Knowing vehicles location HELPs avoiding broadcast storm

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IV Networks: Applications

- Road safety:
  - Accident notification
  - Information on traffic and road conditions
- Passenger entertainment:
  - Audio & video broadcast
  - Distributed gaming
  - Mobile office

Characteristics

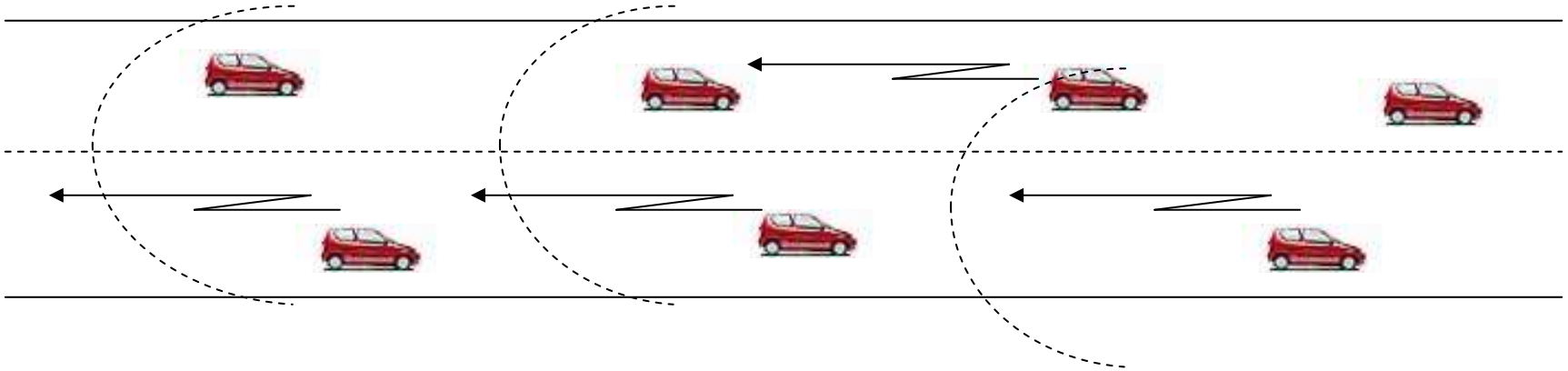
- High mobility → changes in topology
- No energy constraints
- Topology:
  - string type (in every line)
  - clusters (traffic jams)
  - frequent fragmentations

Algorithms designed for MANET may require modifications

Information & Warning Functions

- When: danger detection
- Aim: warning message propagation
- Started by:
  - on board devices
  - driver initiative
- Requirements:
  - High reliability
  - Very short delay

