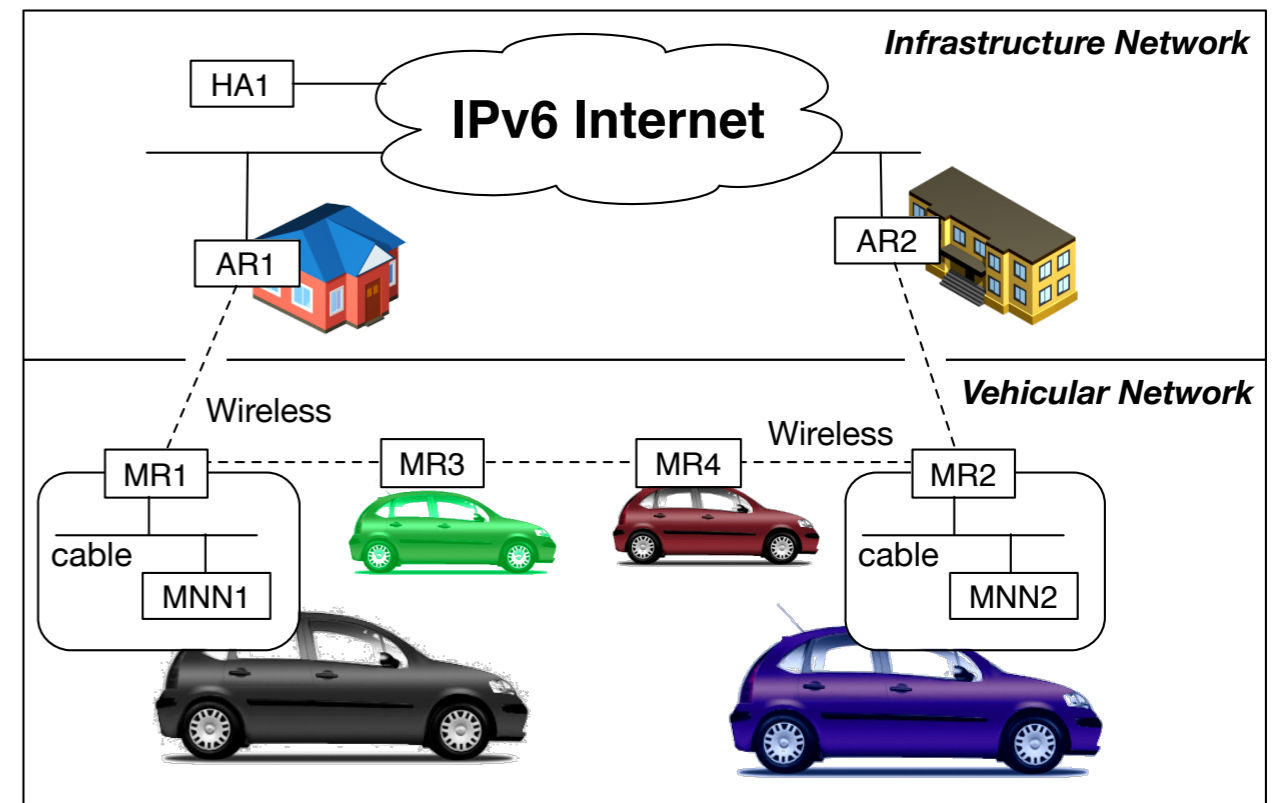
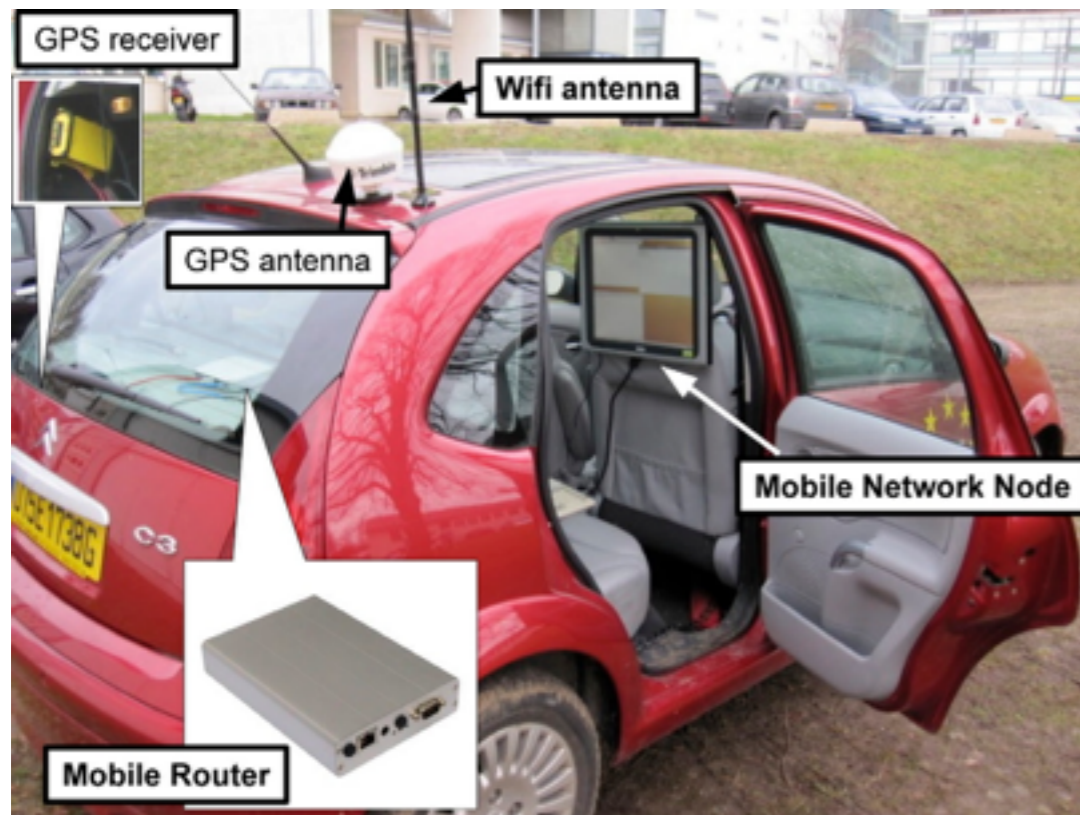
- The evaluation goals are to analyze which **testing conditions** affect which **performance indicators** using **target network protocols**.



