2010 IEEE INTERNATIONAL CONFERENCE
ON INTELLIGENT COMPUTER COMMUNICATION
AND PROCESSING

Routing Protocol for Urban Mobile Networks based on Geographical Location

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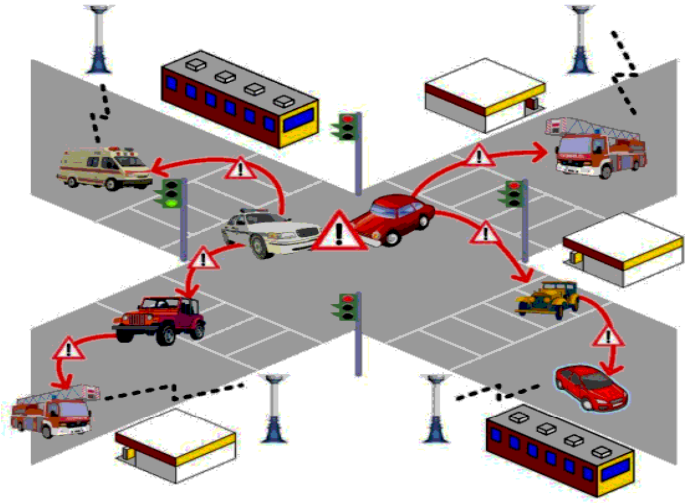
Outline

- Scope and motivation
- Routing protocol
  - Architecture
  - Fitness functions
- Implementation details
- Experimental results
- Conclusion and Future Work

VANETs

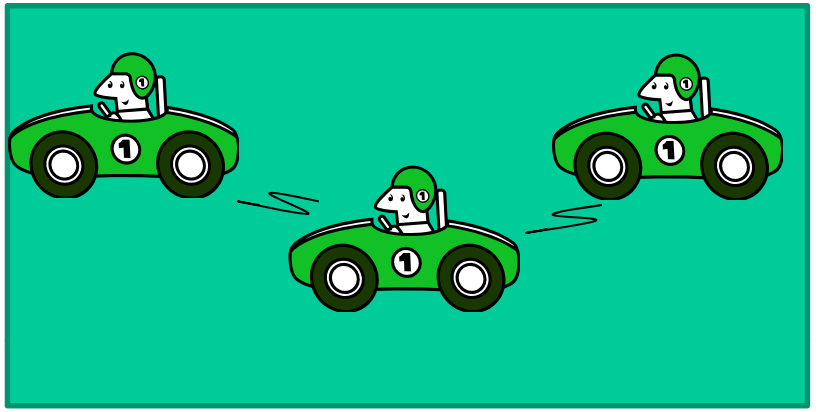
- Technology is moving from wired to wireless networks - Unstructured Networks (Mobile Ad hoc Network - MANET)
  - Vehicular Ad hoc Network (VANET)
- Vehicles form network
- Vehicles equipped with
  - Wireless transceivers
  - Computerized control modules



- Examples of VANET applications:
  - Safety: Accident avoidance warnings, Rapid rescue service
  - Convenience: Detour information, Toll road payments
  - Entertainment: Multimedia entertainment, V2V Communication

Routing protocols

- Communication in VANETs accomplished using vehicle-to-vehicle communication



- Ad hoc Routing Protocols
  - Highest Delivery Ratio
  - Lowest End-to-End Delay
- Current solutions: broadcasting, flooding
  - Proactive (routes update periodically): DSDV
  - Reactive (routes update on-demand): AODV, AOMDV, DSR