Ad-hoc Communication

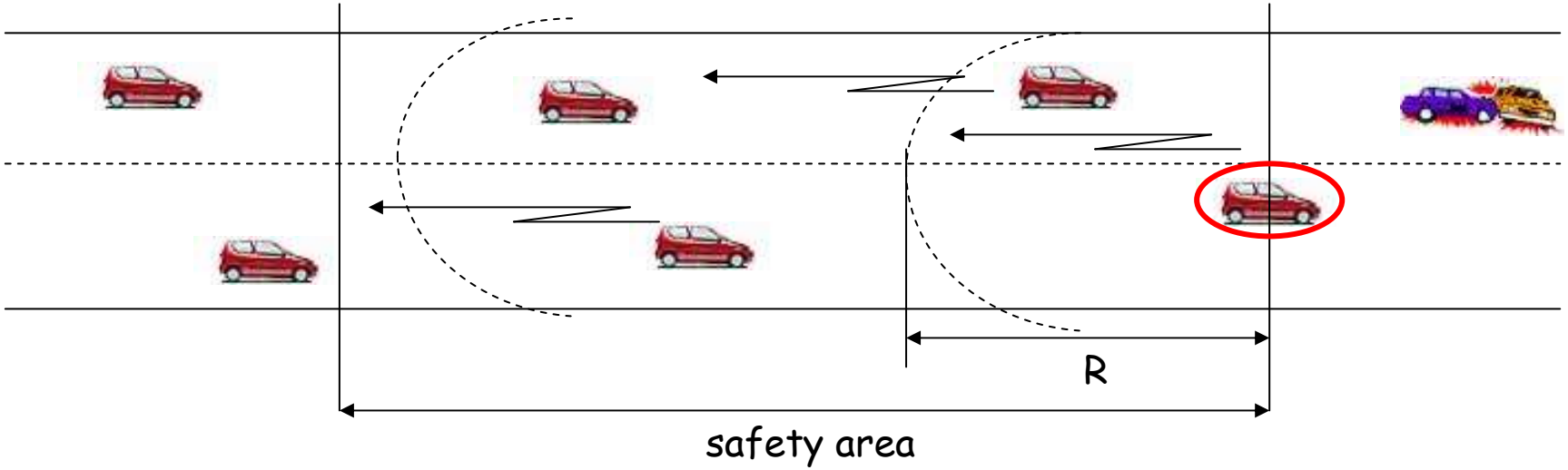


- Pros:
  - flexible;
  - ubiquitous;
  - low latency

Cons:
- reliability

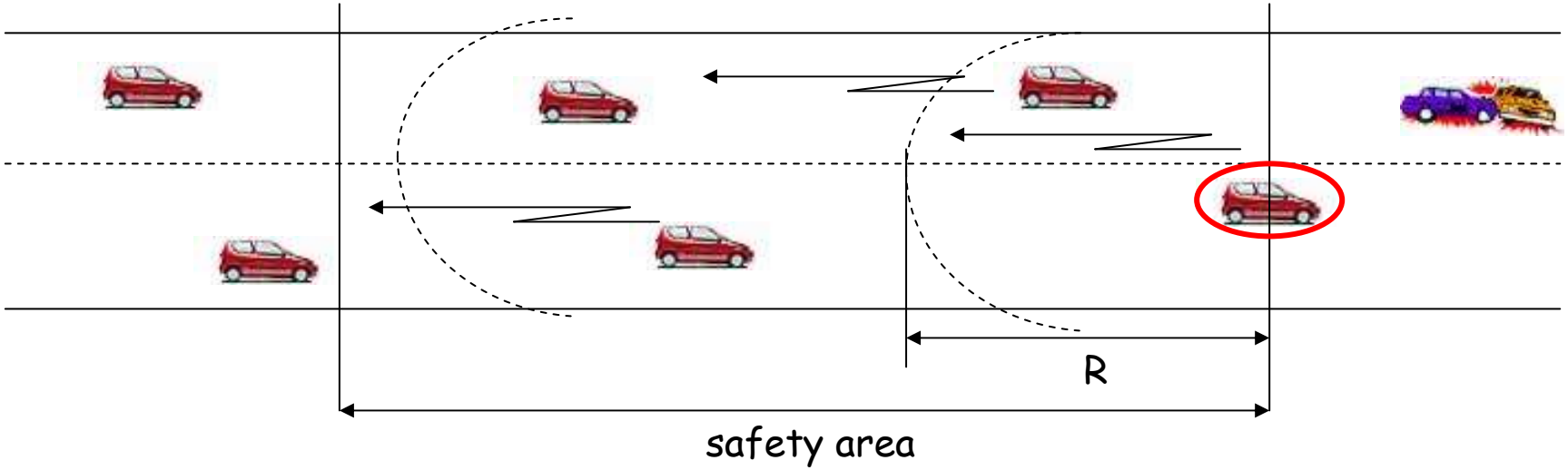
- Aim:
  - Notification of a detected danger
  - Limitation of the messages exchange

The system



- Distribute information in a safety area (s.a.)
- Multi-hop broadcast communication
- Vehicles in the s.a. may act as relays
- Vehicles outside the s.a. never relay the message

The system



- One-way road
- Transmission range *R*
- MAC layer: CSMA capabilities

Our contribution

1. A simple broadcast algorithm for warning delivery service, that
   a) Exploits routing information
   b) Decides to rebroadcast based on:
      - Coverage zone of the message
      - Neighbors position estimation

   HELP (Hello-Estimated Location based Procedure)

2. Evaluation with realistic traffic models

HELP - algorithm

- Exploits hello messages exchange implemented by routing algorithms

- Routing algorithms in IV:
  - Position based: rely on position given by GPS and not only on connectivity
  - Frequent exchange (every B seconds) of short *hello* packet (20 bytes with: id, position, speed)
  - Neighbors table (id,time,position, speed)

HELP - algorithm

- Alert message:
  - Position of the detected danger
  - Time of the warning transmission

  } Driver

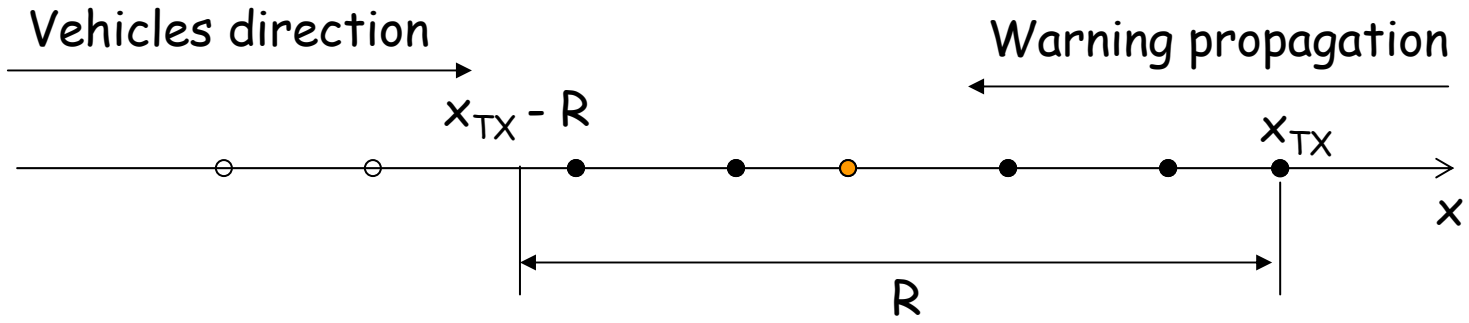
  - Relay position
  - Packet identifier

  } Algorithm

- Vehicles never forward twice the same message

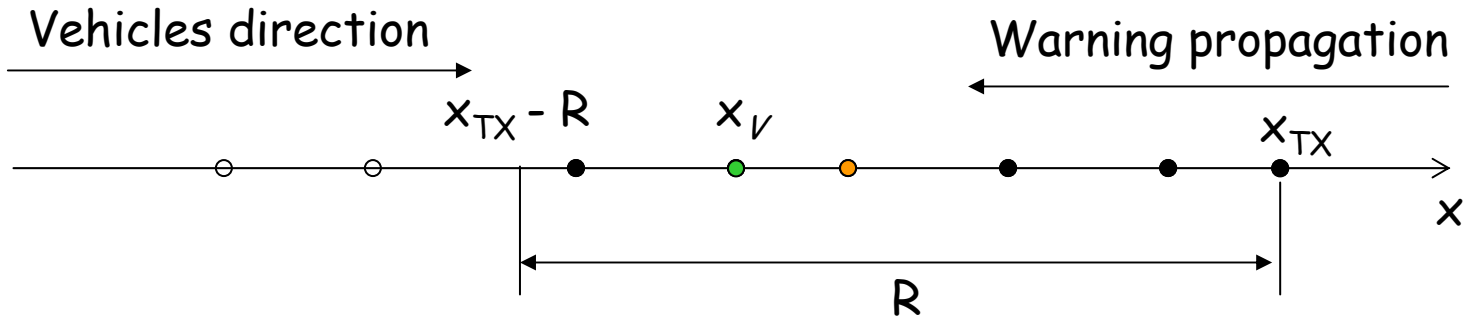
HELP-algorithm

- Uses information of neighbors table
- Estimate the coverage range: $x_{TX} - R$