# Testbed platform

- V2V and V2I network
- ARs and MRs
  - OS: Linux 2.6.29.6
  - Wireless configuration
    - frequency 2.422Ghz
    - Data rate 6 Mbits/s

- NEMO is supported
- GeoNetworking is supported





# Testing Scenarios

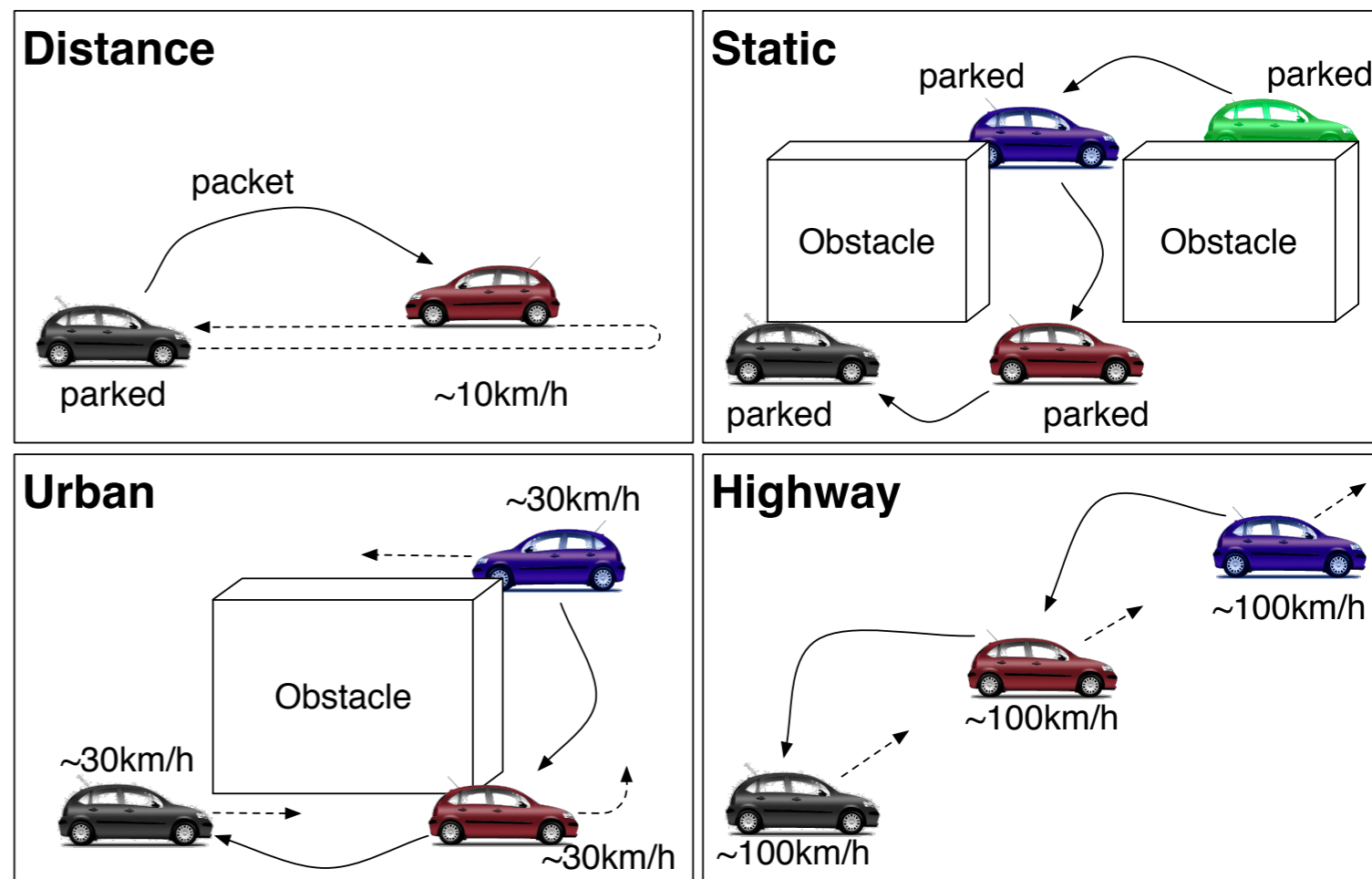
- Location Scenarios

- INRIA Paris-Rocquencourt installations

- Number of vehicles

