Revisiting Message Generation Strategies for Collective Perception in Connected and Automated Driving

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Outlook

1. Introduction to V2X Communications
2. Collective Perception
3. Results
4. Conclusion and Future Work
1. Introduction to V2X Communications

- Vehicle-to-X (V2X): “X” for everything

- Applications: better safety on the road, efficient trip planning, reduction of CO2 emission,...
1. Introduction to V2X Communications

Cooperative Awareness Service

- Cooperative Awareness (CA) Service:
  - “Cooperative Awareness Message” (CAM)
  - Information about the transmitter vehicles

“I am at this position with this speed and heading”
1. Introduction to V2X Communications

Cooperative Awareness Service

Message generation:

- In Europe: default 1CAM/s + depends on the dynamic of the transmitter (heading, position, and speed)
- In the USA: Basic Safety Message (BSM) ≈ CAM. Generated by default at 10 BSM/s.
2. Collective Perception

The idea of Collective Perception:

- Vehicles are equipped with different sensors (LiDAR, radar, camera, ..)

- Each vehicle perceives its environment and generates a list of objects. Vehicles exchange Collective Perception messages.

- Developed in Europe (ETSI TR 103 562 V2.1.1)
2. Collective Perception

- Triggering
- Inclusion
- Redundancy mitigation
- Sending

Waiting time between two consecutive CPMs

Locally perceived environment

Objects perceived by the sensors

Filter objects

Additional filtering when channel load > ?

CPM empty? Need to send anyway?
2. Collective Perception

Locally perceived environment

How to filter objects?

Triggering → Inclusion → Redundancy mitigation → Sending
2. Collective Perception

**ETSI approach:**
Use the CAM rules, but applied to object.
Regard it as “conservative”

**USA approach:**
Objects detected are transmitted 10x per second
Regard it as “greedy”
3. Results

- Simulate both approaches in a scenario with ~5000 vehicles
- Use different % of vehicles being able to transmit CAMs and CPMs, i.e., Percentage of Vehicle Equipped (PVE)
- Divided the scenario in three areas: Urban (U), Highway (H), Sub-urban
- Different sensors configuration
3. Results

- Some of the metrics used:
  1. **Channel Busy Ratio (CBR):** a measure of the channel occupancy.
  2. **Number of Object Detected (NOD):** the number of objects that a vehicle is aware of since the last second.
  3. **Time Between Update (TBU):** the time between two updates of the detected objects.
3. Results

Channel busy ratio (CBR)
3. Results

Number of objects detected (NOD)

![Graph showing the number of objects detected (NOD) against PVE (%) for different strategies. The graph includes lines for U-CPM-conservative, U-CPM-conservative (360), U-CPM-greedy, and U-CPM-greedy (360). There are small variations and a strategy indicated on the graph.]
3. Results
Time between updates (TBU)
4. Conclusion and Future Work

- Both approaches, conservative and greedy, act differently on the trade-off between channel load and quality of perception.

- In areas with few transmitting vehicles or in the early deployment of transmitting vehicles, channel resources are largely available.

- The current ETSI approach is too restrictive in this kind of area. A more ‘greedy’ approach could provide better performance while not saturating the channel.
4. Conclusion and Future Work

Future work:

- Find a way to combine both greedy and conservative approaches to adapt transmissions to the current channel load and traffic conditions.
- Consider other object filtering methods to remove redundant communications on the channel.
4. Conclusion

If you have any questions, please feel free to send me an email!

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References:


