FleaNet : A Virtual Market Place on Vehicular Networks

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Advent of VANETs

- Emerging VANET applications
  - Safety driving (e.g., TrafficView)
  - Content distribution (e.g., CarTorrent/AdTorrent)
  - Vehicular sensors (e.g., MobEyes)
- What about commerce “on wheels”?

Flea Market on VANETs

- Examples
  - A mobile user wants to sell "iPod Mini, 4G"
  - A road side store wants to advertise a special offer
- How to form a "virtual" market place using wireless communications among mobile users as well as pedestrians (including roadside stores)?

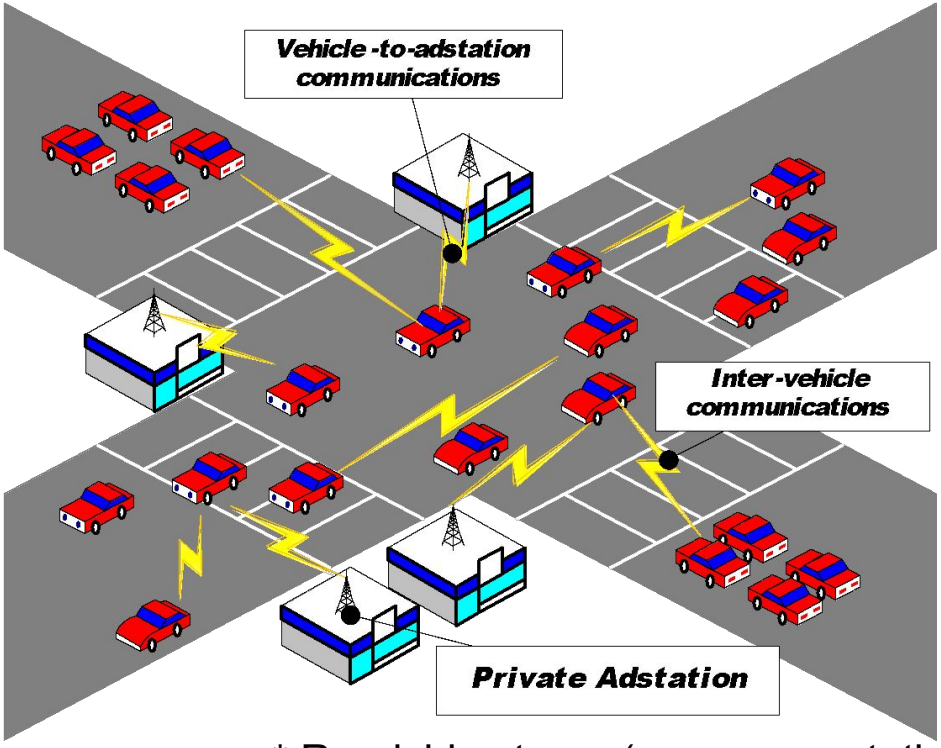
Outline

- FleaNet architecture
- FleaNet protocol design
- Feasibility analysis
- Simulation
- Conclusions

FleaNet Architecture

-- *System Components*

- Vehicle-to-vehicle communications
- Vehicle-to-infrastructure (*ad-station*) communications



* Roadside stores (e.g., a gas station)

