CARISSMA
Automotive Safety Research

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

IARIA

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Short introduction of the presenter

Quentin Delooz works as a researcher at the Center of Automotive Research on Integrated Safety Systems and Measurement Area (CARISSMA), Ingolstadt, Germany, and is pursuing a Ph.D. degree in computer science and engineering with the School of Information Technology, Halmstad University. He received his B.Eng. and M.Eng. degrees in computer systems and networks from the University of Liège, Belgium, in 2016 and 2018, respectively. His current research interests include communications for vehicle safety.

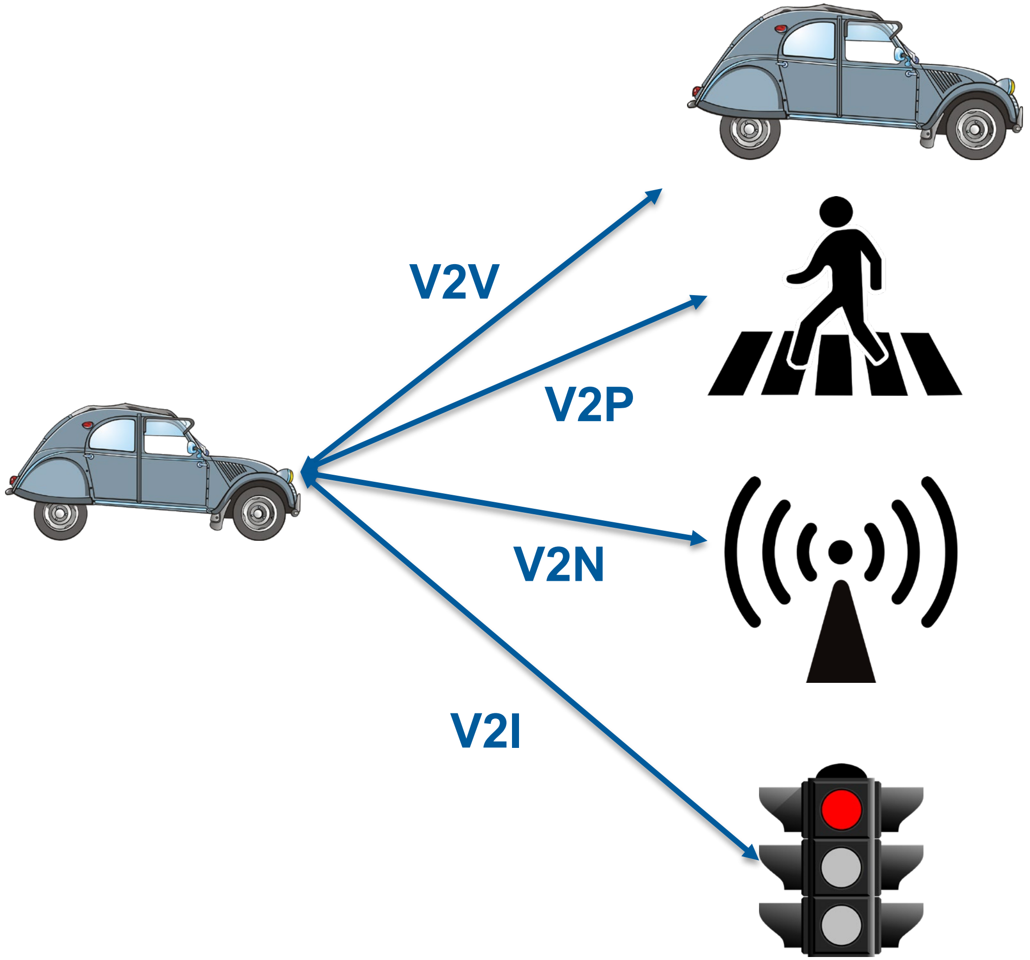
Outlook

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

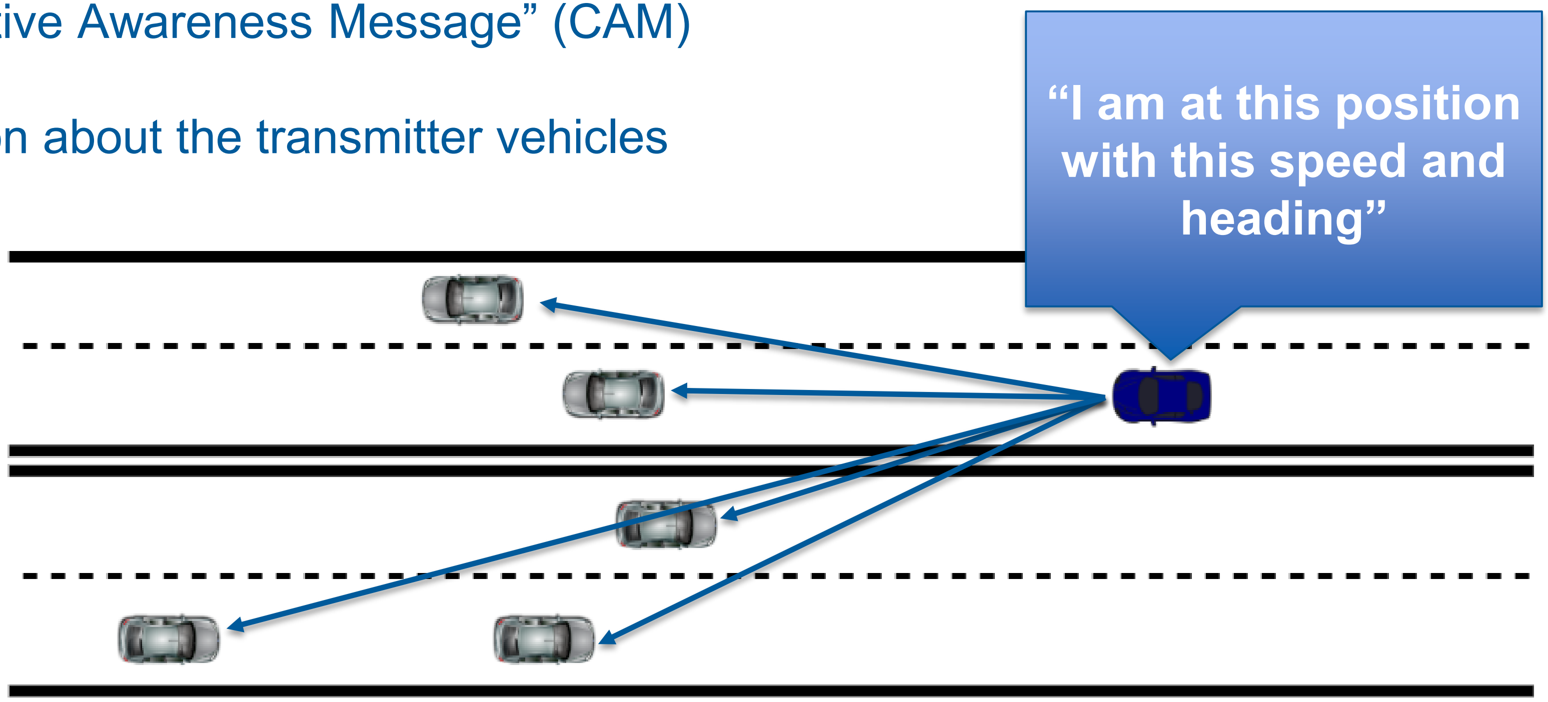
- Applications: better safety on the road, efficient trip planning, reduction of CO2 emission,...



