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# Assessing trustworthiness of V2X messages: a cooperative trust model against CAM- and CPM-based Ghost Vehicles in IoV

Runbo Su, Yujun Jin and Ye-Qiong Song

{runbo.su, yu-jun.jin, ye-qiong.song}@loria.fr, LORIA, CNRS, Université de Lorraine, France



## Background and proposed model

A number of V2X (Vehicle-to-Everything) messages are standardized by the European Telecommunication Standardization Institute (ETSI), such as CAM (Cooperative Awareness Message) and CPM (Collective Perception Message). However, containing safety-related information makes V2X messages susceptible to malicious insider attacks from compromised vehicles after the PKI authentication step [2], such as Ghost Vehicles (GV) [3], passively or actively reaching a 'ghost' state in terms of communication, position, etc.

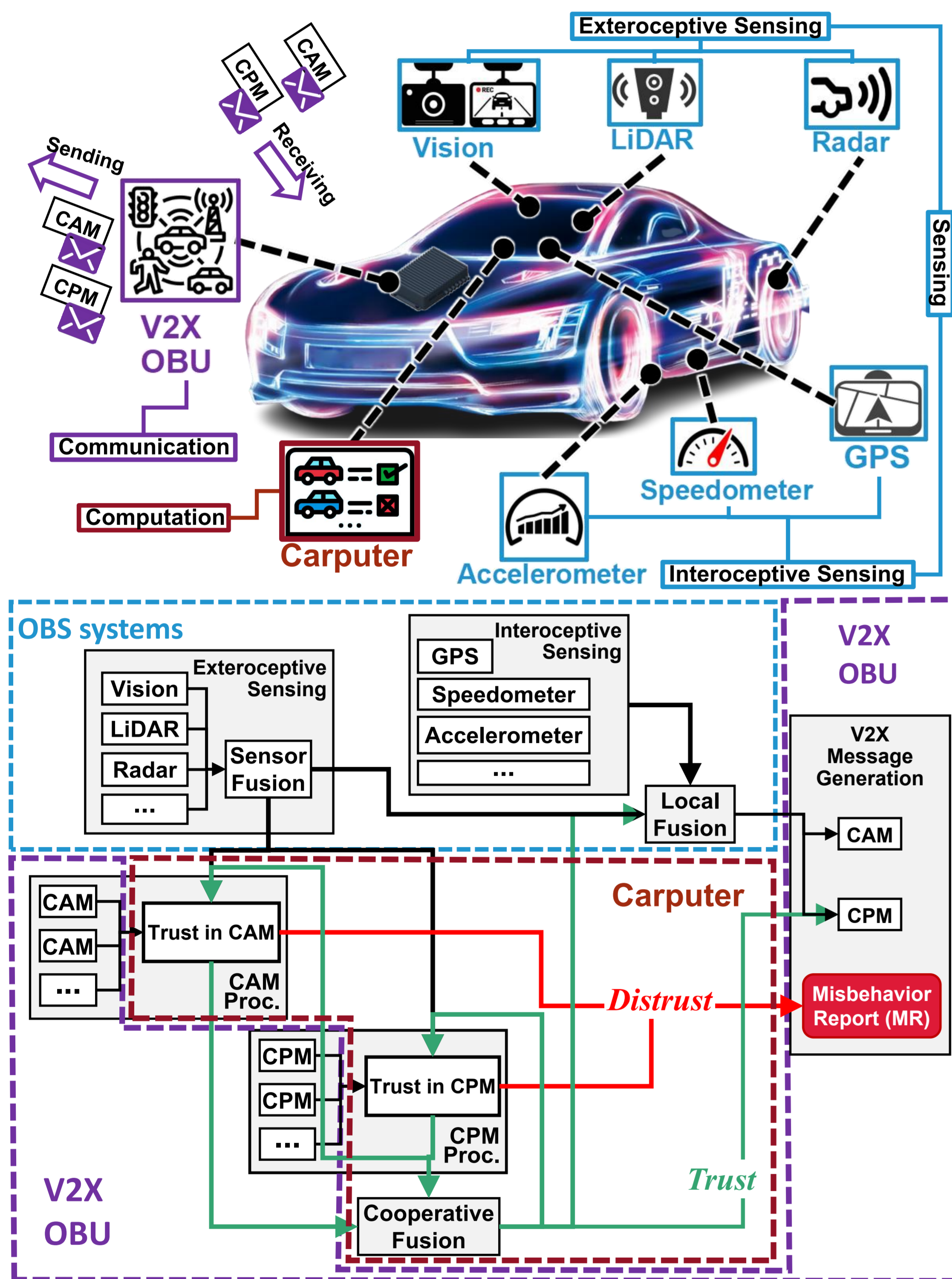


Figure 1. IoV on-board equipment and the functional flows showing how the trust model interacts with OBS (On-Board Sensor) and V2X OBU (On-Board Unit).

