Improving Roads Safety Using Vehicular Communications and WSNs technology

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INTRODUCTION

With the amount of events that can occur on any given road at any given time it can be said that traveling by car can be potentially dangerous.

Should an accident occur between vehicles or some sort of obstacle on the road stop traffic it can cause congestion for miles. This congestion can delay or prevent emergency teams from responding on time and will keep potentially hundreds of others stuck on the road with no knowledge of when traffic will begin to flow again.

There are a lot more vehicles on the road now with "smart" capabilities, such as GPS navigation and smart phone integration. It'd be nice if your car could tell you ahead of time that there was a wreck before you got stuck in the backup.

By using the **IEEE 802.11p** standard, a frequency set aside for vehicular communication, and the **IEEE 802.15.4** standard, used for low-rate and low power Wireless Personal Area Networks (WPANs), having your car alert you of upcoming delays or obstacles might not be too far off.

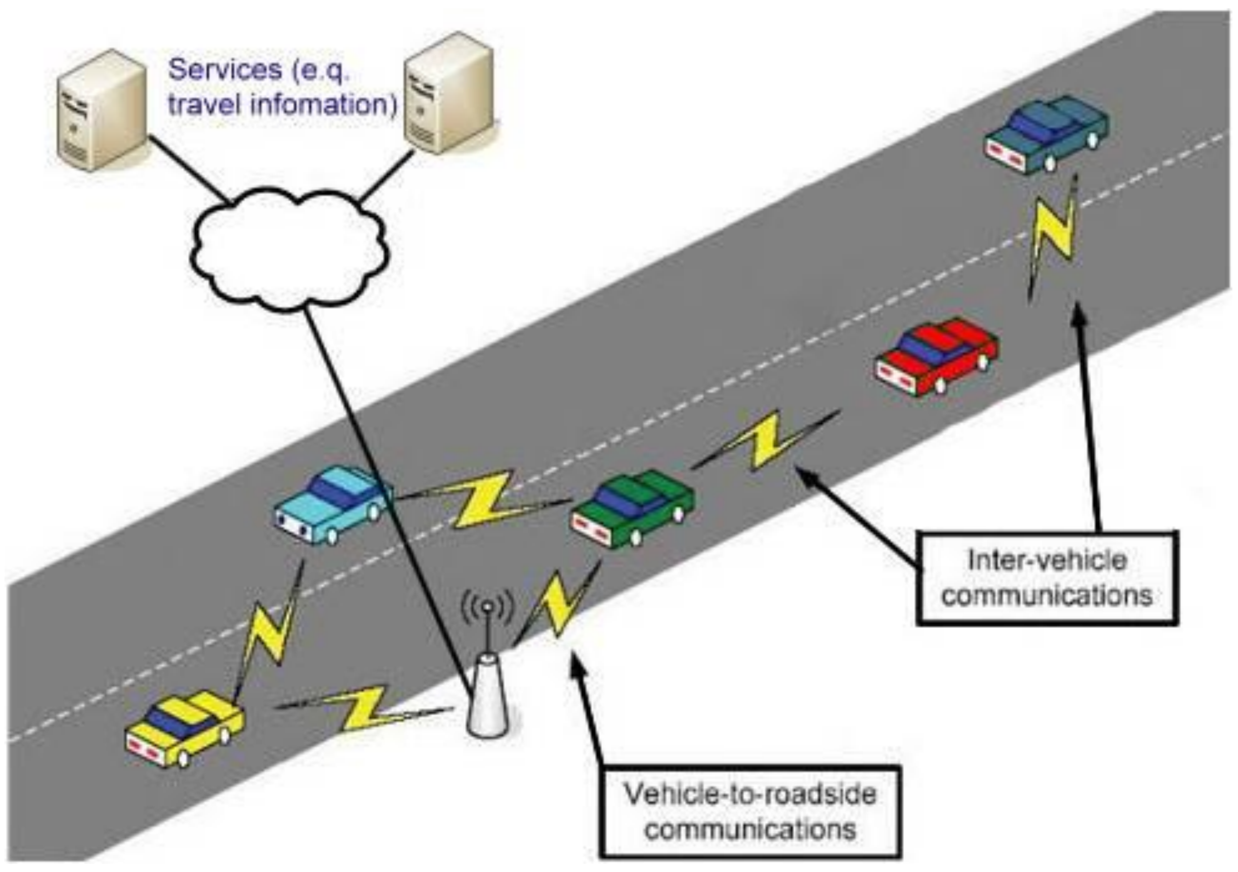

Figure 1. Example of Vehicular Communications using VANETs technology

The benefits of having a wireless system sending information regarding road conditions to drivers include accident prevention by alerting drivers ahead of time and congestion control by allowing drivers enough time to potentially change routes and avoid any delays caused by accidents.