1. Introduction to V2X Communications

Cooperative Awareness Service

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



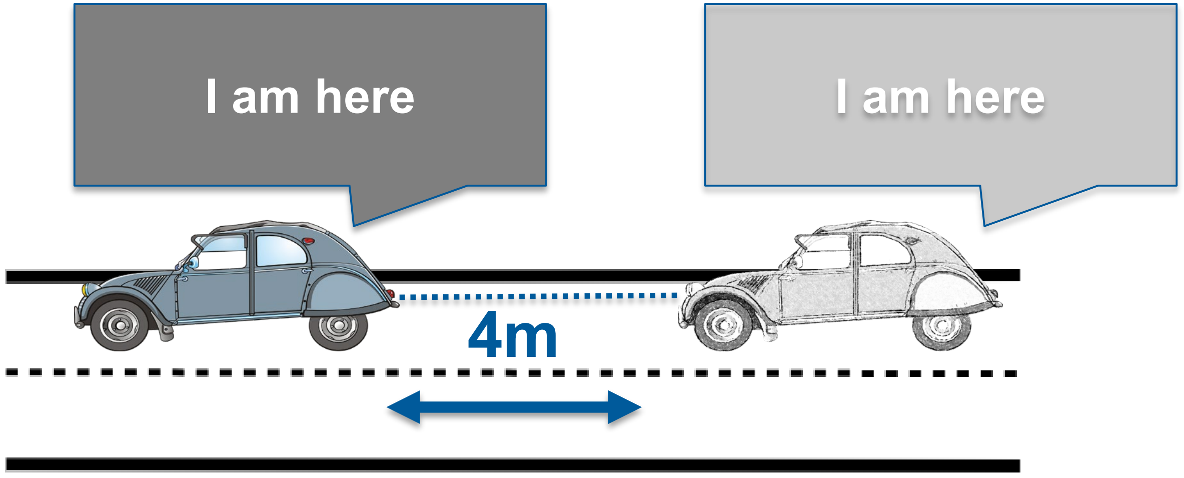
1. Introduction to V2X Communications

Cooperative Awareness Service

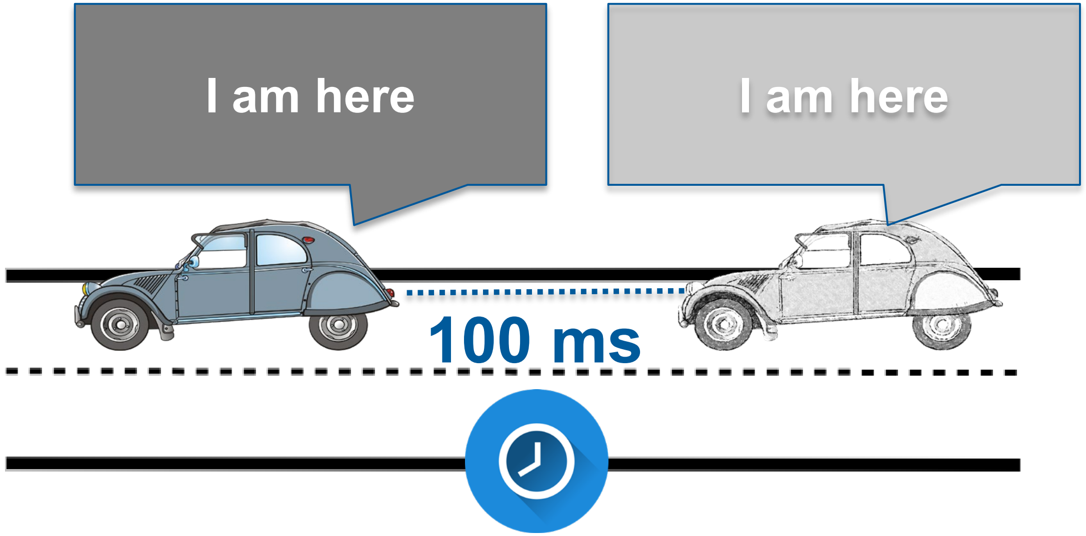
Message generation:

- 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.**

Europe



USA



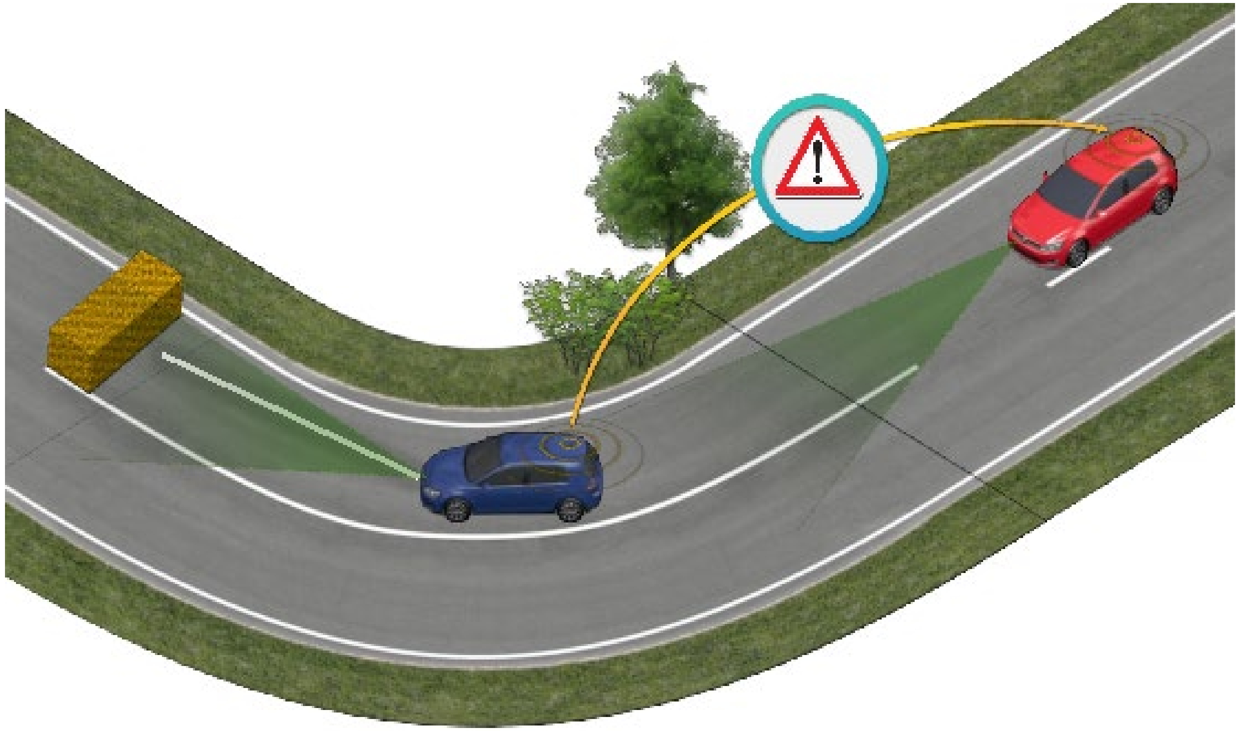
2. Collective Perception

The idea of Collective Perception:

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

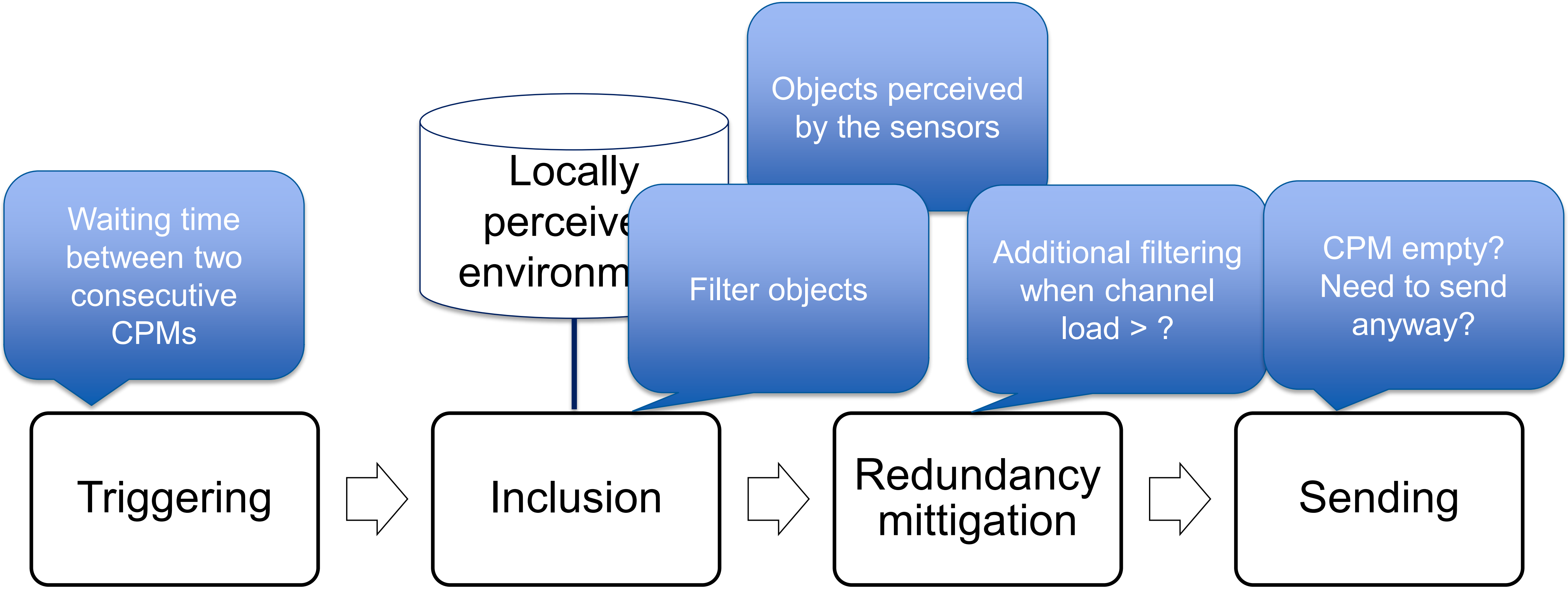
❖Each vehicle perceives its environment and generates a list of objects. Vehicles exchange Collective Perception messages.

❖ Developed in Europe (ETSI TR 103 562 V2.1.1)

