When Cars Start Gossiping
MiNEMA'08

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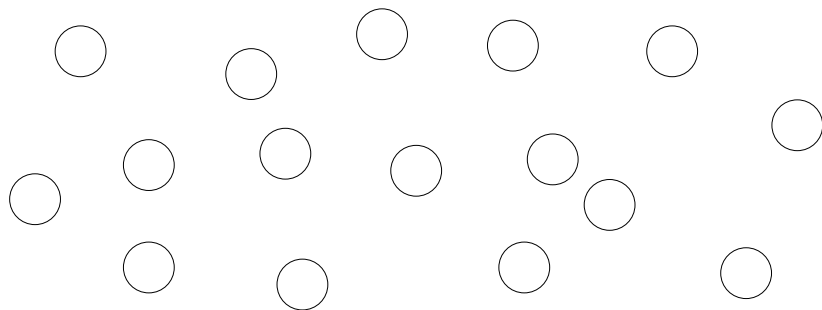
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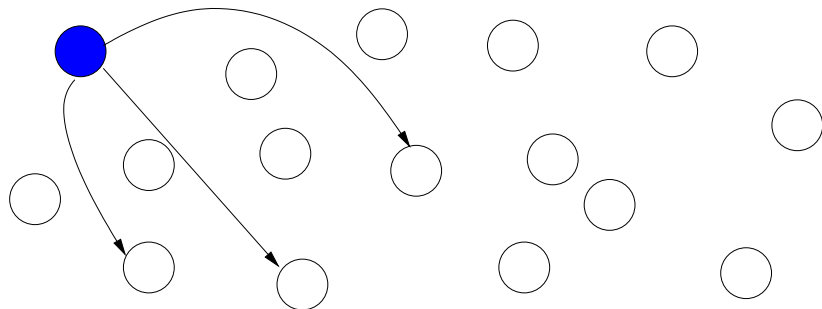
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- A communication paradigm
  - Analogous to rumour or epidemic spreading
  - When receiving a message for the first time, each node retransmits it to a subset of his neighbours
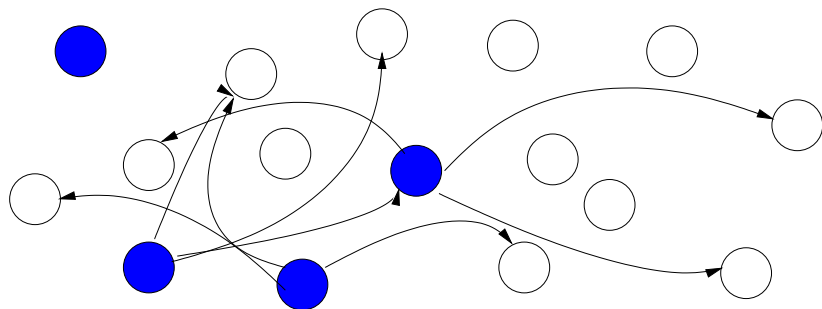 - With a large probability, message is delivered to every node

Gossip

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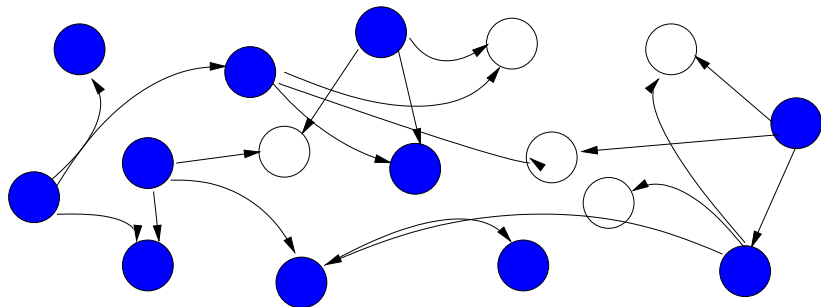 - With a large probability, message is delivered to every node

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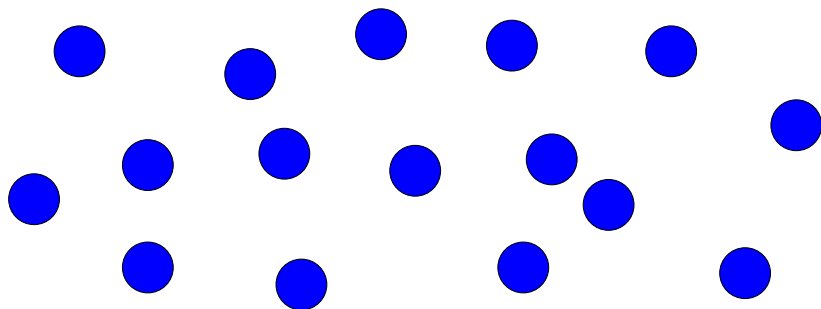 - With a large probability, message is delivered to every node

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- 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
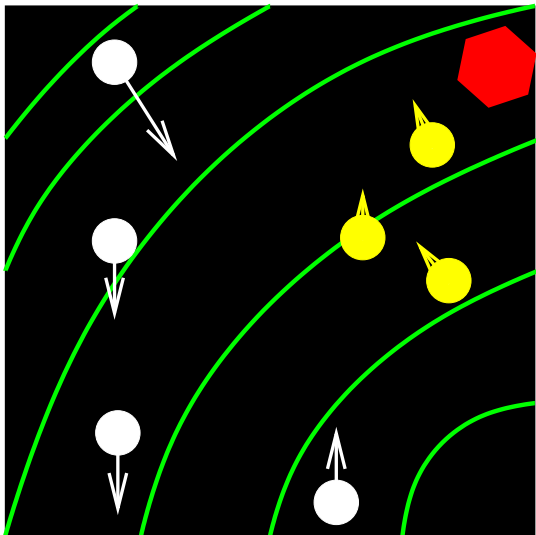 - Looking ahead

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

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

Gossip in VANETs poses new challenges

Gossip(Wired) $\neq$ Gossip(MANET) $\neq$ Gossip(VANET)

	Wired	**MANETs**	**VANETs**
Power	Unlimited	Scarce	Unlimited
Computing Power	Plenty	Scarce	Plenty
Memory	Plenty	Constrained	Plenty
Bandwidth	Unconstrained	Constrained	
Network Delays	Regular	Irregular	
Movement/ Connectivity	Stable	Unpredictable	Predictable
Neighbourhood	Unrestricted	Near by hosts	
Node's Speed	n.a.	Low	High

How Should Cars Gossip?

Challenges to be addressed

- 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)

- 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?
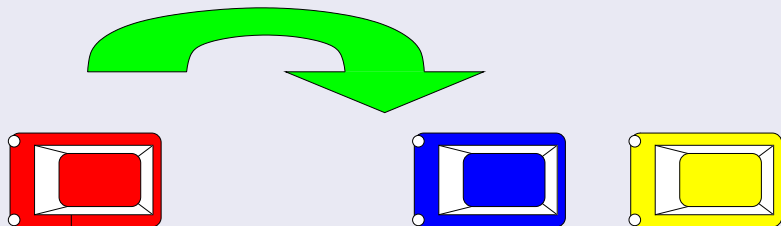
Geographical Information

- 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?

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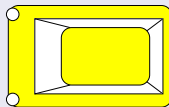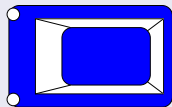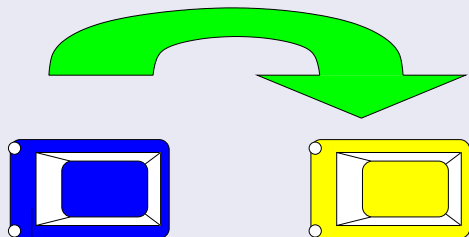
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How to make sure that data is persistently stored in one location?

- 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

- 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?

- 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