FleaNet Architecture

-- Query Formats and Management

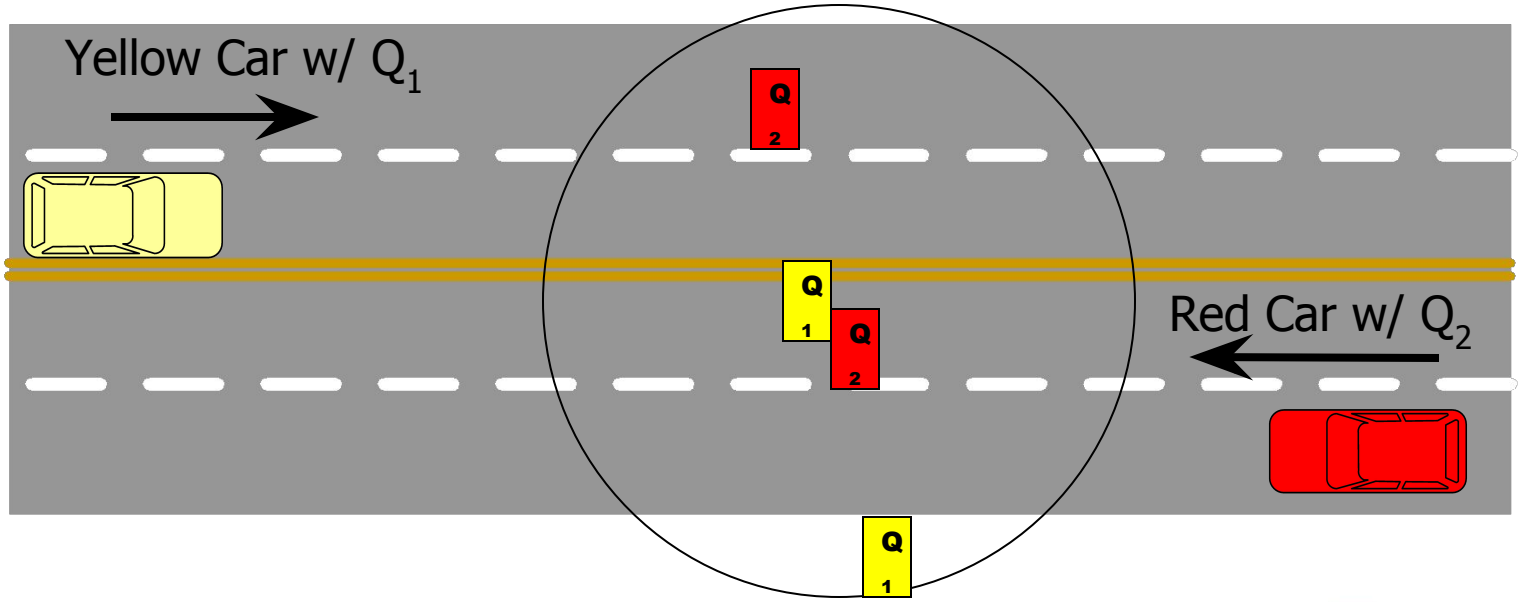
- Users express their interests using formatted queries
  - eBay-like category is provided
    - E.g., Consumer Electronics/Mp3 Player/Apple iPod
- Query management
  - Query storage using a light weight DB (e.g., *Berkeley DB*)
  - Spatial/temporal queries
  - Process an incoming query to find matched queries (i.e., exact or approximate match)
    - E.g. Query(buy an iPod) ⇔ Query(sell an iPod)

FleaNet Protocol Design

- FleaNet building blocks
  - Query dissemination
  - Distributed query processing
  - Transaction notification
    - Seller and buyer are notified
    - This requires routing in the VANET
- VANET challenges
  - Large scale, dense, and highly mobile
- Goal: designing "efficient, scalable, and non-interfering protocols" for VANETs

