Quantitative model for evaluate routing protocols in a vehicular ad hoc networks on highway

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15 December 2010
IEEE VNC'10

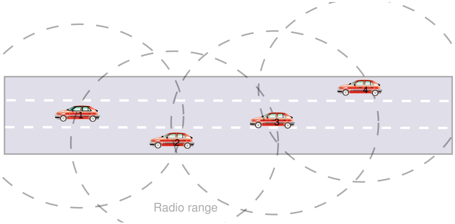
Vehicular networks on highway

Our work concern the vehicular network on highway

- Is a highly dynamic network.
- Several network densities are possibles
- Vehicular networks on highway are linear. We can approximate as one-dimensional networks
- The context is V2V communications.

One-dimensional network

Real representation :



One-dimensional network

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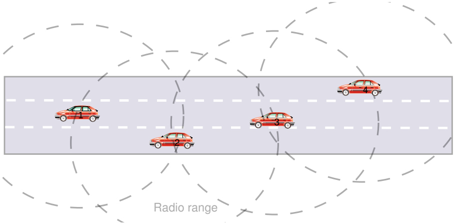
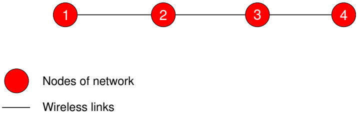


Topological representation :



Ad hoc routing protocols

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- Position-based routing protocol : The path is build "on fly", data are sent to the geographical position of the destination. The source must know the geographical position of the destination. Examples: GPSR, MFR ...

Protocol selection according to network mobility

Protocol selection is done, among other, according to global mobility of network.

- Proactive topological-based routing protocol : Good for network with little mobility
- Reactive topological-based : More robust for high mobility network, but produce signaling messages (requests).
- Position-based protocol : Reduce signaling messages with high mobility network.
  Nevertheless, each node must know its geographical position and geographical position of the destination

Our works concern network on highway, a proactive protocol is not adapted.

Scalability

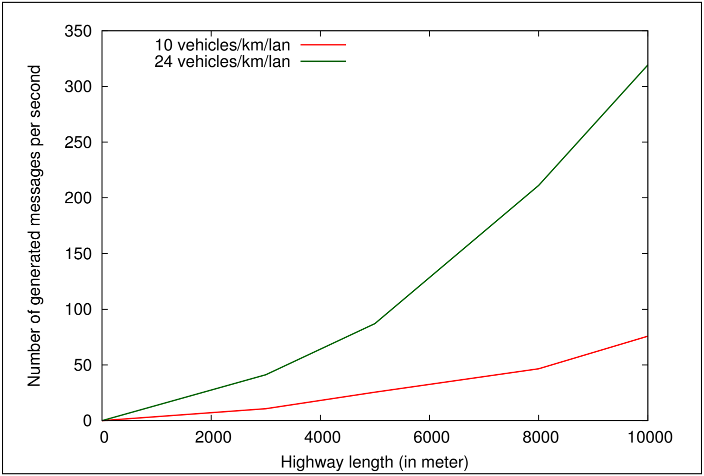
Scalability depends :

- The network density : Total number of nodes by geographic unit.
- The network size (in number of node) grows up with density and length of the network.

The overhead (as the total number of signaling message sent) grows up with size of the network.

Scalability of vehicular network on highway

Scalability evaluation of reactive topological protocol with DSR protocol and vehicular network on highway.



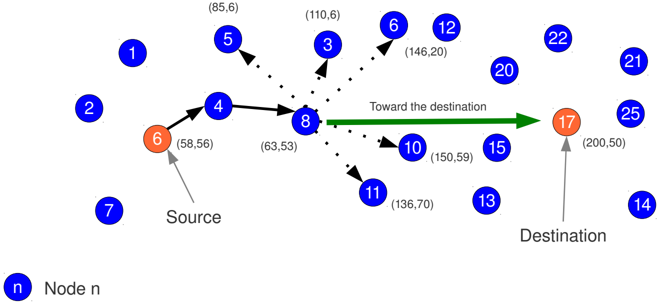
About scalability of the position-based protocol

For position-based protocol, scalability estimation is also important.

Position-based protocols produce signaling messages :

- Neighborhood discovery : beaconning messages.
- Location service : send a request on the entire network.

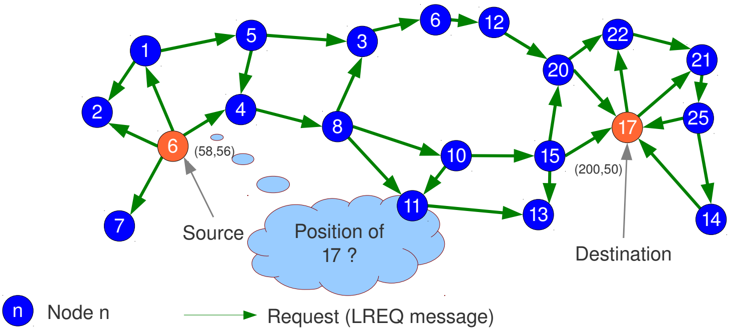
Position-based with CBF (Contention-Based Forwarding)



Each neighbor node waits for a time proportional to the distance between this node and the destination Then, the closest node forwards message in first place, and the others neighbors cancels forwarding.

Greedy location

A position-based protocol must know geographical position of the destination.



The source node flood on the entire network the *LREQ* request. The destination return its position by a *LREP* message.

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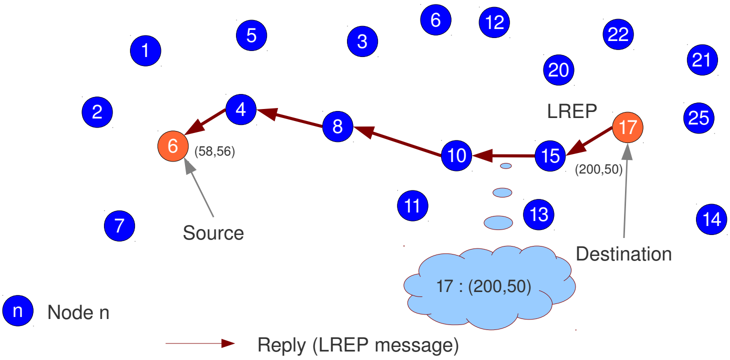
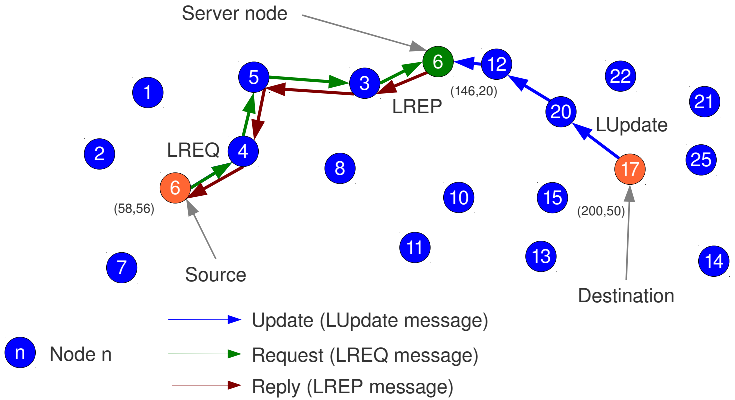


The source node flood on the entire network the *LREQ* request. The destination return its position by a *LREP* message.

Location with rendez-vous protocol

A rendez-vous protocol reduce the total number of signaling message.



A server node is assigned and associate to the destination. The destination sends its position for server node. The source sends a request for server node to discover the position of the destination.

Problems

- Reactive protocol flood the requests on all network .
- Location protocol, without optimisation, flood the requests on the entire network.
- The signaling message transmitted influences the scaling. How can we evaluate the influence of a protocol on the network scaling ?

We propose a quantitative model to count signaling messages for each protocol.

Related works

[FMH+02, MBV07, TMSEFH05] perform a comparison between topological and position-based protocols using simulations

Simulation issues :

- Implementation issue of the used protocol influences the results.
- Assomptions are not allways justified
- Results are difficult to be reproduced

Related works

Quantitative model for evaluating and comparing protocols.

- A quantitative model for evaluating location protocols has been addressed in [DPH05], but only static networks model is analysed.
- In [SMSR02] authors propose a model to evaluate the scalability of ad hoc topological protocols. But, only a lower bound of the overhead is computed in a static context.

Our model

We want to determine the overhead for a protocol P, ie the total number of signaling messages N_P.

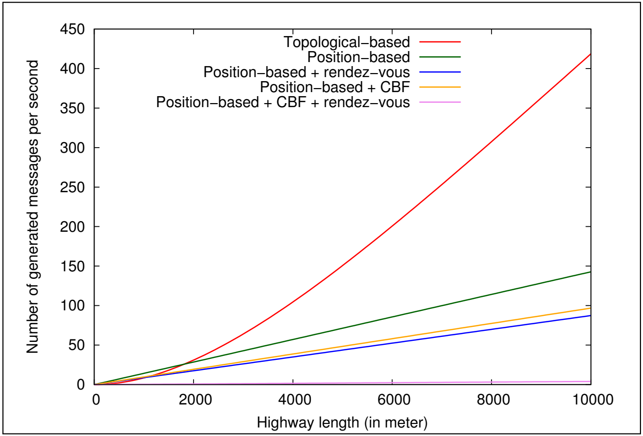
Definition

- m : class of signaling message
  - Ex $m = RREQ$
- $M(P)$: Set of signaling message for a protocol P
  - Ex for DSR : M(DSR) = {RREQ, RREP, RERR}
- $N(m)$: Total number of m messages forwarded by second with the routing protocol p.

$$\boxed{N_P = \sum_{m \in M(P)} N(m)}$$

With this model, we can compare scalability for several routing protocols : position-based with location service , reactive topological-based , .

Number of control messages depending on the highway length.



- Density : 72 vehicles/km.
- Number of generated messages grows with the highway length
- Position-based protocol with optmisations generates less messages than reactive protocol

Conclusion

- Our goal is the comparaison of scalability of routing protocols into a vehicular network on highway
- We studied the process of generation of signaling messages to characterize the overhead
- We compared two classes of routing protocols : position-based and topological-based
- Using a position-based protocol with CBF (Contention-Based Forwarding) and a rendez-vous protocol to location allows a better scalability for a vehicular network on highway

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