or

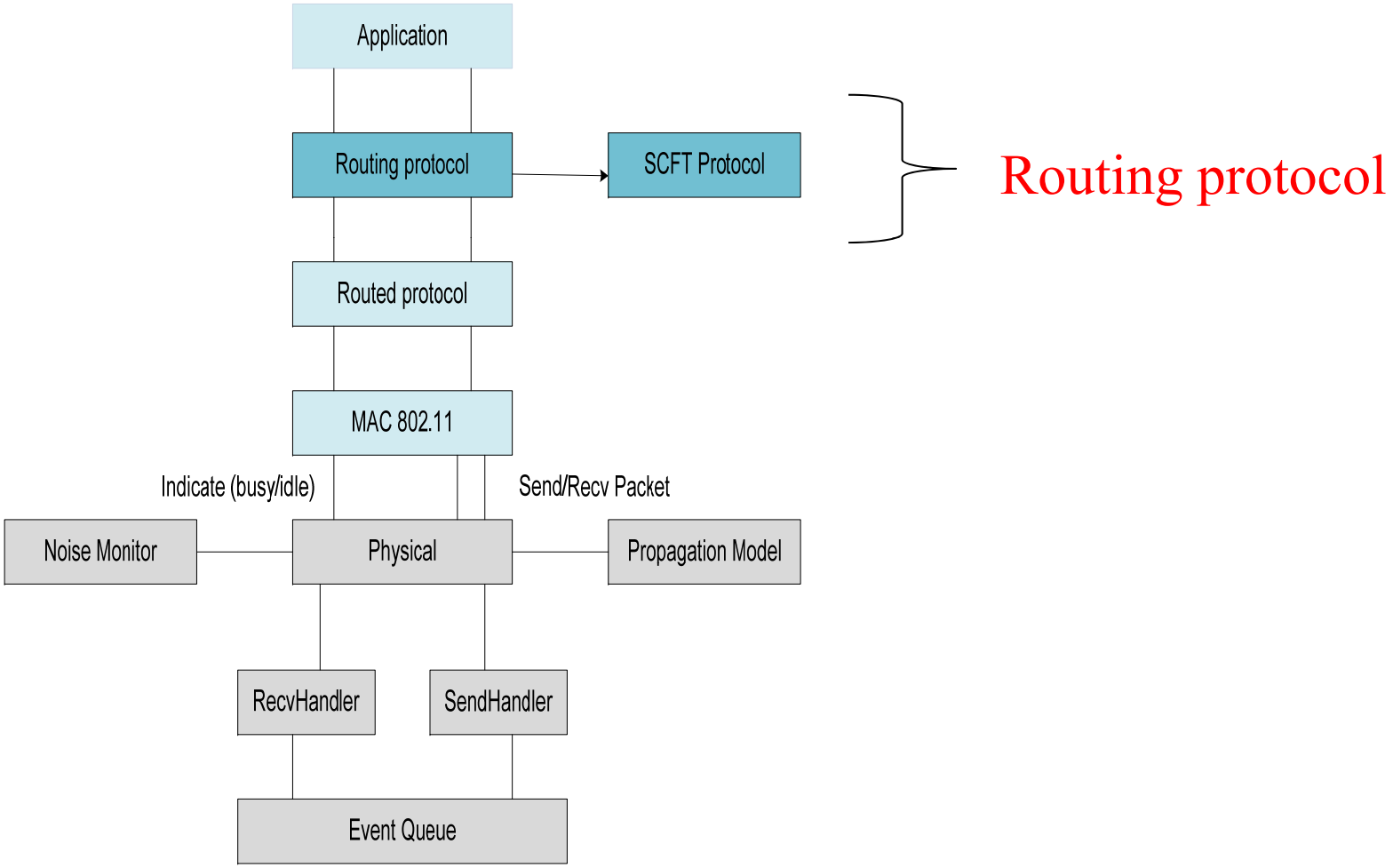
  - Topology-based routing protocols: DSDV, DSR, AODV
  - Location-based routing protocols: LAR, DREAM, GPSR

Objective

- Vehicular ad hoc networks (VANET)
  - Error-prone channels
  - Low-capacity channels
  - Dense, but intermittent connectivity
  - High, but restricted mobility patterns
  - Traffic congestion – broadcast storm
- Objective
  - Store-carry and forward, trajectory based routing protocol for VANETs
  - Based on:
    - Current position and trajectory of cars
    - Distance between vehicles

