Power Efficient Vehicular Ad-hoc Networks

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Outline

INTRODUCTION TO VEHICULAR AD-HOC NETWORKS

INTRODUCTION TO OUR APPROACH

METHODOLOGY

SAFETY APPLICATION

RESULTS

Vehicular Ad-hoc Networks (VANETS)

- Adaptation of Mobile Ad-hoc Networks
- Vehicle to Vehicle and Vehicle to Infrastructure Communications
- Power used to Maintain a Wireless link
- Protocols and Topology

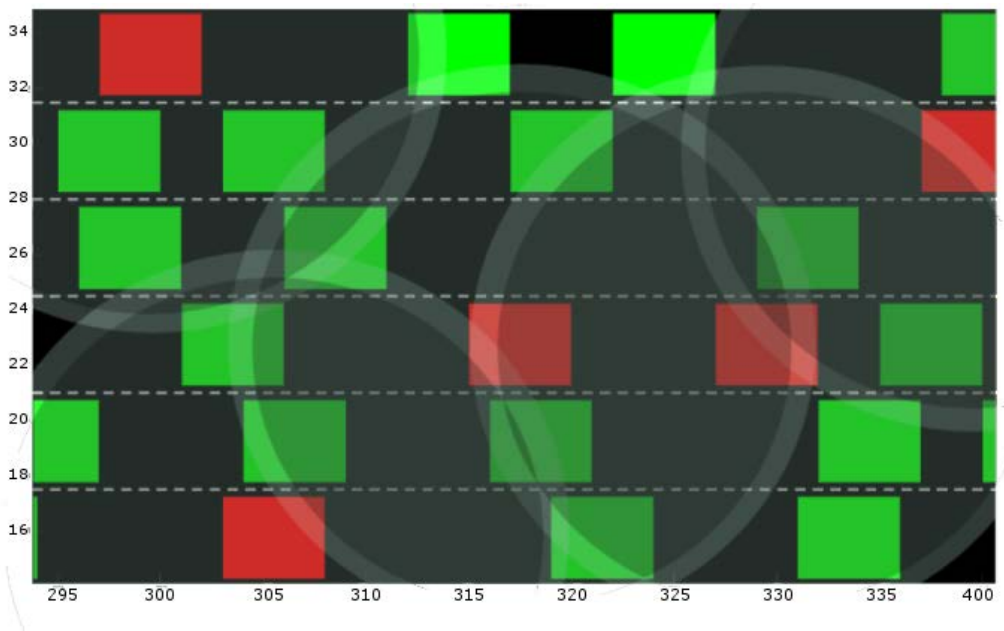
Our Approach

- Topology and Routing Protocol based on Dimensional Reduction, Clustering, and Minimal Length for Line of Sight Connections.
- Use Fuzzy Logic Algorithm for Link Formation
- Link Maintenance Algorithm, for predicting Link Lifetimes

Methodology: Introduction

- Utilizing the one dimensional dynamic of highway
- Predicting locations of up-road vehicles with a fuzzy logic algorithm
- Forming low power, line of sight links between adjacent vehicles

Methodology: Dimensional Reduction



To simplify routing and enable greater frequency reuse, we use the geometry of the road to simplify the standard model of a planar network into a single dimension.

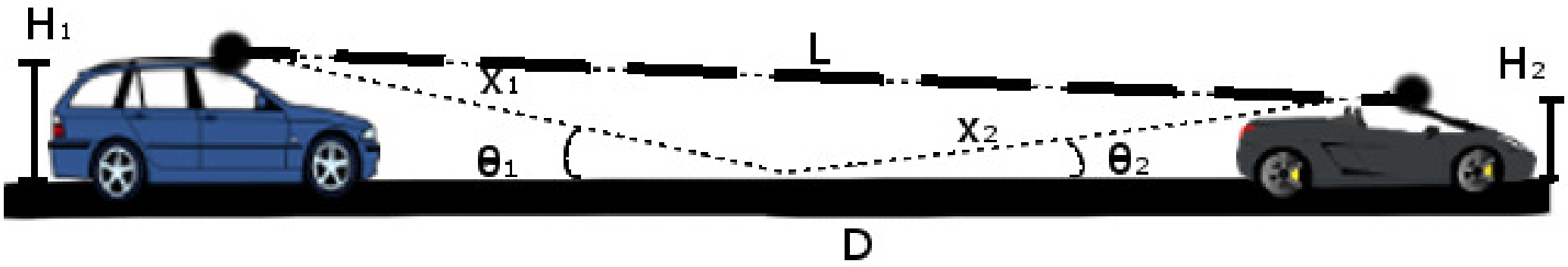
Methodology: Fuzzy Logic

To predict the position of potential links, a fuzzy logic algorithm will be applied to the link distances logged in a vehicle's database.

