Data Dissemination in Vehicular Ad Hoc Networks
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The Big Picture

- Vehicular ad hoc networks - VANET
  - Moving vehicles
  - Stationary sites
    - hotspots, infostations, sensors
- Task
  - Delivery a message from mobile vehicle to the fixed site besides street miles away.
  - Multi-hop forwarding through VANET.

Challenges

- Partitions
- Large scale sparse networks
- Uneven vehicle distribution
- High mobility
- End-to-end connection through multi-hop hard to set up
- Most current Ad hoc routing protocols implicitly rely on the existence of end-to-end connectivity; otherwise, drop packets.

Vehicle-Assisted Data Delivery (VADD)

- “Store, carry and forward”
  - Buffer and carry the packet when no routes
  - Forward the packet to the nodes moves into the vicinity which can help packet delivery
  - Possible to deliver the packet without an end-to-end connection
- Use predictable traffic pattern and vehicle mobility to assist data delivery

Key Issue

- Select a forwarding path with smallest packet delivery delay

Guidelines

- Make the best use of the wireless transmission
- Forward the packet via high density area
- Use intersection as an opportunity to switch the forwarding direction and optimize the forwarding path

VADD: Three Modes

- Intersection Mode
  - Optimize the packet forwarding direction
- StraightWay Mode
  - Geographically greedy forwarding towards next target intersection
- Destination Mode
  - Broadcast packet to destination

VADD: Intersection Mode

- VADD Model - Which direction to go?
  - Find out the next forwarding direction with probabilistically the shortest delay
    1. Estimate the packet forwarding delay ($D_{\text{tar}}$) between two adjacent intersections based on traffic statistics
    2. Use the probabilistic method to estimate the expected delivery delay from current intersection to the destination.
      $$D_{\text{tar}} = D_{\text{current}} + \sum_{j=1}^{n} (P_{\text{prob}} \times D_{j}) \cdots (1)$$
    3. Generate a linear equation system, and solve it by Gaussian Elimination
      $$P \cdot X = -D \cdots (2)$$

Output: Priority list of the outgoing directions for the packet forwarding

VADD Protocols

- L-VADD
  - Pick the closest carrier towards the preferred direction only based on location, e.g. A-B.
    - Vulnerable to Forwarding Loop
    - Negative on delivery ratio
- D-VADD
  - Only probe those carriers moving towards the preferred direction, e.g. A-C
    - Can be proved no Forwarding Loop
    - Delay may be higher
- H-VADD
  - Hybrid of L-VADD and D-VADD.

VADD: Intersection Mode

- VADD Protocol - Which carrier to take?
  - Not trivial, need to consider
    - Location
    - Mobility
  - VADD Intersection Protocols
    - Location First VADD (L-VADD)
    - Direction First VADD (D-VADD)
    - Hybrid VADD (H-VADD)

Result

- Delivery Ratio:
  - L-VADD (Low ratio)
  - D-VADD (High ratio)

- Delivery Delay:
  - L-VADD (Low delay)
  - D-VADD (High delay)

Conclusion

- Existing routing protocols are not suitable for DTN applications in VANET.
- VADD adopts the idea of “carry and forward”, and also explores the predictable vehicle mobility.
- Simulation results shows that the VADD protocols are better suitable for the multi-hop data delivery in VANET.

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