- Up to four vehicles are considered in our case

- Mobility Scenarios



# Data Flows and Performance Indicators

## ■ Data Flows

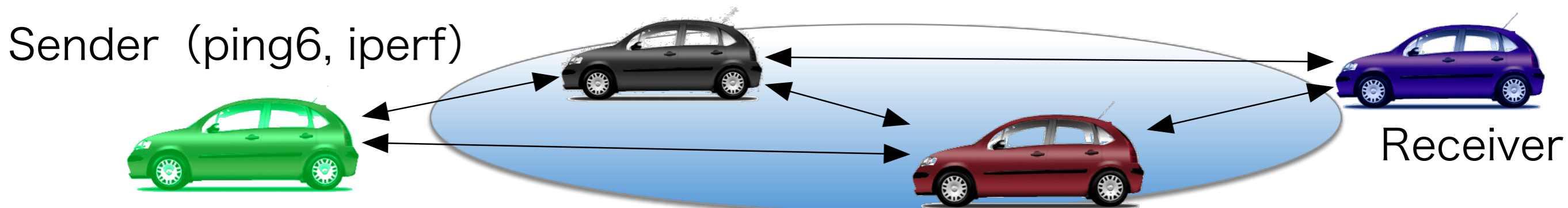
- UDP
- TCP
- ICMPv6

## ■ Performance Indicators

- Packet Delivery Ratio
- Round Trip Time
- Bandwidth
- Jitter

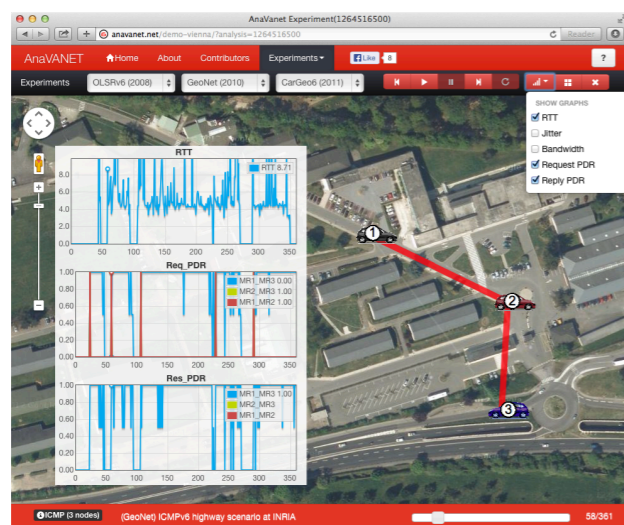
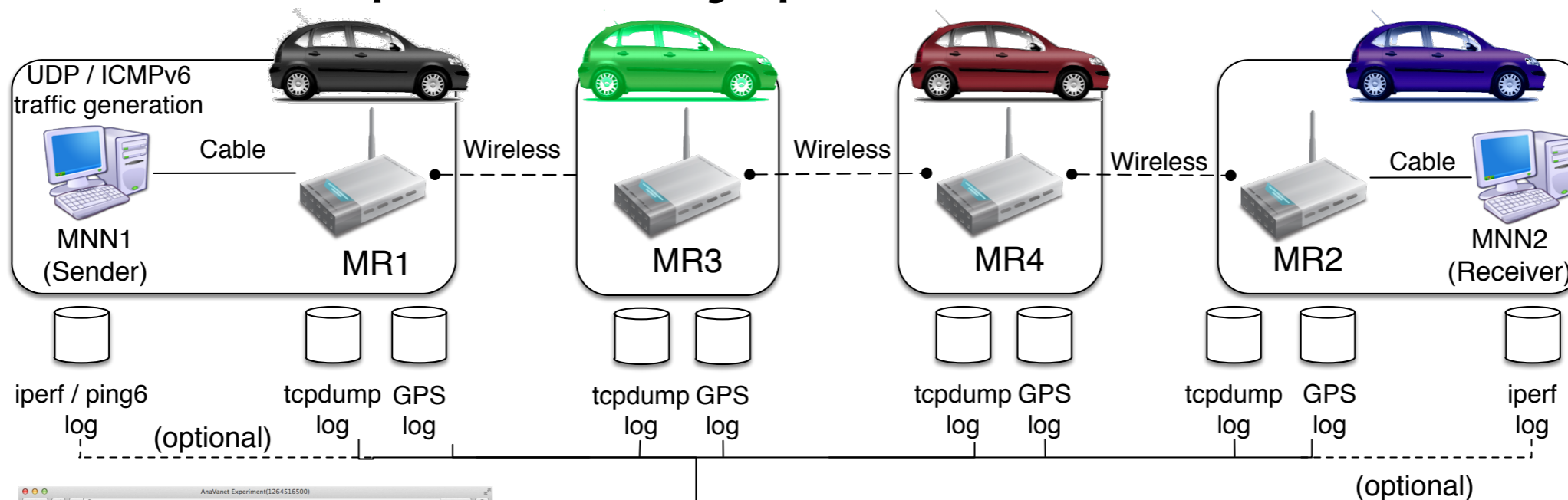
## ■ Geographic metric