## Considered Traffic Scenario in Simulation



Figure 2. Considered Traffic Scenario

## GV attacks

-CAM-based GV Attack Model [4]:

- OOA (On-Off): Attacker switches between good and bad to mislead the trust evaluation, by intentionally doubling its original communication frequency.
- NCA (NewComer): The attacker vehicle fabricates a new identity to convey CAM with the purpose of refreshing its trust.

-CPM-based GV Attack Model [5]:

Table 1. CPM-based GV Attack Parameters

GV Type	Parameters/Description
Constant	$x = 461.937, y = 414.526$
Constant Offset	$\Delta x = -100, \Delta y = -50$
Random	Uniformly random in playground
Random Offset	$d$ uniformly random from $[0, 150]$ $\theta$ uniformly random from $[0, 2\pi]$ $\Delta x = d * \cos\theta, \Delta y = d * \sin\theta$

## Trust in CAM

We set  $T^i$  representing the trust of evaluated CAM sender vehicle  $i$ :

$$p_1^i = (1 - \rho) \sum \rho^{t - t_n^i}$$

$$p_2^i = \rho^{\lambda/n}$$

$$T^i = (p_1^i * p_2^i)^{1/2}$$

Figure 3. Composition of Trust in CAM

$t$  is the current time and  $t_n^i$  is the timestamp of  $n^{th}$  CAM from  $i$ ,  $\rho \in [0, 1]$  is the decay factor, and  $\lambda$  in  $p_2$  is a scale factor. To summarize,  $p_1$  calculates the freshness of the received CAM message, and  $p_2$  determines the level of acquaintance of the CAM sender vehicle.

