When Cars Start Gossiping
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Gossip

- A communication paradigm
  - Analogous to rumour or epidemic spreading
  - When receiving a message for the first time, each node retransmits it to a subset of his neighbours
  - With a large probability, message is delivered to every node
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Gossip

- Was shown to be:
  - Easy to implement
  - Scalable: nodes just need a partial view of the network
  - Highly resilient: bimodal
- Applications
  - Data replication
  - Information dissemination
  - Mobile computing
Vehicular Networks

- Data networks using computer devices embedded in cars
- Applications
  - Locating free parking spots
  - Traffic condition
  - Requests for assistance
  - Collision avoidance
  - Localised advertising
  - Looking ahead
Vehicular Ad Hoc Networks (VANETs)

- MANETs of vehicles
  - Infrastructure-less
  - Fully decentralised
  - Self managed

Advantages of ad hoc

- Handle massive amounts of:
  - Data: speed, direction, alerts, ads
  - Hosts: traffic jam, downtown

- Applications do not present a clear billing model
- Most of the information has a local scope
Lunch
   The Great Tavern
   Today’s Special: Codfish
   Menu: 12Eur
   West End: 12m
Glasgow’s Dinner
   Eat as much as you can: 15Eur
   Down Town: 20m
Gas
   Shell
   10% Discount for 20+ gallons
   Highway 8N, 10m
B&B
   …
Why Should Cars Gossip?

Why gossip?

**Network dynamicity**  Hard to keep structure
- Hosts move at high speed

**Large scale**  In number of hosts, in geographical extension
Related Work

- A number of projects addressed car-to-car short range communication
  - Including gossip algorithms

Gossip in VANETs poses new challenges
### Gossip(Wired) ≠ Gossip(MANET) ≠ Gossip(VANET)

<table>
<thead>
<tr>
<th></th>
<th>Wired</th>
<th>MANETs</th>
<th>VANETs</th>
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</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
<td>Unlimited</td>
<td>Scarce</td>
<td>Unlimited</td>
</tr>
<tr>
<td><strong>Computing Power</strong></td>
<td>Plenty</td>
<td>Scarce</td>
<td>Plenty</td>
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<tr>
<td><strong>Memory</strong></td>
<td>Plenty</td>
<td>Constrained</td>
<td>Plenty</td>
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<tr>
<td><strong>Bandwidth</strong></td>
<td>Unconstrained</td>
<td>Constrained</td>
<td>Plenty</td>
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<tr>
<td><strong>Network Delays</strong></td>
<td>Regular</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td><strong>Movement/Connectivity</strong></td>
<td>Stable</td>
<td>Unpredictable</td>
<td>Predictable</td>
</tr>
<tr>
<td><strong>Neighbourhood</strong></td>
<td>Unrestricted</td>
<td>Near by hosts</td>
<td></td>
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<tr>
<td><strong>Node’s Speed</strong></td>
<td>n.a.</td>
<td>Low</td>
<td>High</td>
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How Should Cars Gossip?

Challenges to be addressed
Limited Connectivity

- Random selection of the neighbours is biased
  - You can only communicate with close by cars
- Cluster formation
  - A challenge to bimodal behaviour

How to ensure wide message propagation?

- Hybrid car-to-car + infra-structured
- Infrastructure possibly deployed at specific points (e.g. gas stations)
Mobility Patterns

- Cars do not move at random
  - Partial occupation of the region
  - Attracted to specific locations at specific times
    - downtown in the morning
  - Create dynamic but well-defined network topologies

How will a random protocol react to a predictable movement pattern?
Opportunistic Routing

- Connectivity is not always guaranteed in VANETs
  - E.g. in rural areas
- Delay-Tolerant Networks (DTNs) have been investigated for regions with low node density
  - DTNs do not scale well

Can gossip protocols improve the scalability of DTNs?
Geographical Information

- It is safe to assume that all cars will have a GPS on-board soon
  - Permits to tag some data with a location
    - E.g. cars parked on the road
    - Obstacles
  - Data can be restricted to some region of interest

Can we make a localised gossip?
Persistence

- Some data is persistent
  - At least for some amount of time
    - E.g. road blocks

How to make sure that data is persistently stored in one location?
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Communication Paradigms

- Gossip may not be enough
- Pub-sub?
  - E.g. announce interest in restaurants

How to manage subscriptions and deliver data?

- Taking advantage of the known route
  - Using other cars heading to the subscriber?
  - Storing data on info-stations where it is known that subscribers will pass
Data Management

- Aggregation is fundamental for system scalability
  - Widely studied problem for sensor networks
- Examples
  - Traffic jam queries and replies
  - Registrations

How to aggregate data in a mobile environment?
Security and Privacy

- To cooperate should be inexpensive
  - Use of unlicensed spectrum
  - Cars have plenty of resources
  - Message forwarding occurs in background
- It should not compromise the user
  - E.g. snooping message sources and content to learn the location of persons you know
- Information must be validated
  - Announce a severe traffic jam in our intended route

How to penalise malicious users and enforce user anonymity?
VANETs are a challenging networking environment
- Different from MANETs and Wired Networks
- With promising applications

Gossip is a communication model
- Robust
- Scalable

We believe that gossip will play an important role in vehicular applications

Many challenges to be addressed