This also can benefit emergency response teams since reduced traffic congestion can allow for faster response times as well as having real-time updates on the road condition at the source.

As nice as this sounds it most certainly would not be an over night phenomenon. Roads and highways would have to be retrofitted with **wireless sensors** and the only vehicles that would benefit from this would be those capable of receiving information from either other vehicles Road-Side Units (RSUs). In order for this to be widespread it needs to become a manufacturing standard in both vehicular and road construction.

RESEARCH AIMS

- To reduce the transmission delay of information between vehicles.
- To reduce packet congestion at the broadcasting beacons.

STRATEGY

- Use of Wireless Sensor networks (WSNs) for more accurate and timely detection of events on the roads by delineating the sleep/active modes duration of the sensors.
- Adapt beacon transmission frequency for car-to-car communication based on the congestion load in the surrounding.

RESULTS

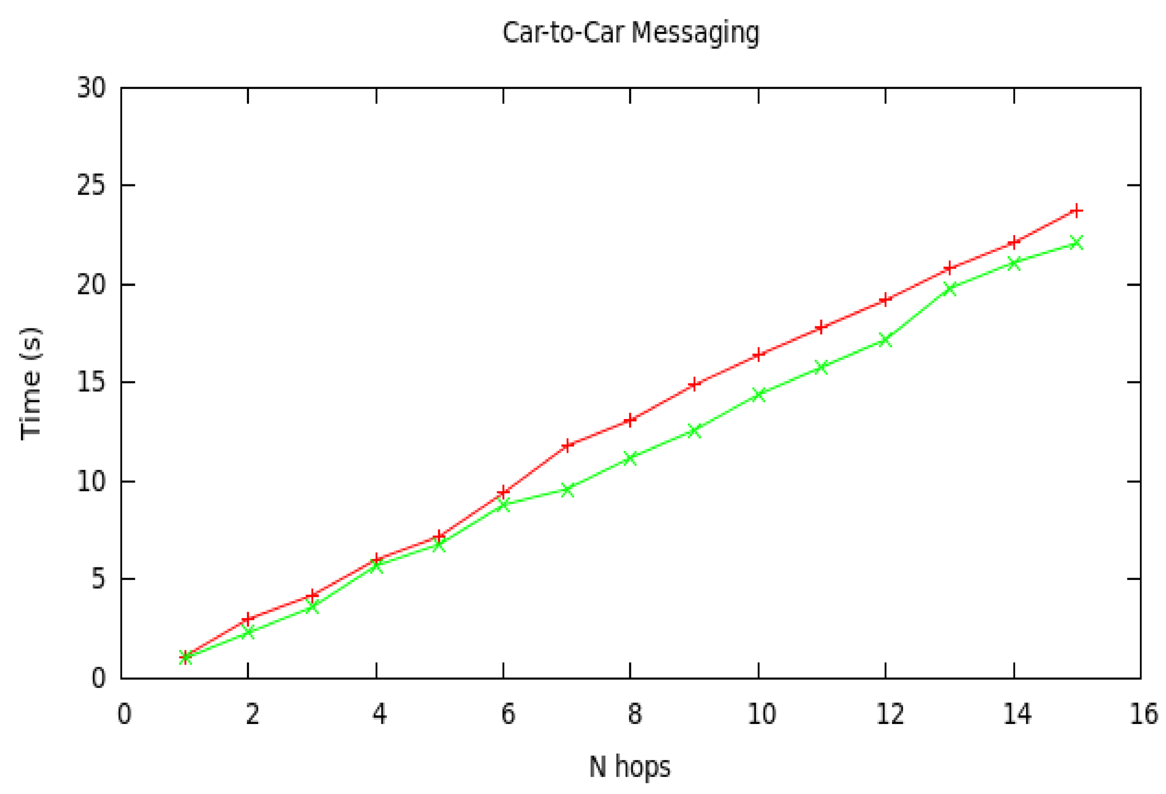

Figure 2. Beacon messages transmission delay vs. number of hops

Red: Message delay for 15 hops with a velocity varying from **16 m/s** to **23 m/s.**

Green: Message delay for 15 hops with a velocity varying from **23 m/s to 53 m/s.**

Both follow linear trend and based on the graph it can be said that the faster the vehicles are moving, particularly if these vehicles are behind the initial sender, the sooner they receive the message.

