Does ETSI beaconing frequency control provide cooperative awareness?

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CAMs triggering in accordance to the ETSI EN 302 637–2 demonstrates a poor performance in a platooning scenario
System Model

Car\textsubscript{N-1} Car\textsubscript{N-2} \cdots Car\textsubscript{2} Car\textsubscript{1}  

Leading vehicle

communication range

N vehicles
Each vehicle:

- generates CAMs in accordance to the ETSI EN 302 637-2 "Specification of Cooperative Awareness Basic Service";
Each vehicle:

- generates CAMs in accordance to the ETSI EN 302 637-2 "Specification of Cooperative Awareness Basic Service";
- transmits CAMs on a dedicated channel in accordance to the IEEE 802.11p.
ETSI EN 302 637-2 kinematic rules

CAM shall be triggered in one of two cases:

- The time elapsed since the last CAM generation is equal or larger than $T_{\text{max}} = 1000$ ms.
- The time elapsed since the last CAM generation is equal or larger than $T_{\text{min}} = 100$ ms and any of the following events has occurred:
  1. "Event A": the absolute difference between the current position of the vehicle and its position included in the previous CAM exceeds $d_{\text{min}} = 4$ m;
  2. "Event B": the absolute difference between the current speed and the speed included in the previous CAM exceeds $\nu_{\text{min}} = 0.5$ m/s;
  3. "Event C": the absolute difference between the current direction of the vehicle and the direction included in the previous CAM exceeds $4^\circ$.
Reference scenario

- The kinematic parameters of the leading vehicle are modeled via the Intelligent Driver Model
- All the vehicles in the platoon increase or decrease their speed synchronously
Identified problem
CAMs Generation Moments: Synchronization

"Event A": $d_{\text{min}} = 4$ m;
"Event B": $\nu_{\text{min}} = 0.5$ m/s;
Identified problem
CAMs Generation Moments: Synchronization

Constant speed $v$

Event A

$V_1$ $V_2$ $V_3$ $V_4$ $V_5$ $V_6$ $V_7$ $V_8$ $V_1$ $V_2$ $V_3$

$Event B$

$V_4,5,6$ $V_7$ $V_8$ $V_1$ $V_2$ $V_3$

$t: \Delta v \geq v_{\min}$

$T_{\text{min}}$

$d_{\text{min}}/v$

“Event A”: $d_{\text{min}} = 4 \text{ m}$;

“Event B”: $v_{\text{min}} = 0.5 \text{ m/s}$;
Identified problem
CAMs Generation Moments: Grouping

PDF of the number of groups with $m$ vehicles

- CAMs in one group may collide
- CAMs from different groups never collide
Identified problem
CAMs Generation Moments: Grouping

CAM collision probability

Groups -> Collisions

THANK YOU FOR YOUR ATTENTION!