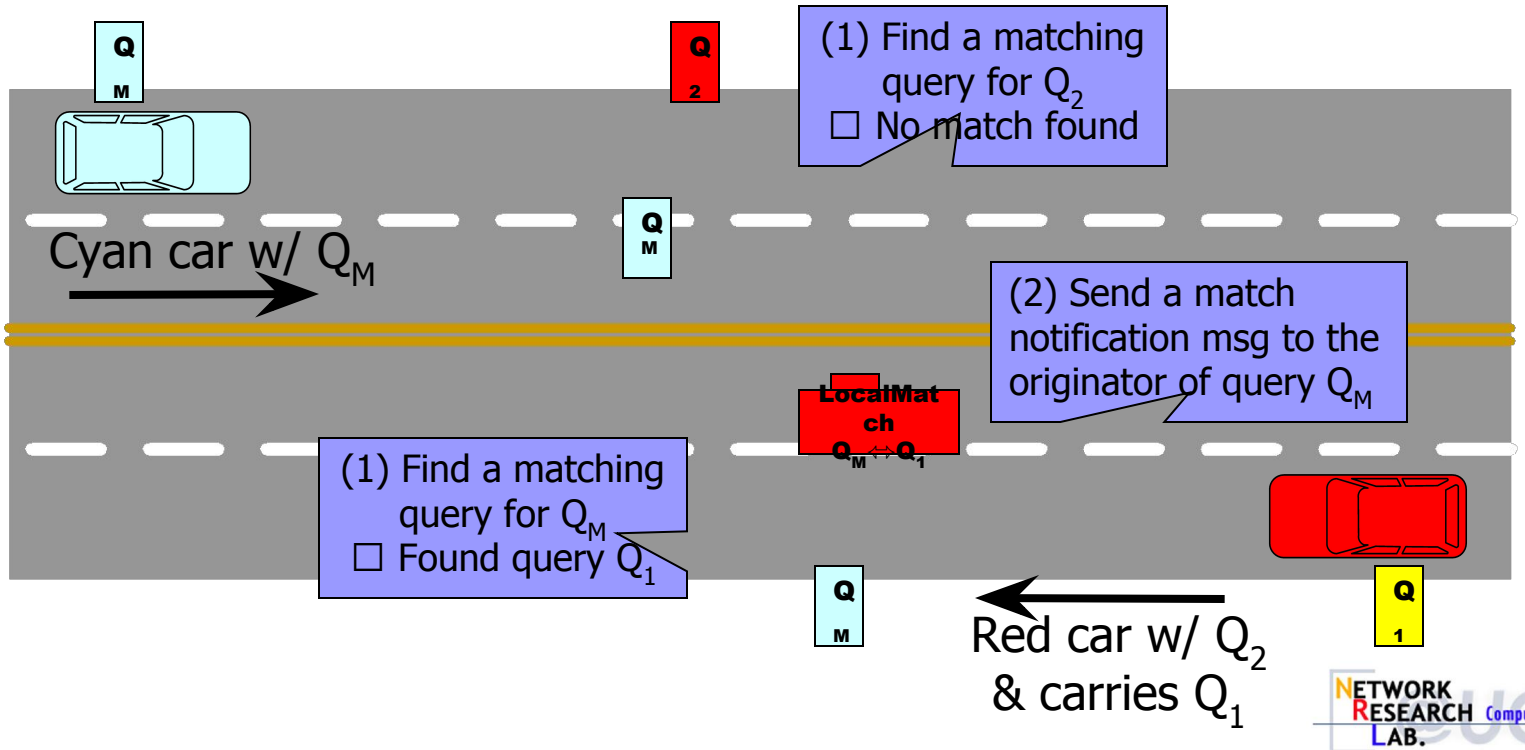
Query Dissemination

- Query dissemination exploiting vehicle mobility
- Query "originator" periodically advertises its query to 1-hop neighbors
  - Vehicles "carry" received queries w/o further relaying