- Hop count
- Speed
- Position of cars
- Distance between cars



# Overview of the AnaVANET system

- Generate packets with UDP, TCP and ICMPv6
- Capture packets in all the nodes
- Trace them packet by packet



AnaVANET Web viewer

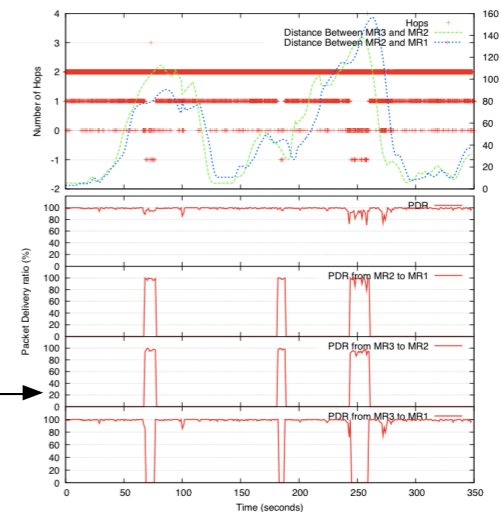
<http://anavanet.net/>

AnaVANET

XML statistics  
Packet trace

Web front-end  
(Google maps)

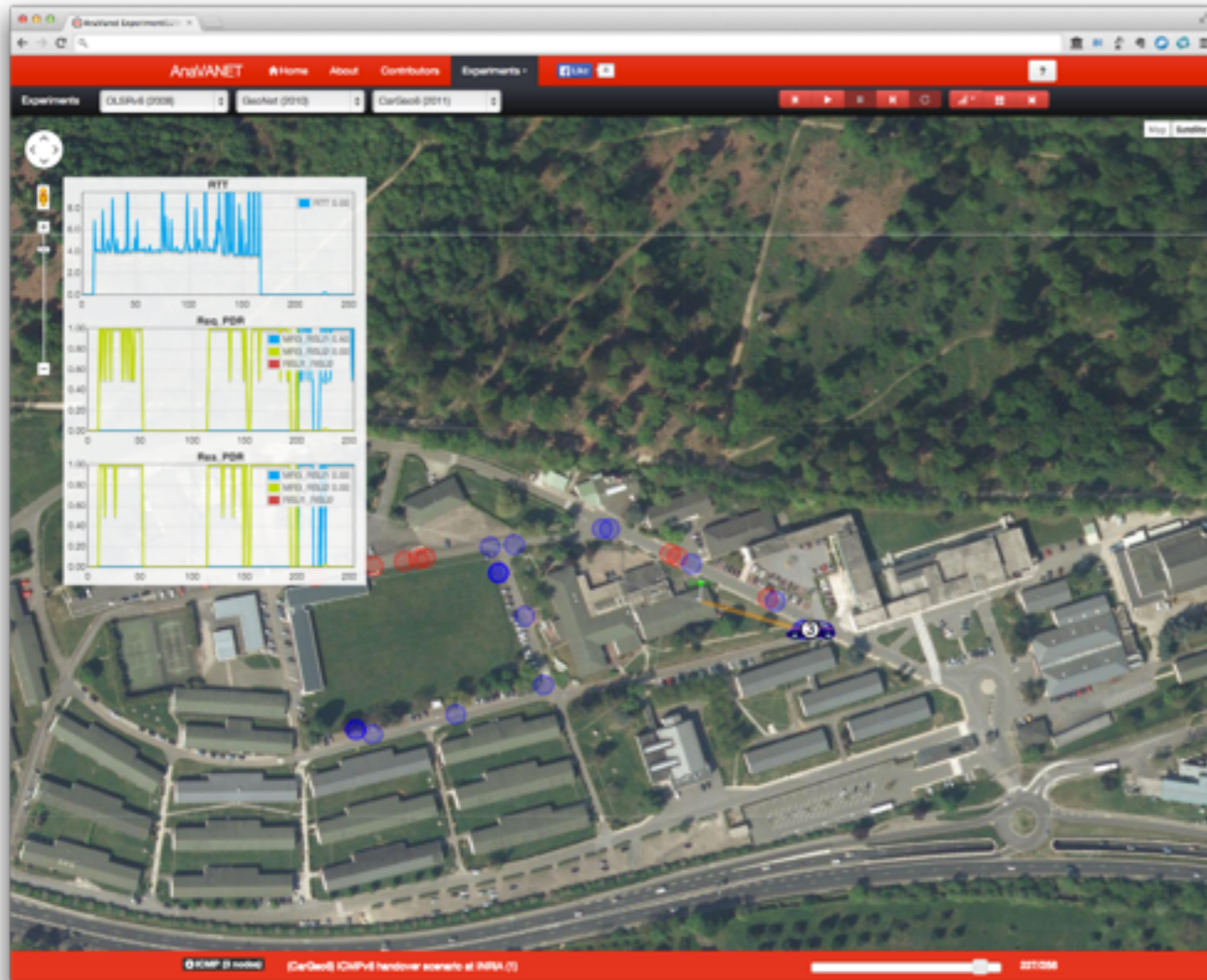
Gnuplot



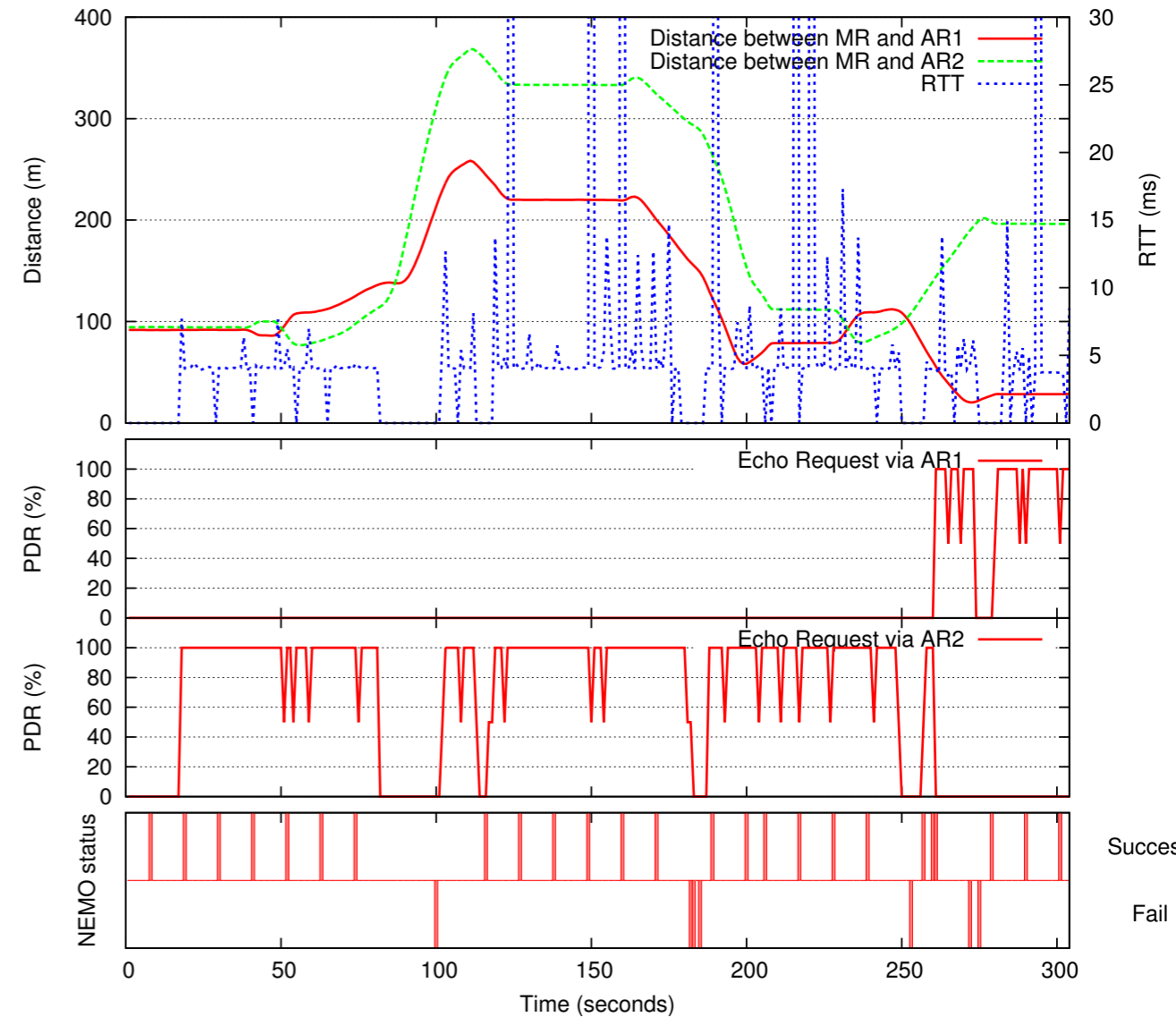
Graphs

# Output examples

- Google maps shows the performance indicators with
  - Movement
  - Distance
  - Obstacles

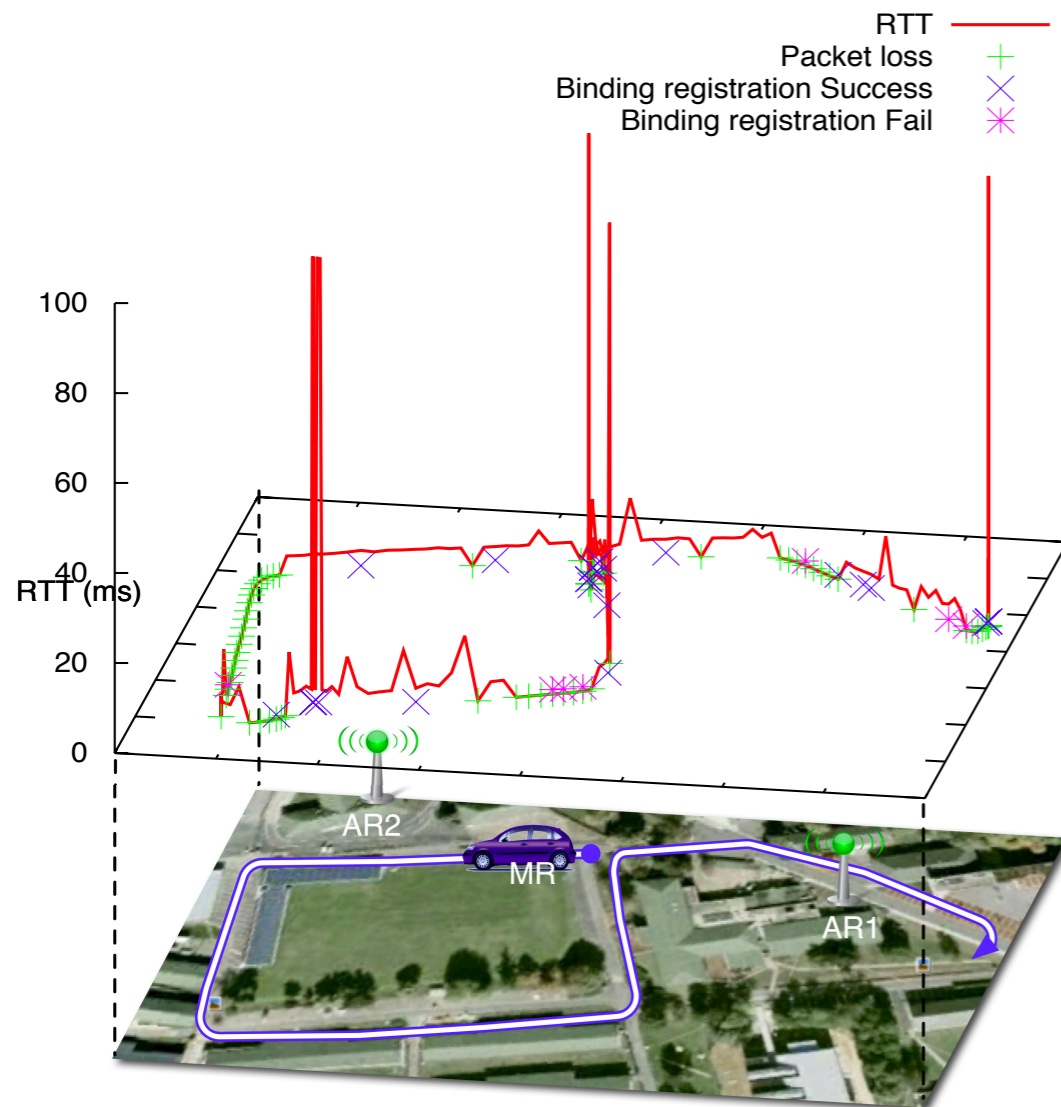


- Graphs generated by gnuplot shows as follow

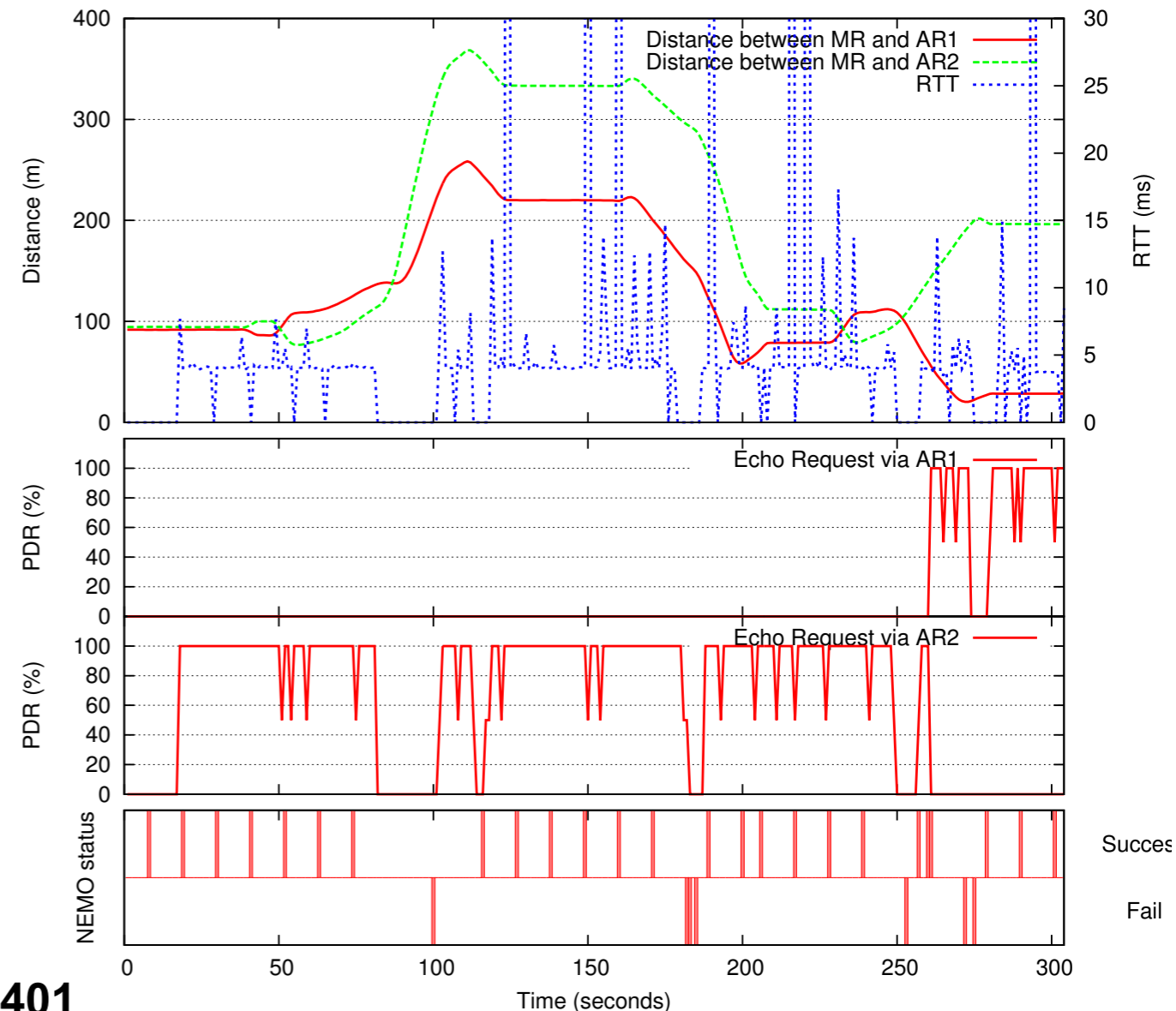


# IPv6 GeoNetworking using NEMO (ICMPv6)

- 64 bytes in 0.5s interval