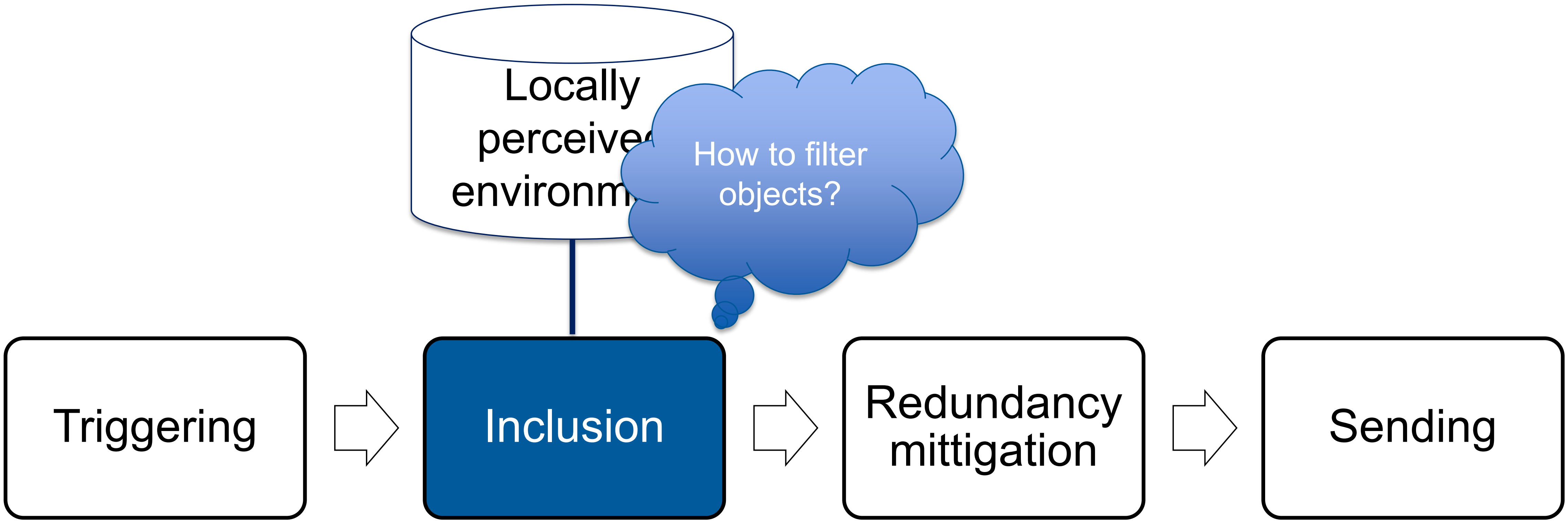


Picture from: H. Günther, B. Mennenga, O. Trauer, R. Riebl and L. Wolf, "Realizing collective perception in a vehicle," *2016 IEEE Vehicular Networking Conference (VNC)*, Columbus, OH, 2016, pp. 1-8, doi: 10.1109/VNC.2016.7835930.

2. Collective Perception



2. Collective Perception

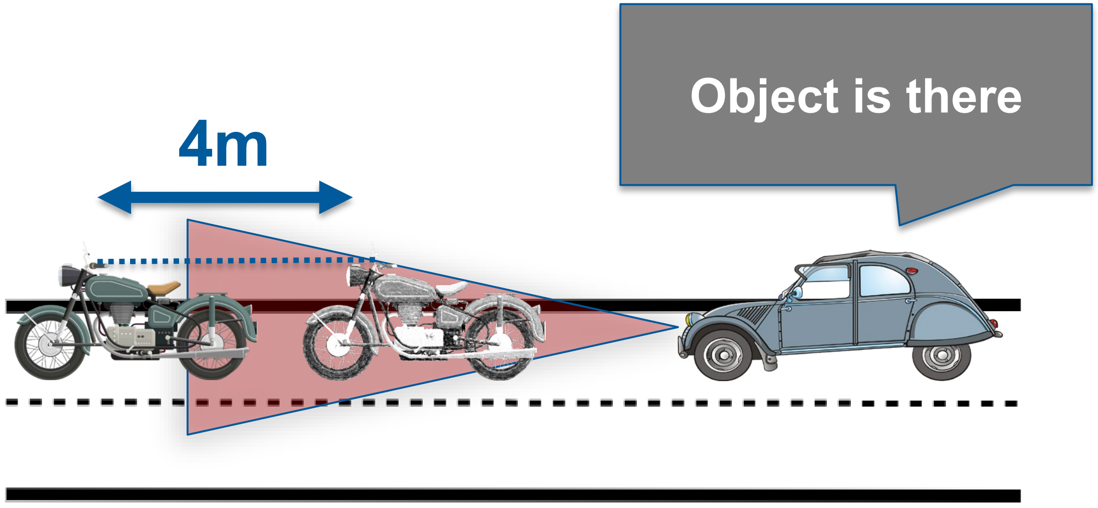


2. Collective Perception

ETSI approach:

Use the CAM rules, but applied to object.

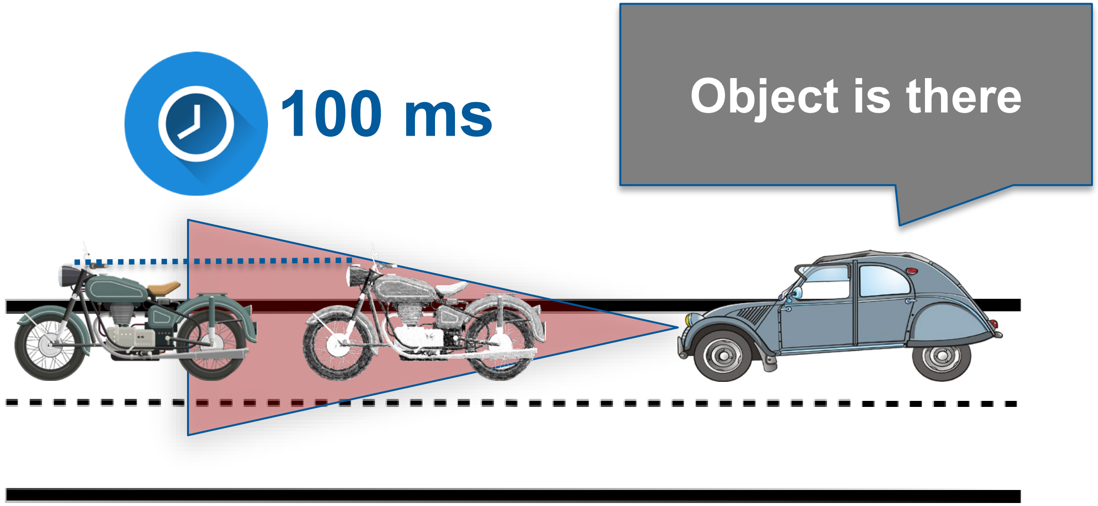
Regard it as “**conservative**”



USA approach:

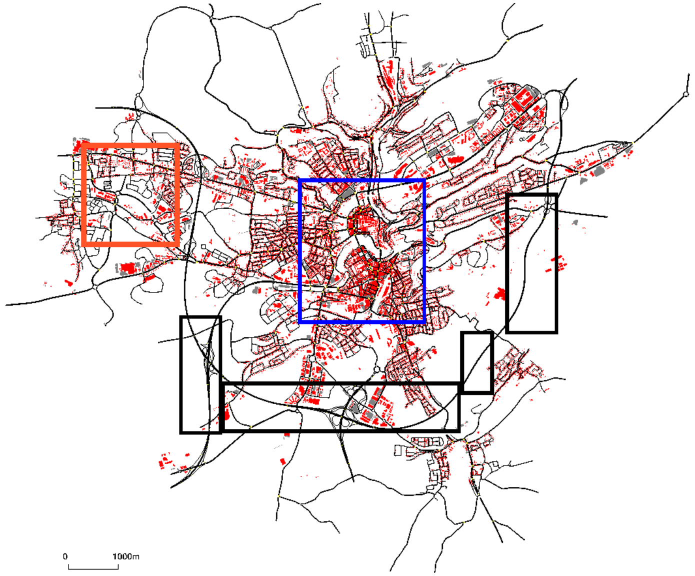
Objects detected are transmitted 10x per second

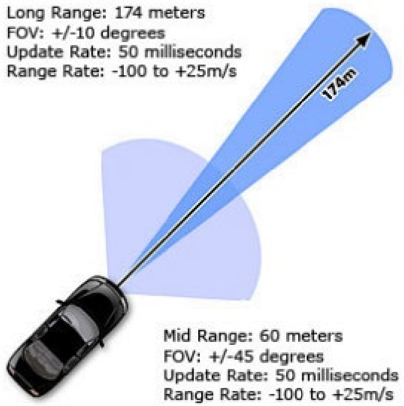
Regard it as “**greedy**”

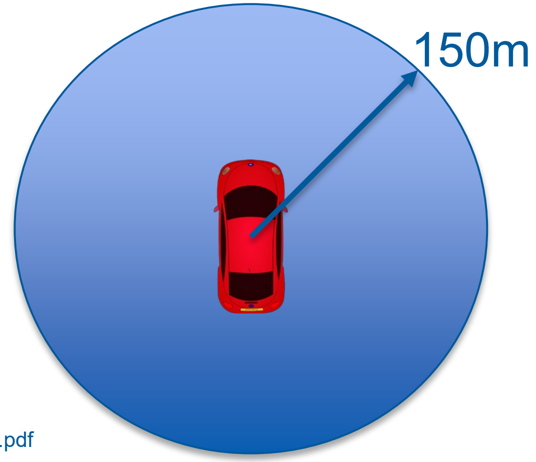


3. Results

- ❖ 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







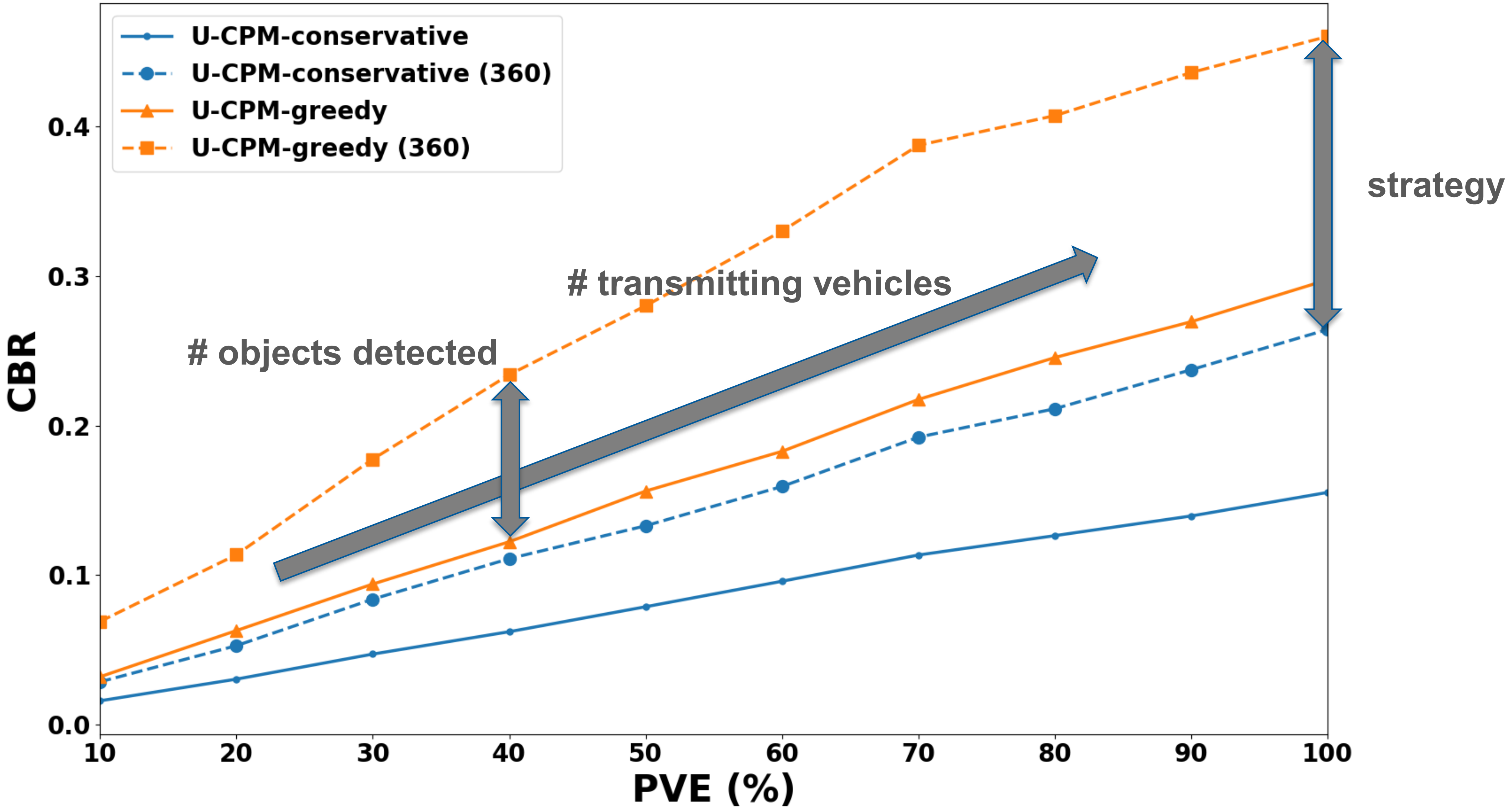
Picture from: https://www.autonomoustuff.com/wp-content/uploads/2016/08/delphi-esr.pdf