The SCFT routing protocol

- Modules implementing different communication functions

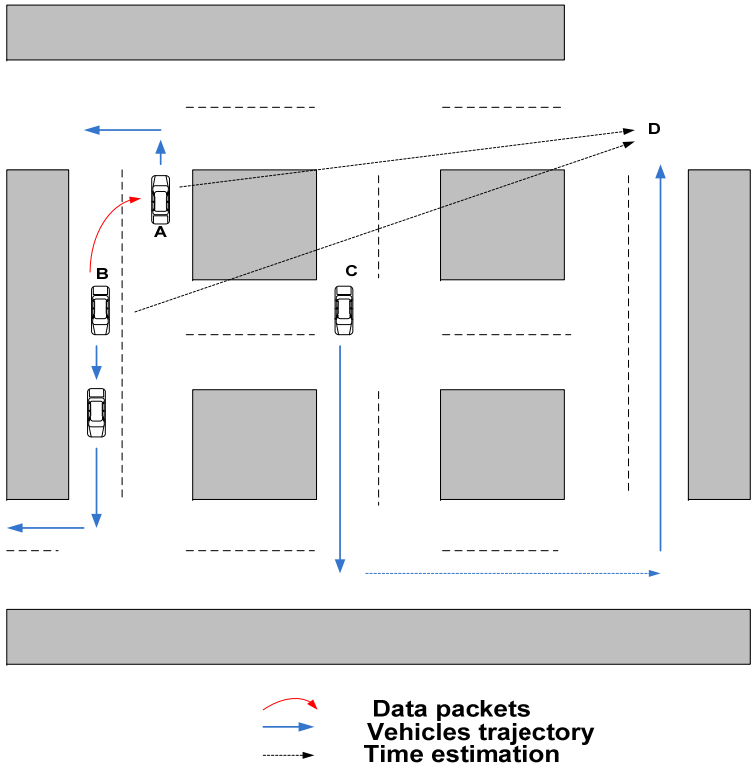


The routing protocol (1)

- Each car is equipped with a Decision Module that chooses the next hop to forward a message to…
  - If a hop exists, the message is forwarded to it;
  - Otherwise, the message is stored until an appropriate hop is found.
- The forwarding hop can be:
  - A neighbor car
  - A communication device from road infrastructure.
- The decision module uses:
  - Locally-available digital maps
  - Trajectory of the vehicles.

The routing protocol (2)

- The decision is influenced by the distance between two vehicles
  - The wireless range of the equipments installed on the vehicles can create problems for message transmission.
  - Causes of message losses include:
    - the movement vectors of the two vehicles
    - the transmitter and the receiver
- Compute an area in which messages transmitted have a high probability to reach their destination:
  - Uses the vehicle speed, wireless range and trajectory fitness



Routing algorithm

fitness(id) = fitness_distance(id) + fitness_speed(id)+ fitness_trajectory(id)

Message receiving

if id_destination == id_vehicle then

message successfully received

else

message stored in queue

Message sending

if fitness(id_destination) > value then

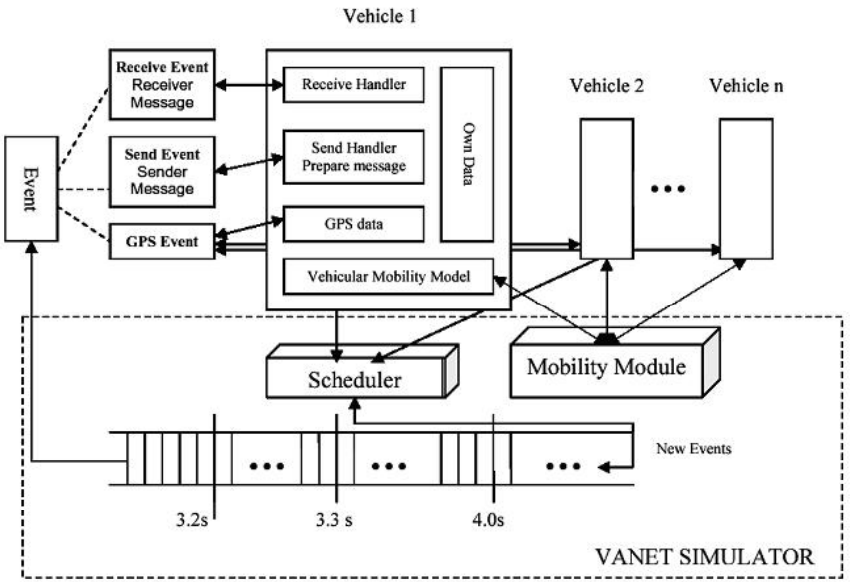
message forward

else

message stored -> use store-carry

Pilot implementation

- Evaluation implementation of the routing protocol in VNSim
- Discrete-event VANET simulator for evaluating the performances of a wide-range of VANET technologies
  - ranging from wireless networking protocols and dissemination strategies to applications being developed over VANETs
- Two main models:
  - vehicular mobility model
  - wireless networking model
- The extensions to the simulator include the components used by the SCFT routing protocol