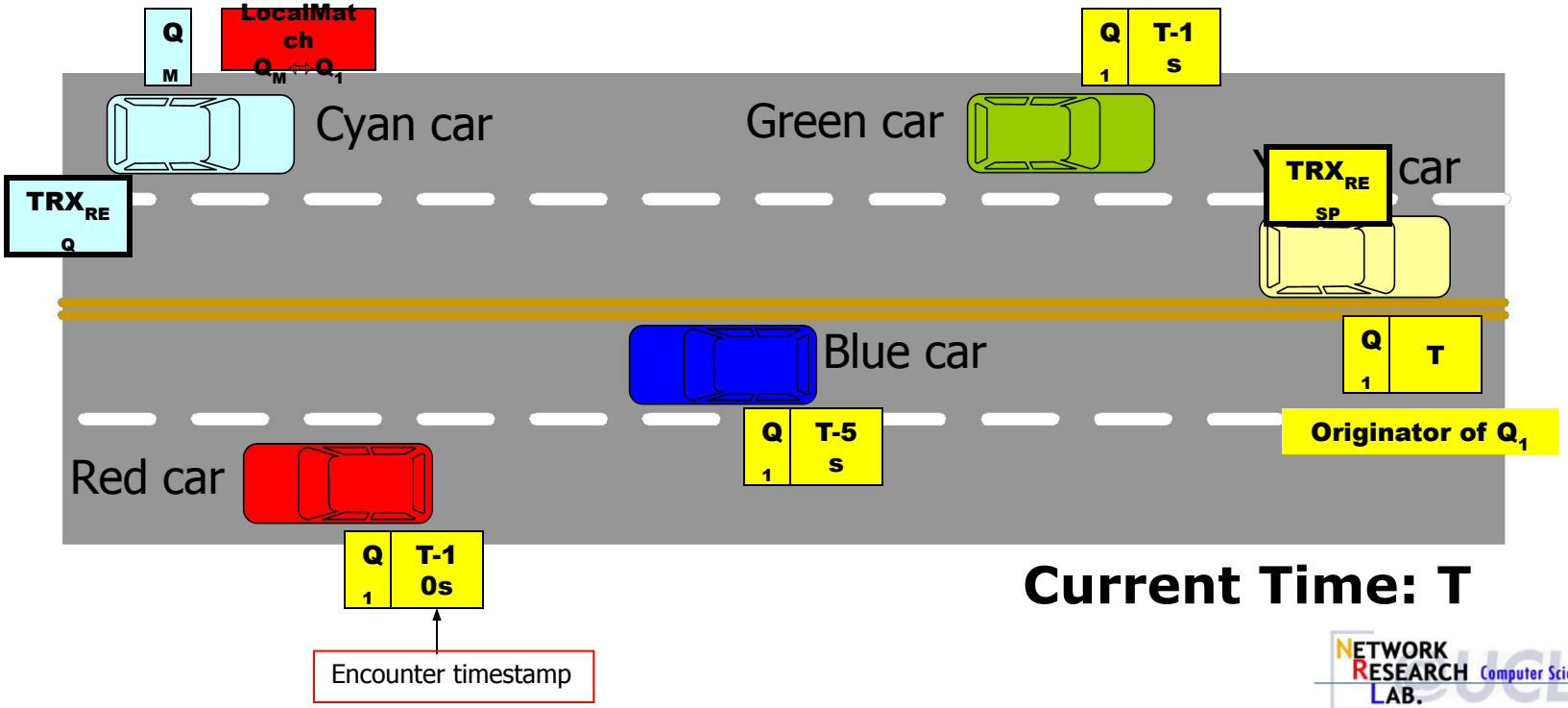
Distributed Query Processing

- Received query is processed to find a match of interests
  - Eg. Q_1 – buy iPod / Q_M – sell iPod / Q_2 – buy Car



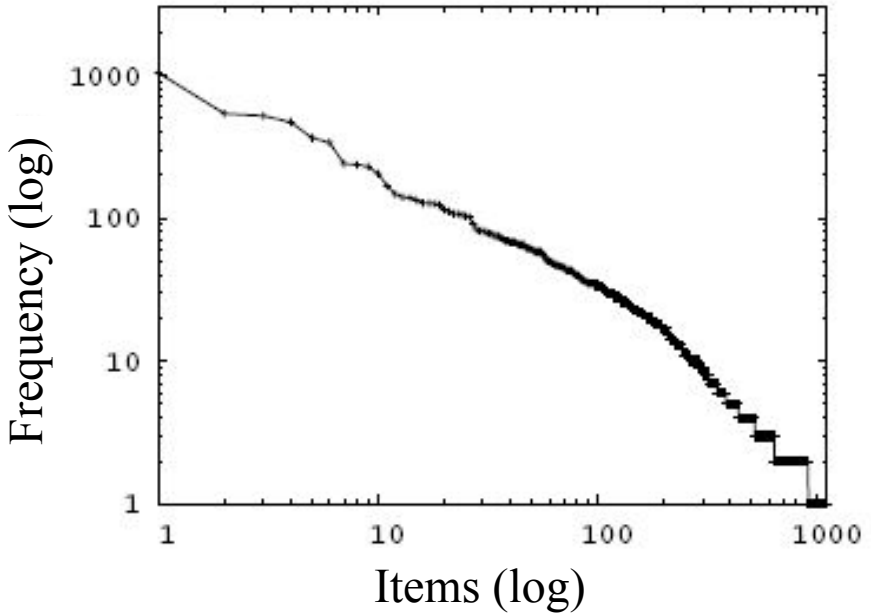
Transaction Notification

- After seeing a match, use Last Encounter Routing (LER) to notify seller/buyer
  - Forward a packet to the node with more "recent" encounter