- We rate link distances from the most to the least probable
- Universal Transverse Mercator (UTM) coordinates

Methodology: Link Formation

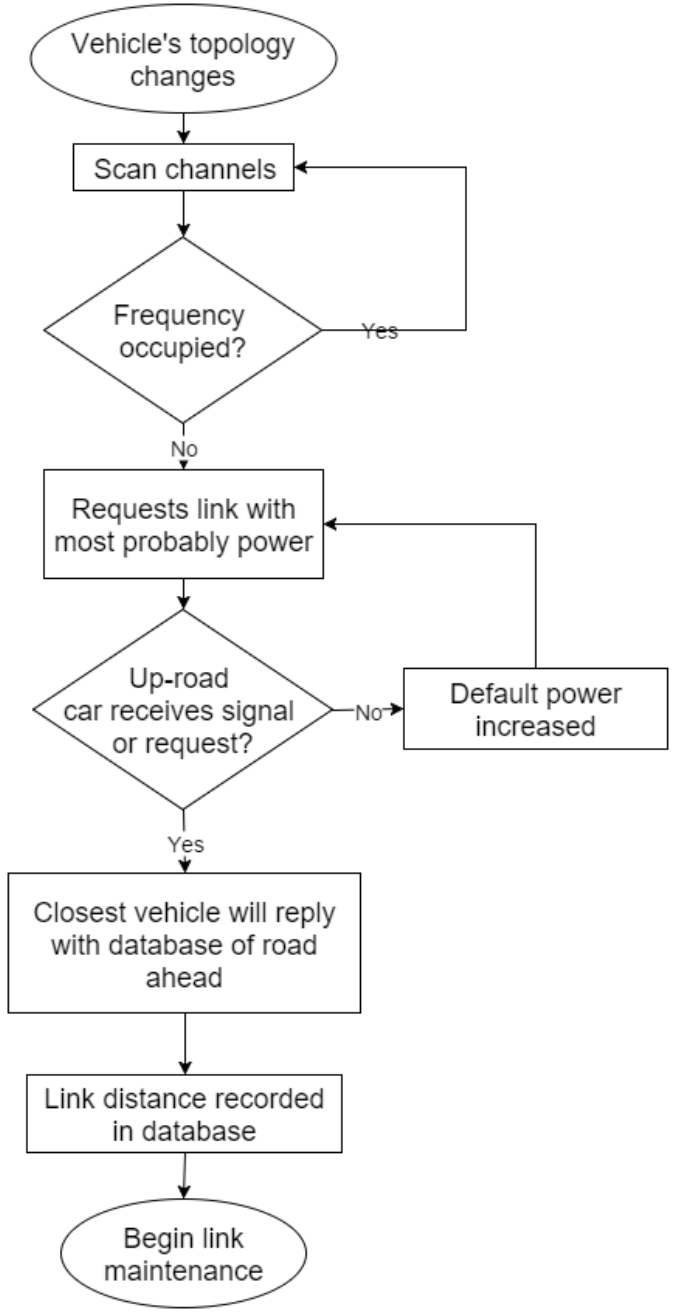
- Two-Ray Ground Reflection Model
- Variables: Link Distance (D), Line of Site Distance (L), Height of Vehicles (H1 and H2), Reflection Angles (Θ1 and Θ2), and the Ground Reflected Paths (X1 and X2)