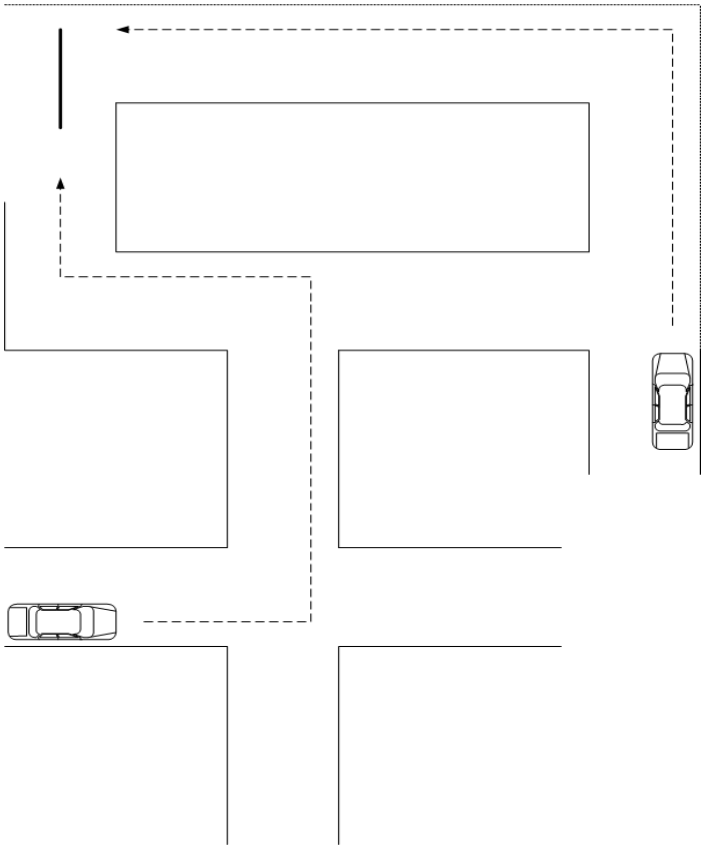


Fitness functions

- Fitness function for distance:
  - The function appreciates if there are neighbors that might reach the destination or the forwarding vehicle is within the distance covered by the wireless range.
  - Vehicle in direct range? Vehicle sending the message has any neighbors in its action range?
- Fitness function for speed:
  - Difference between the speed vectors of the carrier vehicle and the last known speed of the destination vehicle.
- Fitness function for the trajectory:
  - Road segments that are common to the vehicle carrying the message and the last known trajectory of the destination vehicle.

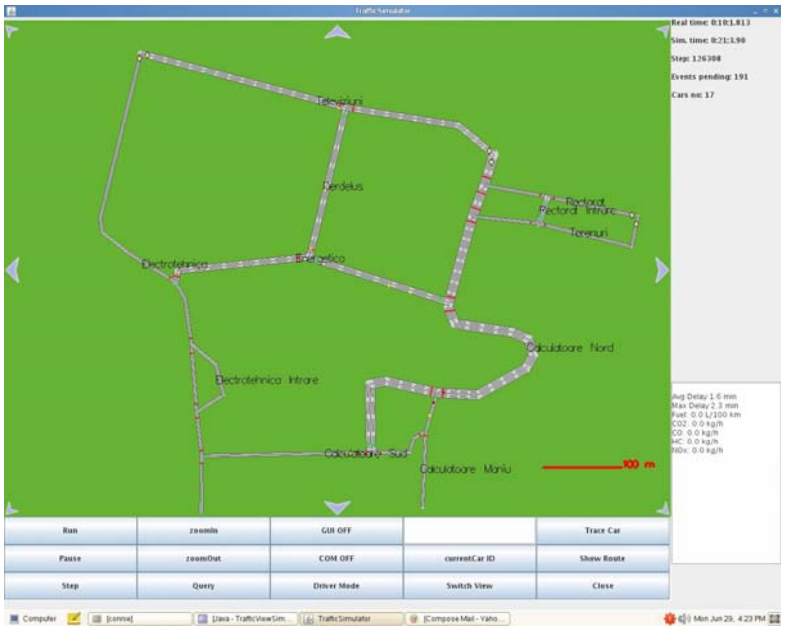
Routing decision

- The fitness looks for common segments between the last known trajectory of the destination car and cars potentially capable of forwarding the message
- The protocol also **estimates** the time when that vehicles reach such common segments.
- If acceptable time difference between the moments the two vehicles reach the same segment
  - Message is forwarded
- In addition, each vehicle continuously broadcasts: location, id, trajectory