FleaNet Latency

- Restricted mobility patterns are harmful to opportunistic data dissemination
- However, latency can be greatly improved by the popularity of queries
- Popularity distribution of 16,862 posting (make+model) in the vehicle ad section of Craigslist (Mar. 2006)



FleaNet Scalability

- Assume that only the query originator can "periodically" advertise a query to its neighbors
- We are interested in link load
- Load depends only on average number of neighbors and advertisement period (not on network size)
- Example:
  - Parameter setting : R=250m, 1500B packet size, BW=11Mbps
  - N=1,000 nodes in 2,400m x 2,400m (i.e., 90 nodes within one's communication range)
  - Advertisement period: 2 seconds
  - Worst case link utilization: < 4%

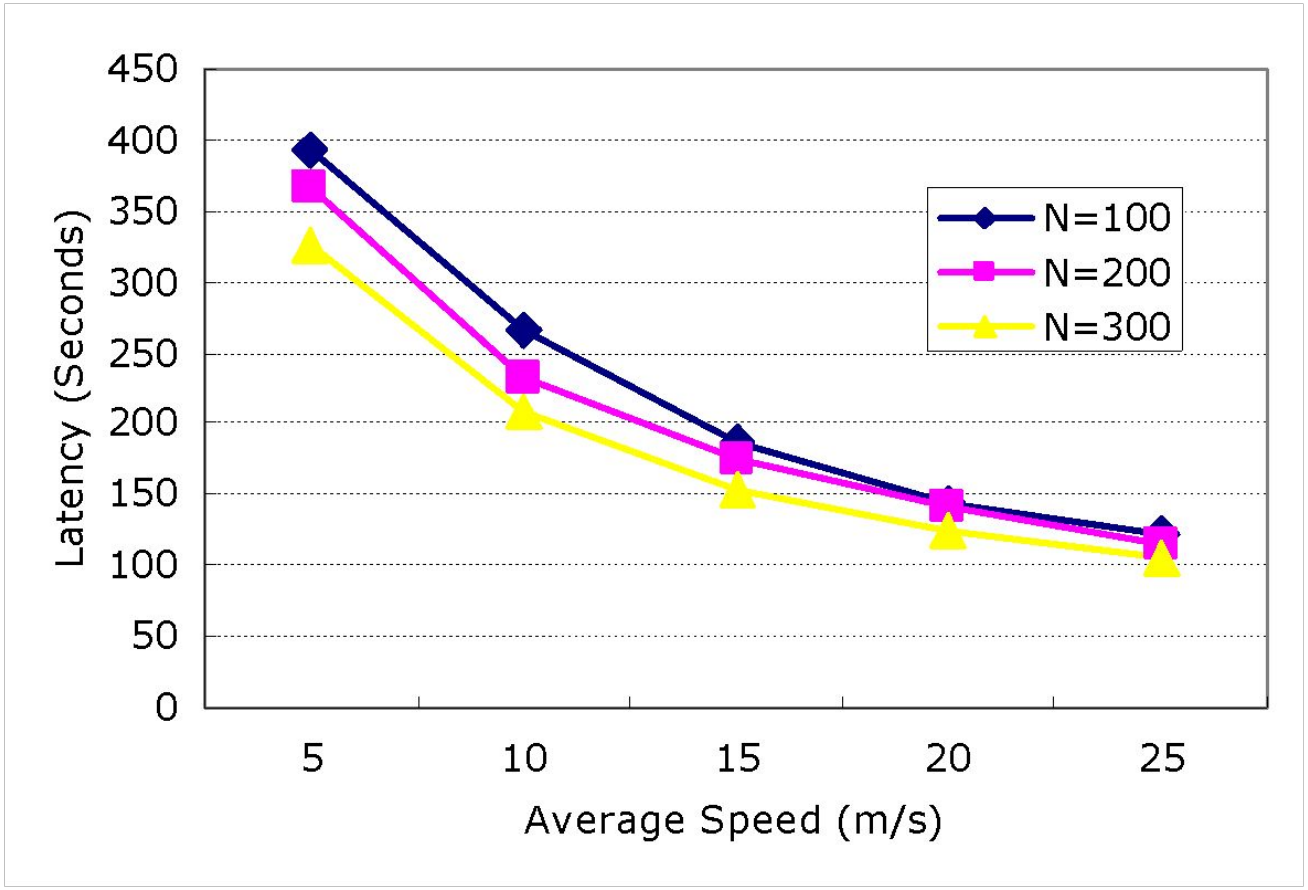
Simulations

- Ns-2 network simulator
- 802.11b - 2Mbps, 250M radio range
- Two-ray ground reflection model
- "Track" mobility model
  - Vehicles move in the 2400mx2400m Westwood area in the vicinity of the UCLA campus
- Metric
  - Average latency: time to find a matched query of interest