HELP-algorithm

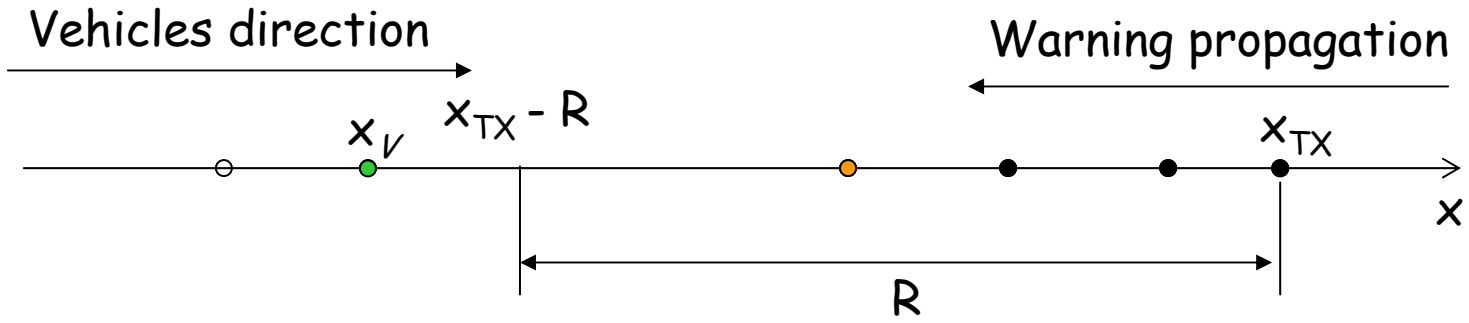
- Estimate neighbors position
- Find the closest following vehicle V (in x_V)



- If $x_V > x_{TX} - R \rightarrow$ do not relay

HELP-algorithm

- Find the closest following vehicle V (in x_V)



- If $x_V < x_{TX} - R \rightarrow$ relay

HELP-algorithm evaluation

Traffic models:

- Vehicles have constant speed
  $\Rightarrow$ HELP has optimal performance
- "home-made" traffic models
  $\Rightarrow$ unaccurate evaluation

- Evaluation with realistic traffic models is a must

Realistic traffic model

- One dimensional movements