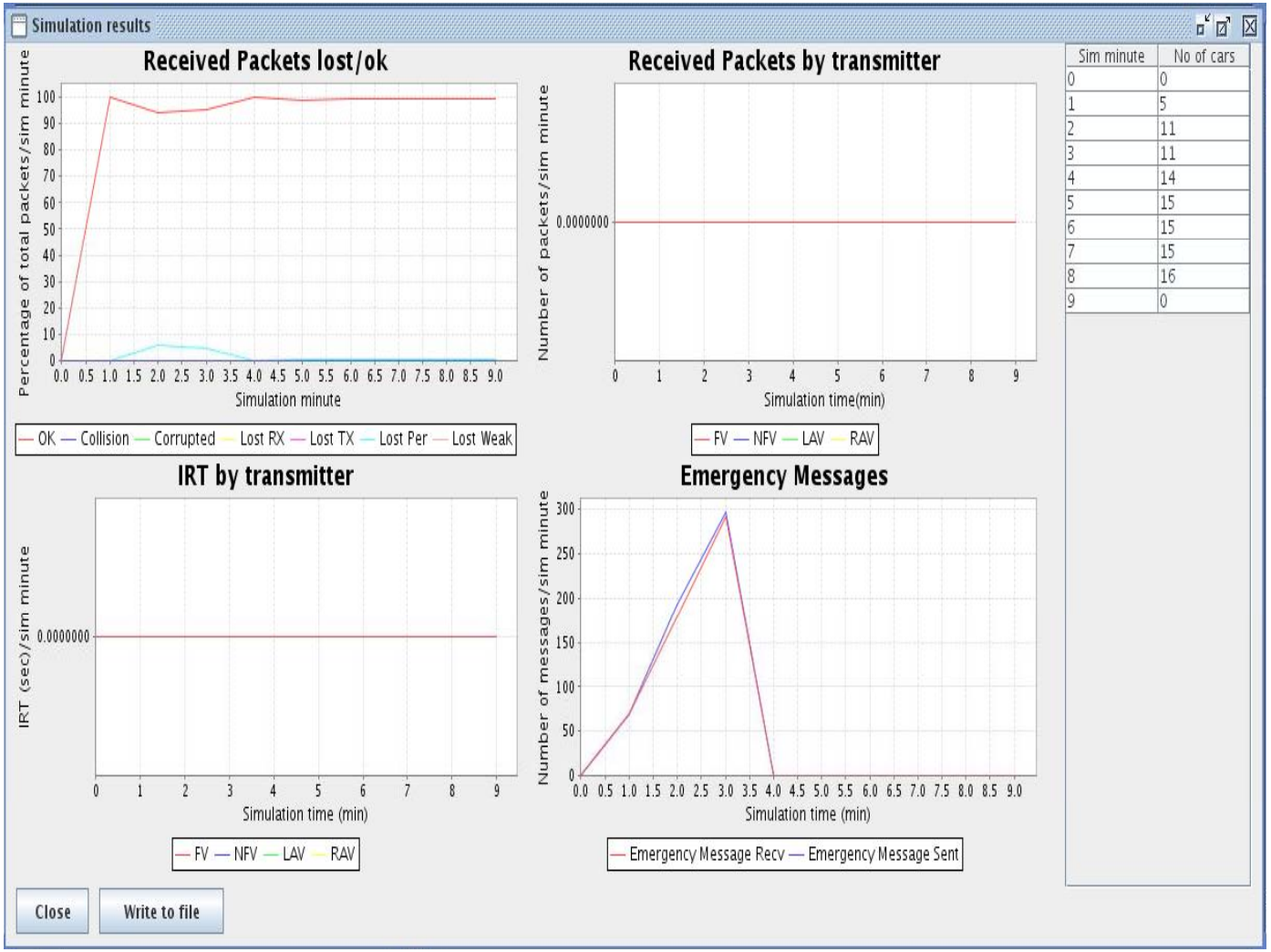
Experimental scenario

- Simulated urban environment that resembles a real-world traffic situation in Bucharest.
  - wireless range for each vehicle is 200m,
  - wireless range of the access points available within the road infrastructure is 1000 m,
  - a flow of 100 vehicles/hour/each lane of each road.
- We executed a number of experiments:
  - We varied the average speeds, distance between cars and various trajectories for the vehicles.