Westwood area, 2400mx2400m

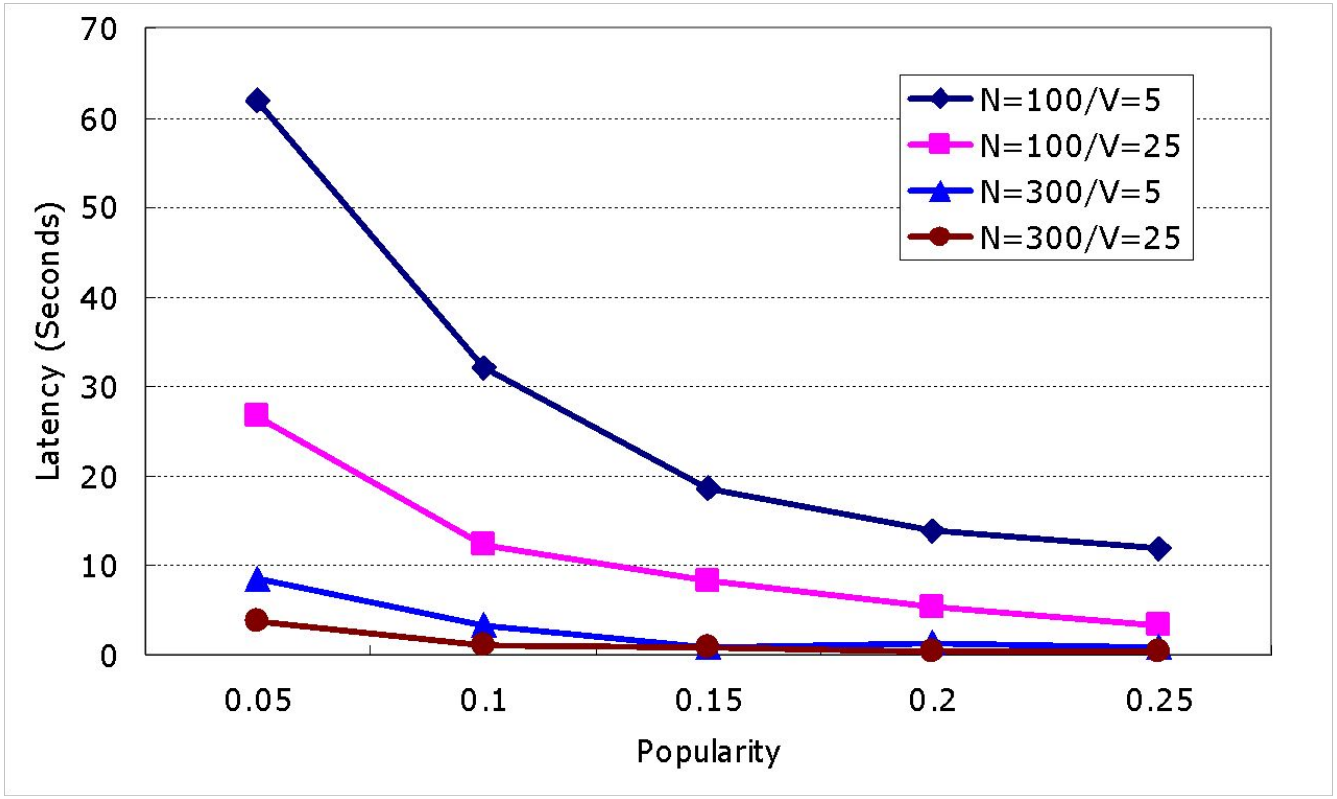
Simulation Results

- Impact of density and speed



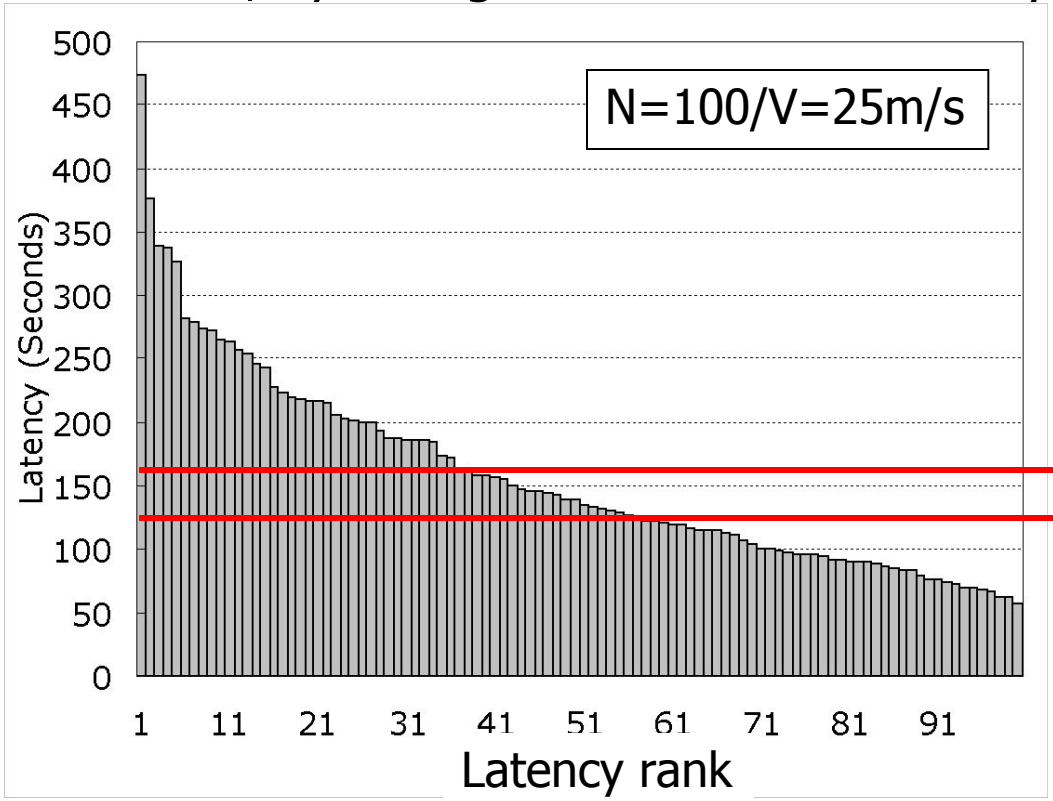
Simulation Results

- Impact of query popularity
  - Popularity: the fraction of users with the same interest
  - For a single buyer, increase the number of sellers (e.g., N=200/0.1 = 20 sellers)



Simulation Results

- Impact of ad-station location
  - Given N=100, fix each node in its initial location, and set it as a "stationary" ad-station (as a buyer)
  - measure the average latency to the remaining 99 mobile nodes (run 99 times, by taking turns as a seller: 1 buyer ⇔ 1 seller)



Conclusions

- Proposed a virtual market concept in VANETs:
  - A mix of mobile and stationary users carry out buy/sell transactions (or any other matching of common interests) using vehicular networks
- Mobility-assisted query dissemination and resolution (scalable and non-interfering)
  - Node density/speed are closely related to the performance
  - Popularity of a query greatly improves the performance
  - Location of an ad-station is important to the performance
- Future work
  - Query aggregation to improve the performance
    - Unpopular queries/queries from ad-stations
  - How to enforce cooperativeness of users?
  - Security: false query injection and spamming?