  (single lane but multi-lanes models exist)
- Vehicle *k* described by
  position and speed (x_k,v_k)
- Vehicle-to-vehicle distance: $d_k=x_{k-1} - x_k$
- Discrete models
  - Space measured in cells (length that vehicles occupy in a jam)
  - Time discretized in steps
  - Speed measured in cell/step

Nagel-Schreckenberg model

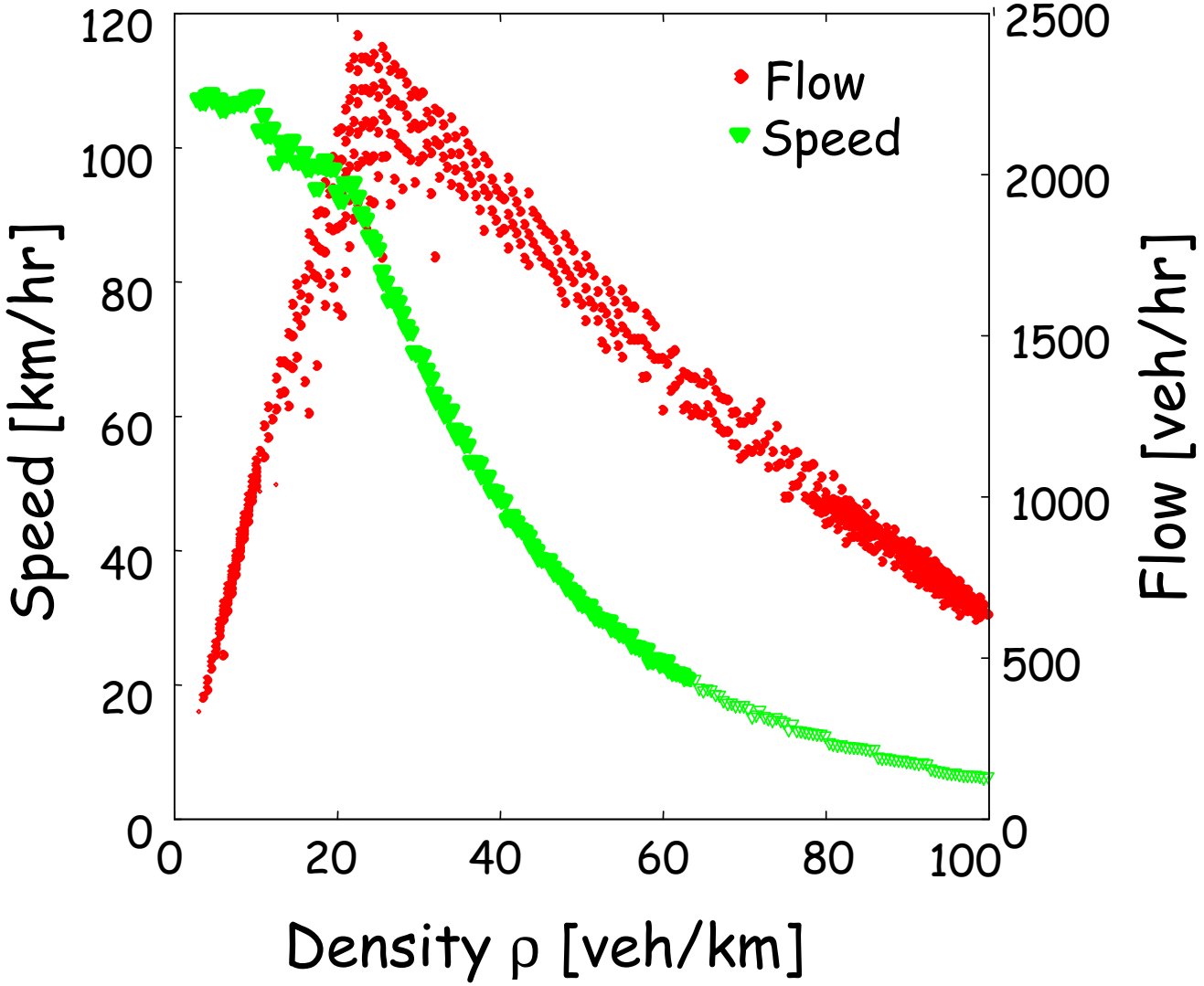
- Speed update (at every step):
  - Acceleration: $v_k \leftarrow \min(v_k+1, V_{max})$
  - Safety distance: $v_k \leftarrow \min(d_k-1, v_k)$
  - Randomization : $v_k \leftarrow \max(0, v_k-1)$ w.p. P_d
- Position update
  - Motion: $x_k \leftarrow x_k+v_k$