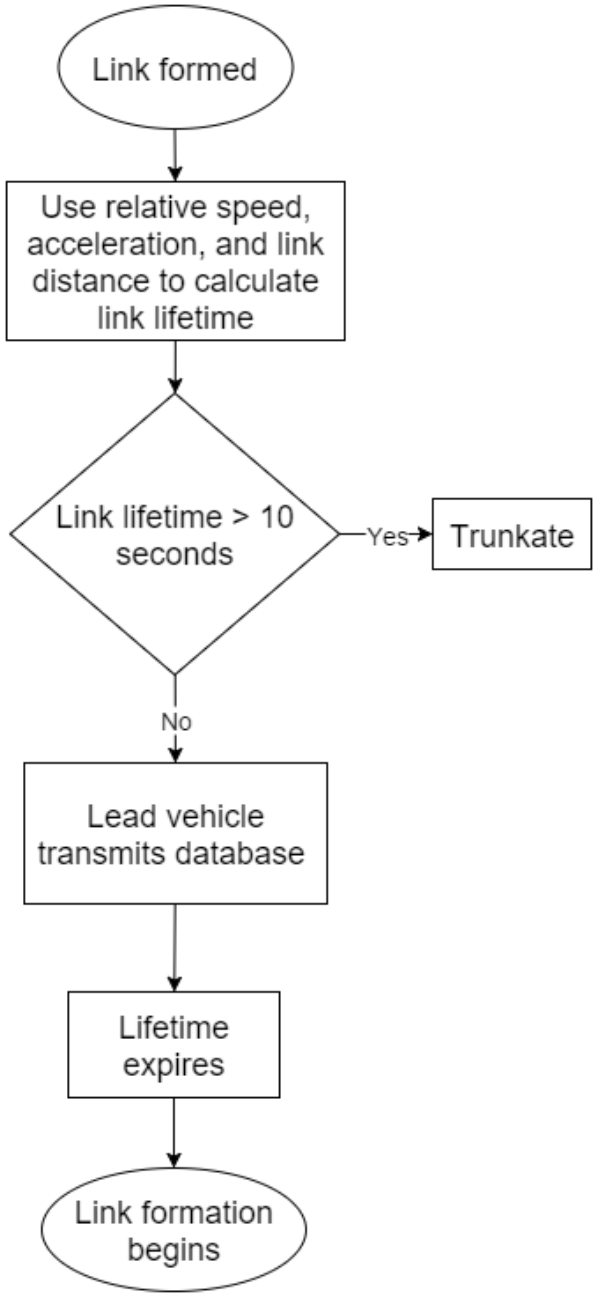
Network Maintenance

- Two categories to consider:
  - Link Lifetime
  - Amount of power used to send information down-road

Link Formation



Link Maintenance



Message Format

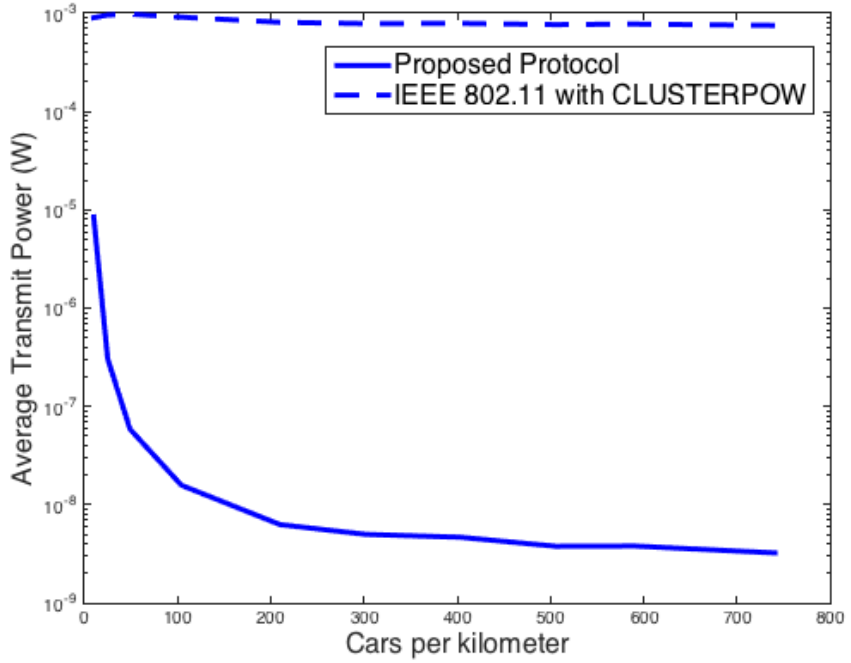
- Transmit raw data about each vehicle without aggregation
- Minimum of fourteen parameters
  - Network control only depends on latitude, longitude, speed, and acceleration
  - Remaining ten fields kept for application use

Results

		Proposed Network:		IEEE 802.11:	
Number of Lanes	Number of Simulated Cars	Average Transmit Power (Watts)	Average Max Update Frequency (Hz)	Average Transmit Power (Watts)	Average Max Update Frequency (Hz)
1	10	8.448798e-06	2390.19	9.000000e-04	2390.19
2	25	3.042131e-07	956.074	9.600000e-04	100.639
3	49	5.848702e-08	487.793	9.795918e-04	55.672
4	104	1.577975e-08	229.826	9.134615e-04	25.6525
5	210	6.261866e-09	113.818	8.095238e-04	10.7867
6	302	4.980621e-09	79.1452	7.847682e-04	7.09014
7	403	4.661964e-09	59.3098	7.890819e-04	4.92893
8	506	3.766406e-09	47.2369	7.667984e-04	3.63248
9	590	3.791124e-09	40.5116	7.762712e-04	2.9174
10	741	3.225761e-09	32.2562	7.516869e-04	2.03864

Results

Maximum Update Frequency per Car Density



Average Transmit Power per Car Density