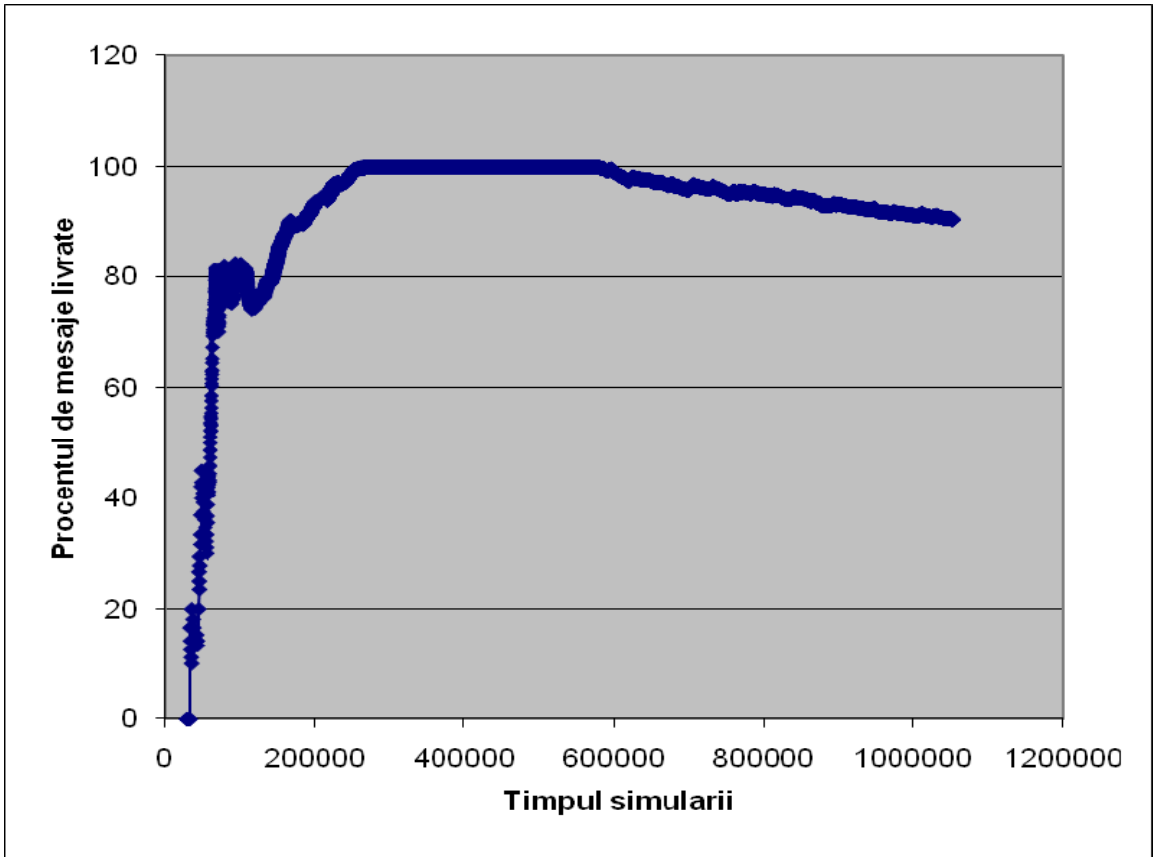
Experimental results

- The results show the performance of the routing protocol to successfully deliver messages and the load of the network.



Experimental results

- The percentage of messages being delivered is above 90%.



Conclusions

- Within VANETs, the communication protocols are extremely important, because, due to the intrinsic properties of such environments, they reflect a series of characteristics which set them apart from traditional approaches.
- We presented a routing protocol designed for VANET environments.
- The protocol is able to reduce the time interval needed for the transmission of messages between vehicles using the resources currently available in such environments.
- The evaluation of the protocol revealed that it functions properly and is able to increase the number of message correctly delivered, while minimizing the time for the transmission and optimizing the network throughput.

Q&A

Thank you!

http://cipsm.rogrid.pub.ro/vanet.html