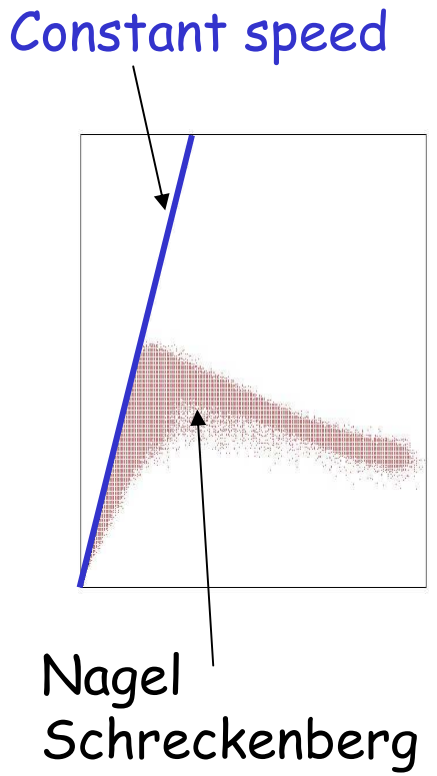
- Typical parameters

Cell: 7.5m V_{max}: 112km/h (5 cells/step)

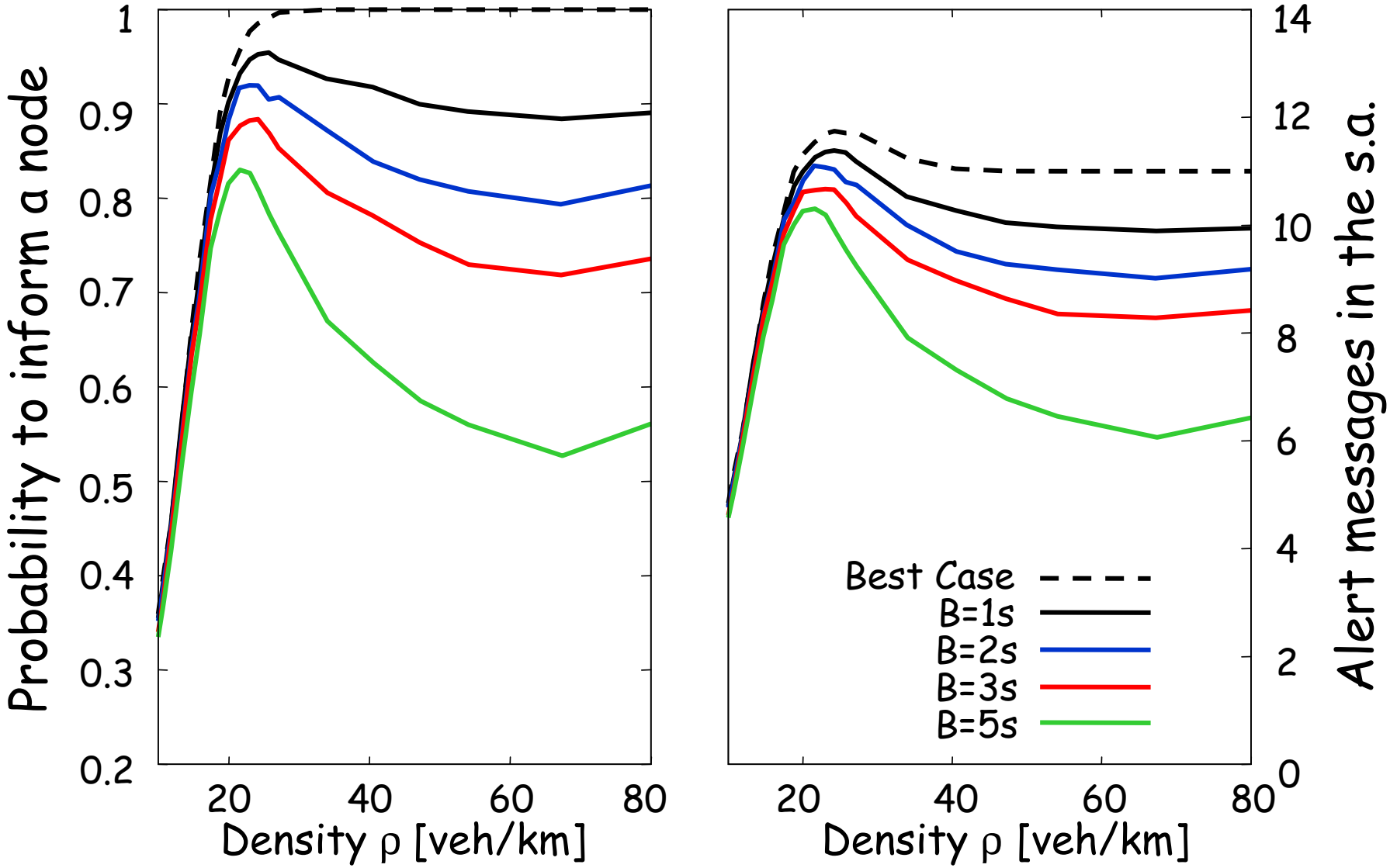
Step: 1.2s P_d=0.16

Nagel-Schreckenberg model





HELP-algorithm (s.a.= 2Km)



HELP-algorithm

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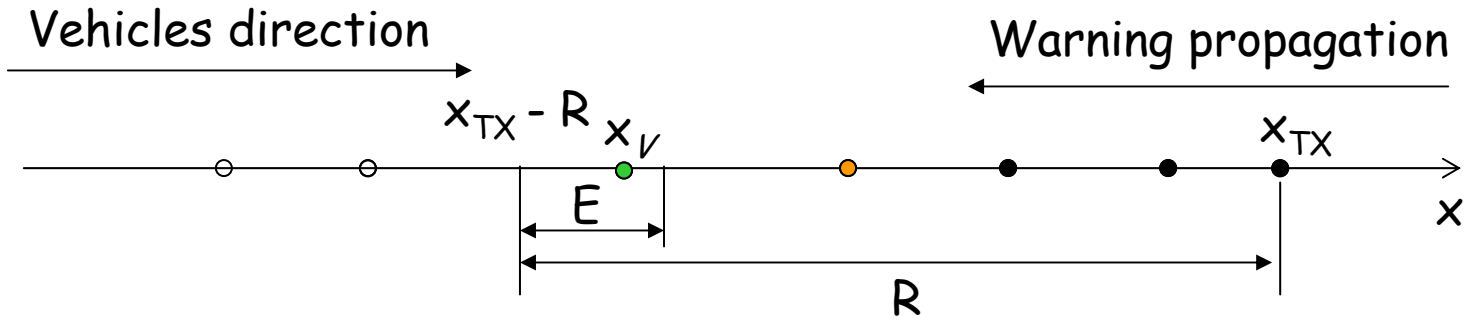
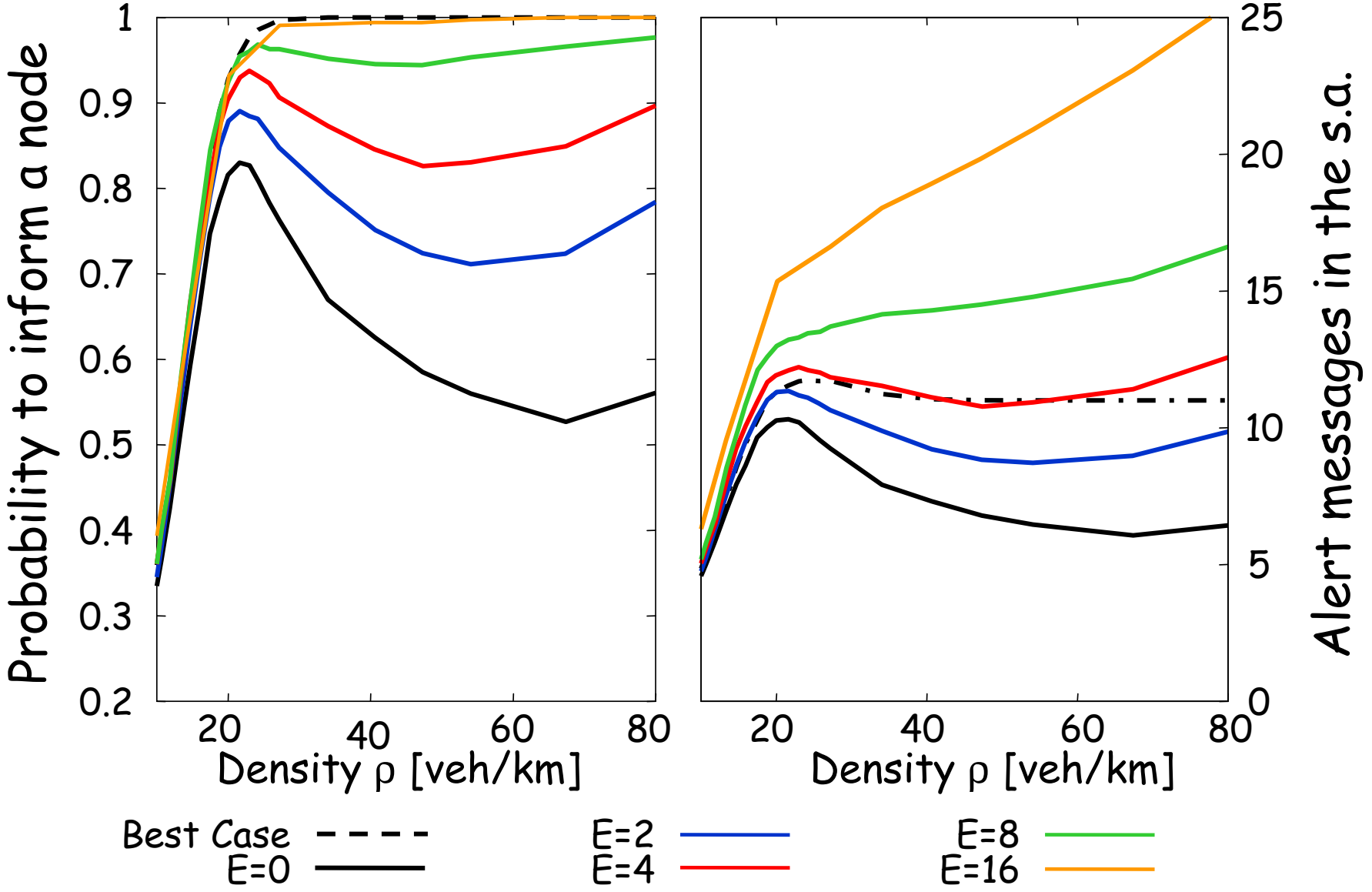


- If $x_V < x_{TX} - R + E \rightarrow$ relay

HELP-algorithm (s.a.= 2Km)



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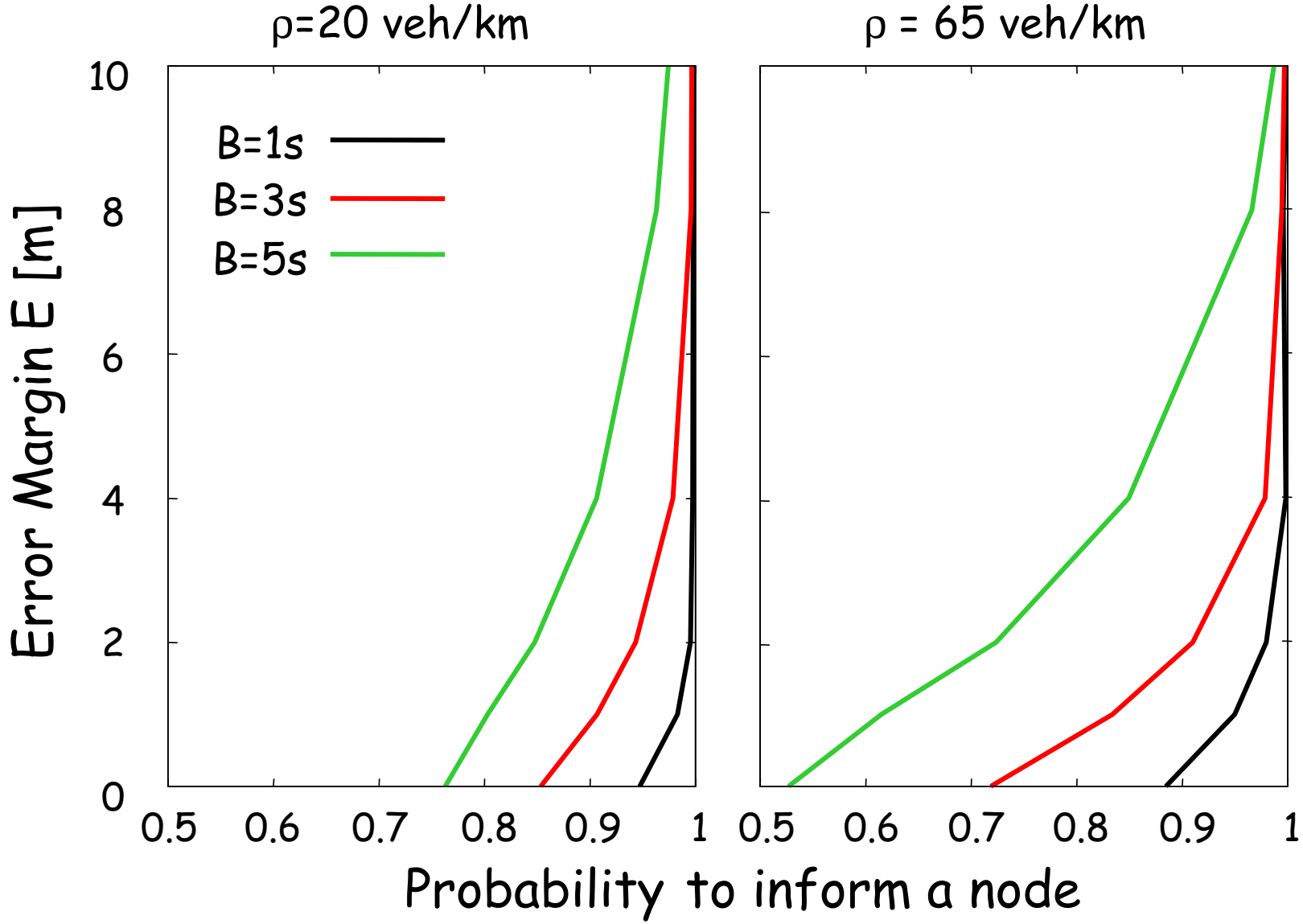

Conclusions

- By tuning beaconing interval and error margin, Help:
  - Achieves the desired ratio of informed nodes
  - Limits the number of exchanged messages
- Future work:
  - Study of how the speed varies in B s
  - Adaptive choice of the error margin E

Thanks!