- RTT is about 5ms
- Binding registrations are lost in the south road



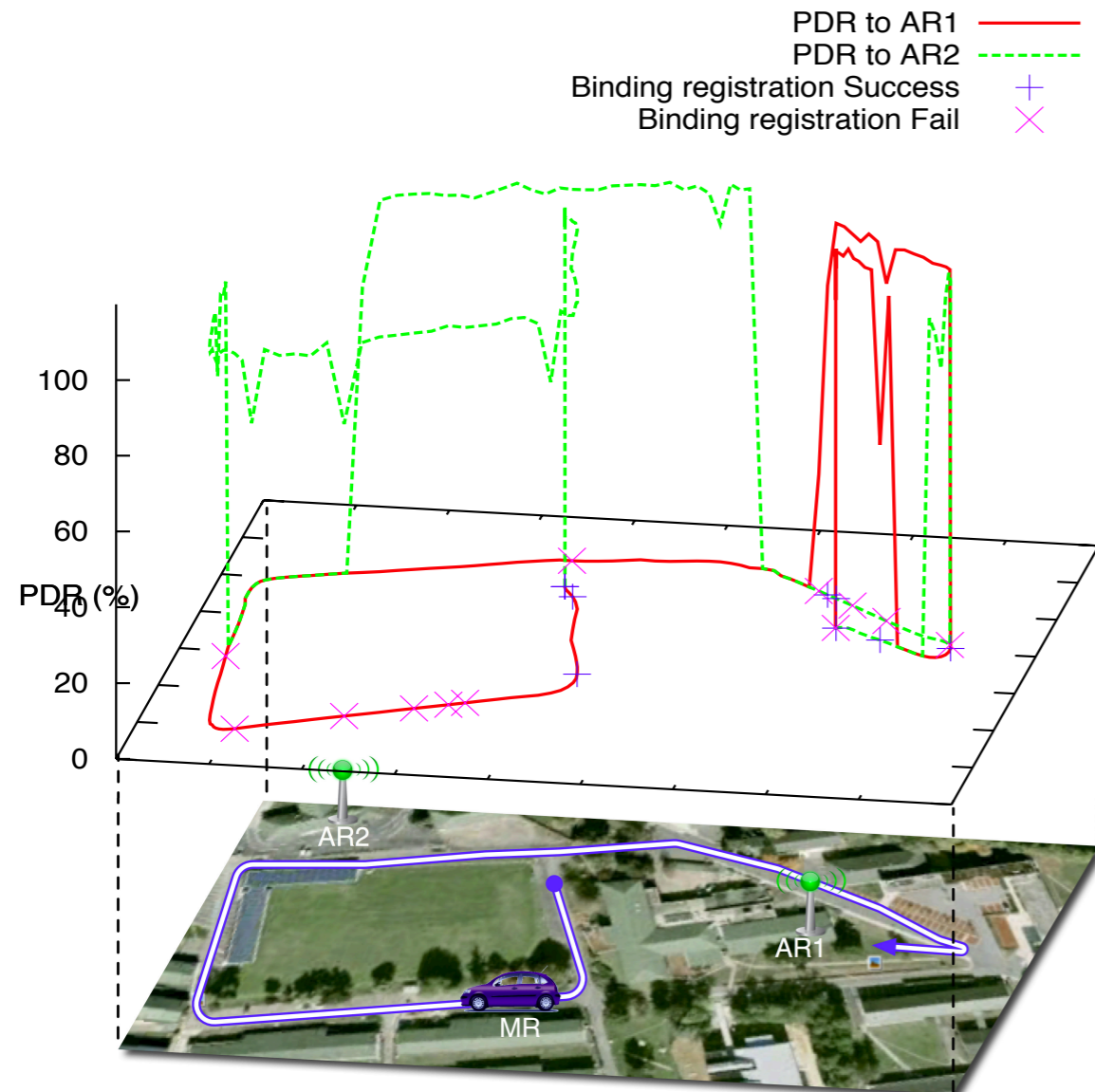
- Handover
  - without packet loss
  - 120m from AR2, 50m from AR1