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.

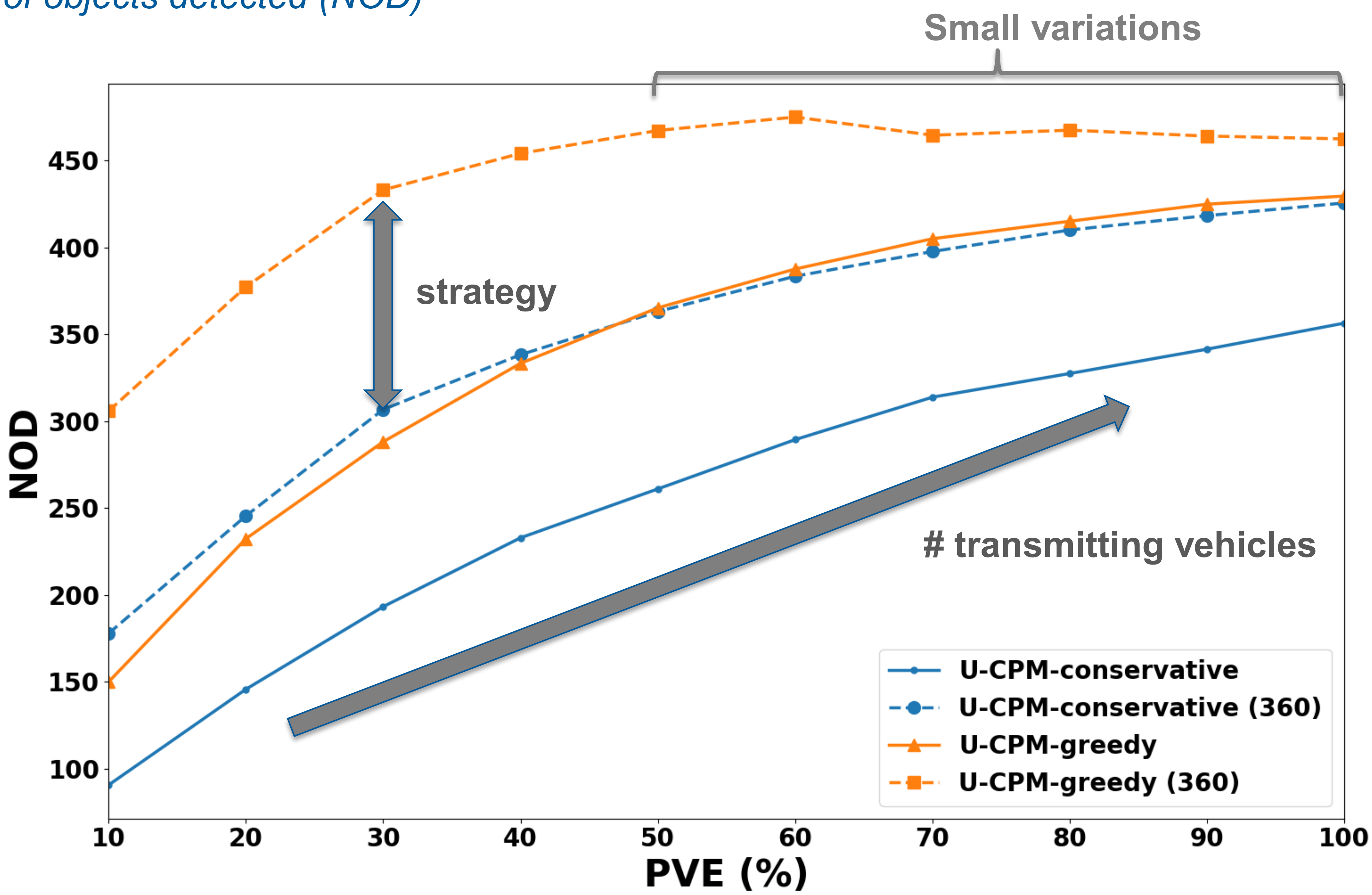
3. Results

Channel busy ratio (CBR)



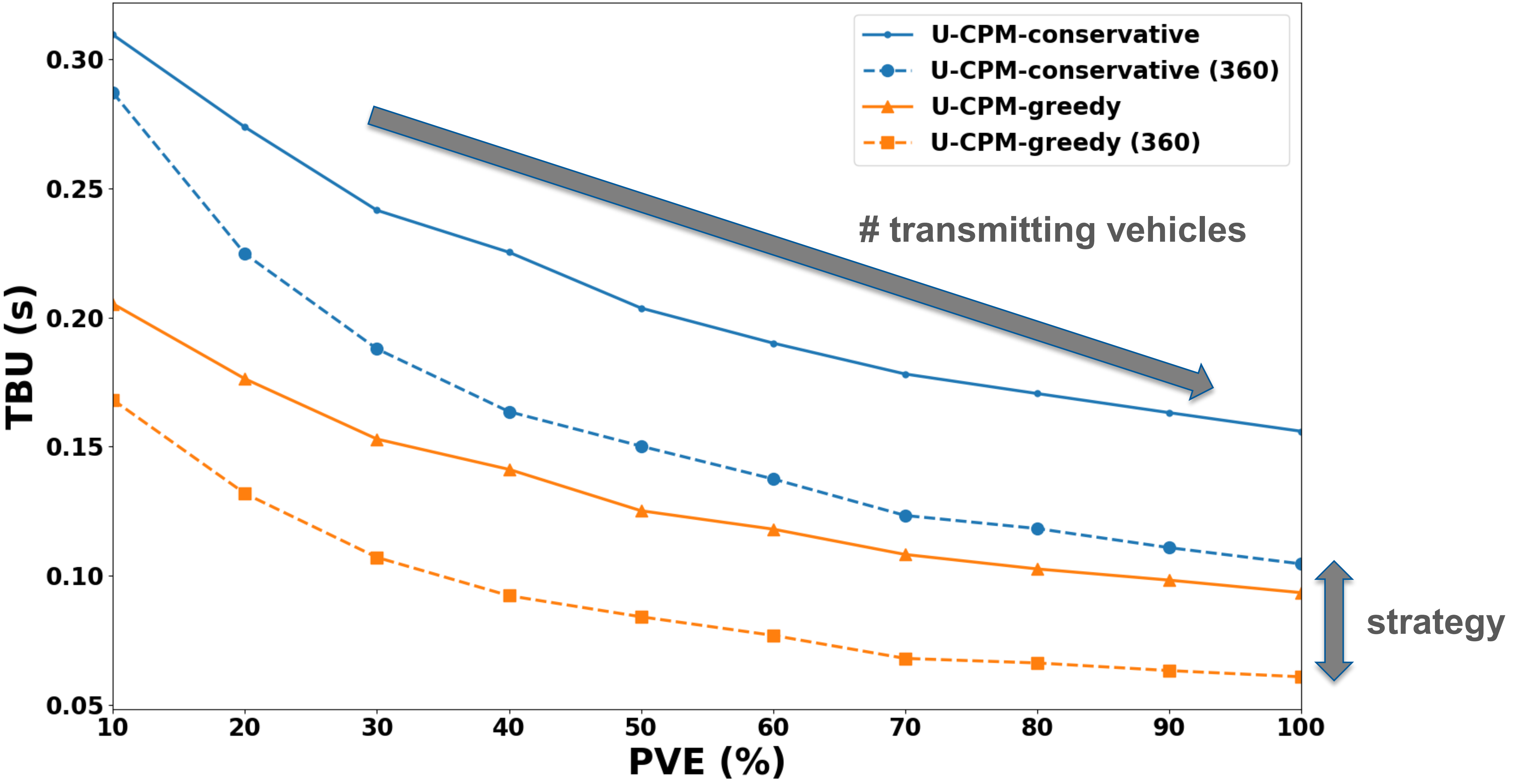
3. Results

Number of objects detected (NOD)



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:

1. ETSI, “Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Analysis of the Collective Perception Service (CPS); Release 2,” Dec. 2019, ETSI TR 103 562 V2.1.1.
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5. P. A. Lopez et al., “Microscopic traffic simulation using SUMO,” in 2018 21st International Conference on Intelligent Transportation Systems (ITSC), 2018, pp. 2575–2582.