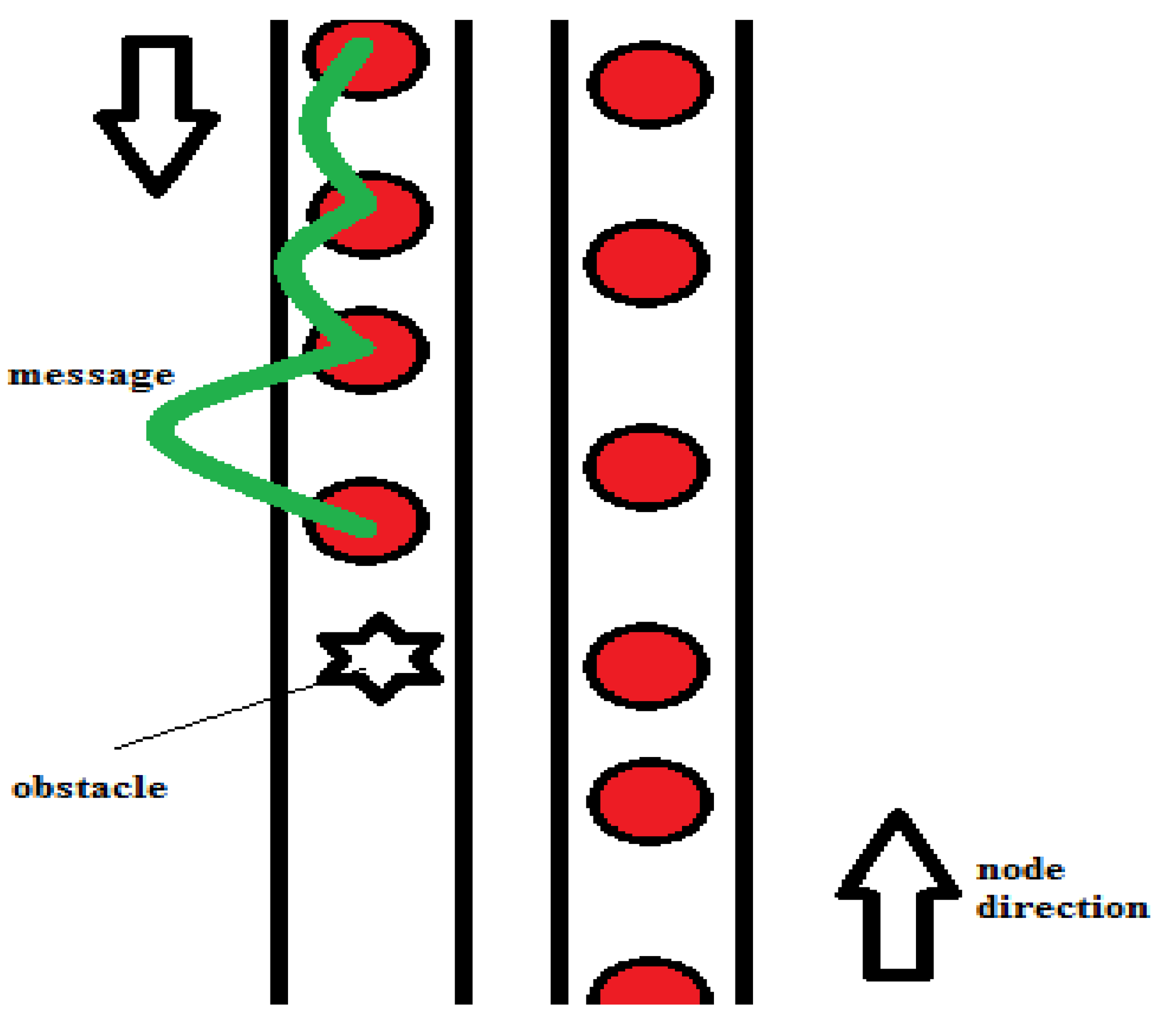

Figure 3. Example of road topology, 2-lane highway with vehicles traveling in opposite directions

Once a vehicle receives a message, in this case about a road hazard, it then sends it to each node based on its **cluster** design. In this case the **Cluster Head (CH)** is simply the first node encountered, this is not necessarily the best way but is the most simple for the purposes of this project.

METHODOLOGY

- **NS-3** network simulator to design the road environment topology and evaluate the performance of the proposed architecture.
- **VANET** for vehicle control.
- Constant Velocity Mobility Model
- Constant Acceleration Mobility Model
- **Python**
- **C++**

DISCUSSION

- Through the combination of the NS-3 network simulator and the functionality added by VANET it's possible to create a simulated highway of nodes (vehicles) traveling in ways similar to normal vehicles.
- In simulations of vehicles traveling on a highway it became apparent that the time it took for a message to be sent from one node to another depends on both the velocities of the vehicles as well as the distance between them.
- The power needed for inter-vehicular communication can be ignored since the vehicles battery can be used.

CONCLUSION

- Based on these results and observations it should be within reason to assert that wireless, real-time communications between vehicles on a road is entirely possible.
- Future work would include connecting the broadcast beacons and wireless sensors to roads with obstructions and transmit this information in real time to a vehicular cluster-head.

REFERENCES

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3. 802.11p-2010 - IEEE Standard for Information technology– Local and metropolitan area networks– Specific requirements– Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 6: Wireless Access in Vehicular Environments

4. NS-3: http://www.nsnam.org