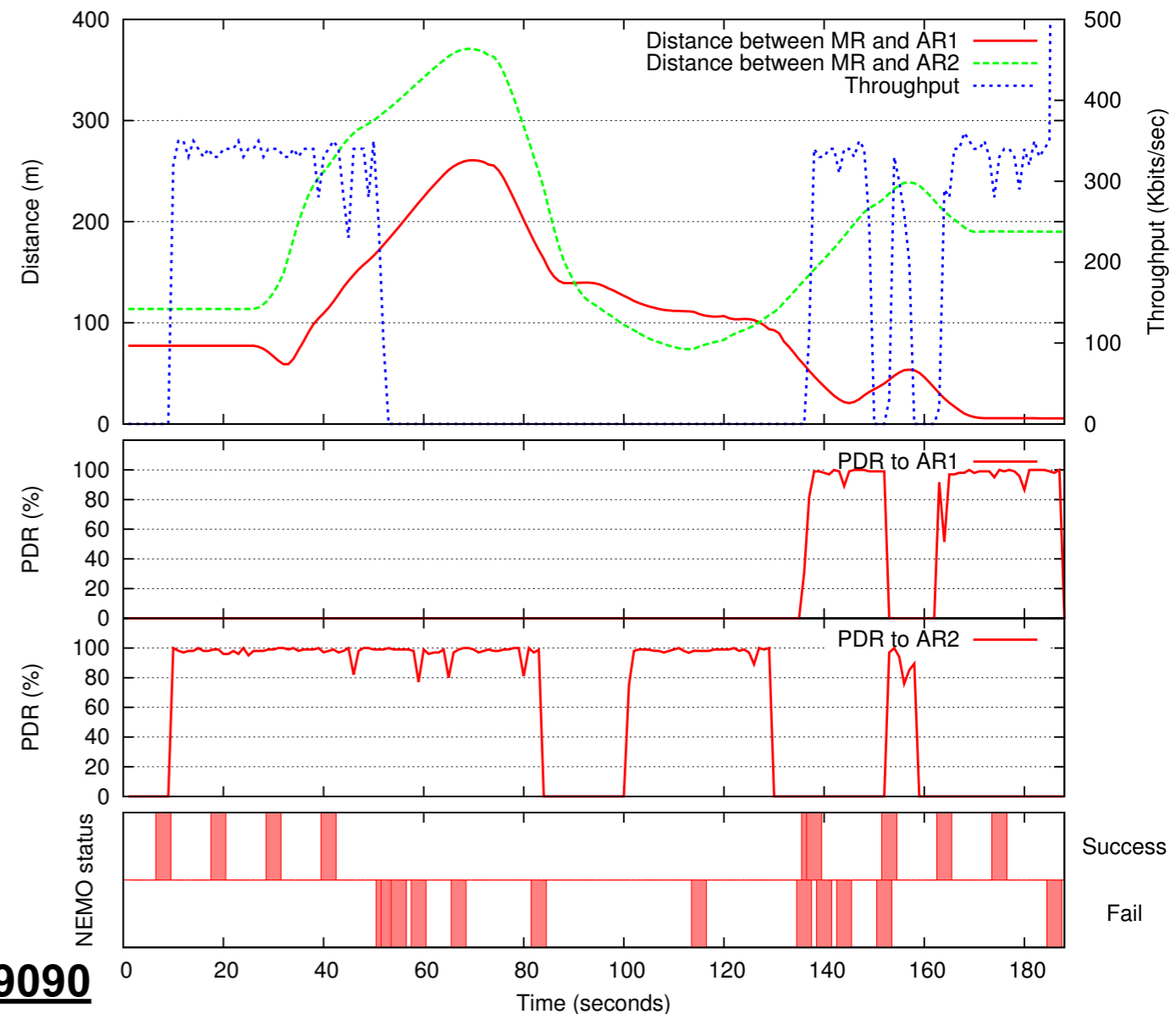
<http://anavanet.net/demo-vienna/?analysis=1296754401>

# IPv6 GeoNetworking using NEMO (UDP)

- 1250 Bytes packet with 1 Mbps rate
- UDP packets are lost during 4 seconds in handover



- Disconnection time after the binding registration failure was seven seconds (= 1 + 2 + 4)



<http://anavanet.net/demo-vienna/?analysis=1296759090>

# Conclusions and future works

## ■ Conclusions

- Analysis of evaluation of vehicular networks
- Evaluation methodology
  - Analysis of metric impacts the network performance
  - Performance indicators
- Design and Implementation of AnaVANET
- Evaluation of IPv6 GeoNetworking using NEMO

## ■ Future work

- Link layer extension i.e. channel quality, load ratio
- Support for multicast data flows
- Evaluation of real Cooperative ITS application

Thank you for attention

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