## Trust in CPM

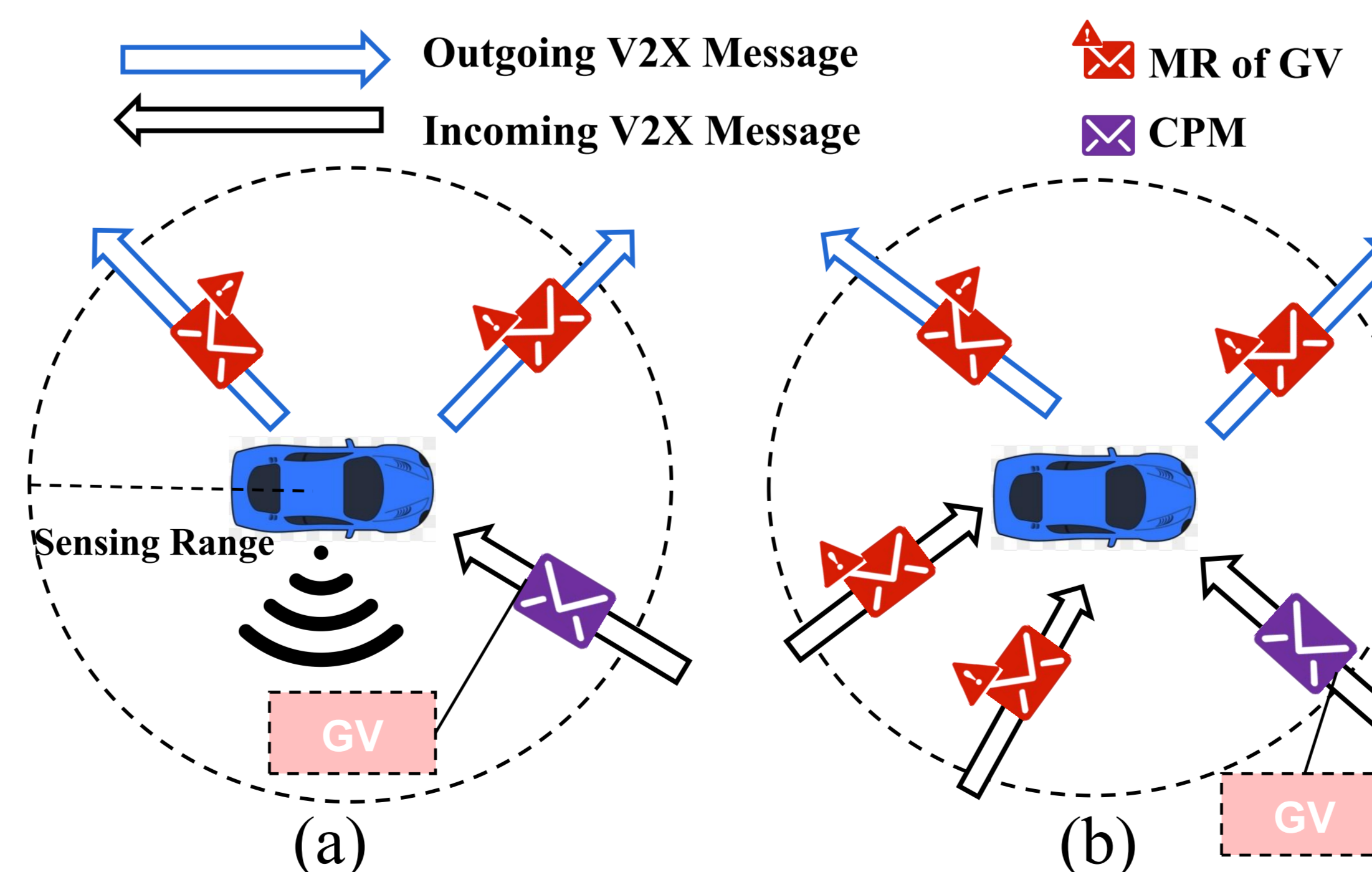


Figure 4. Two GV detection cases: in (a) or out (b) of the evaluator vehicle's perception range

## Simulation results by using Veins Simulator [1]

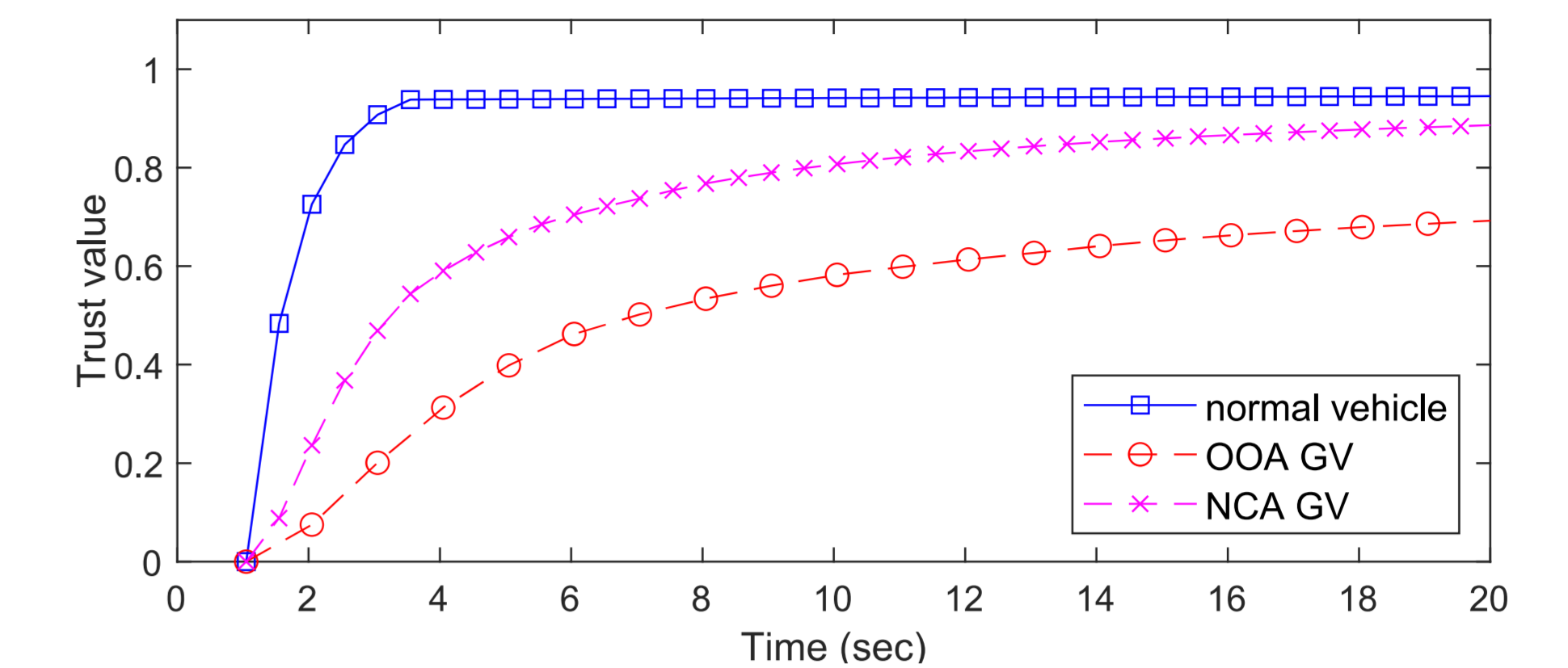


Figure 5. Changes in vehicles' trust values in the presence of OOA and NCA

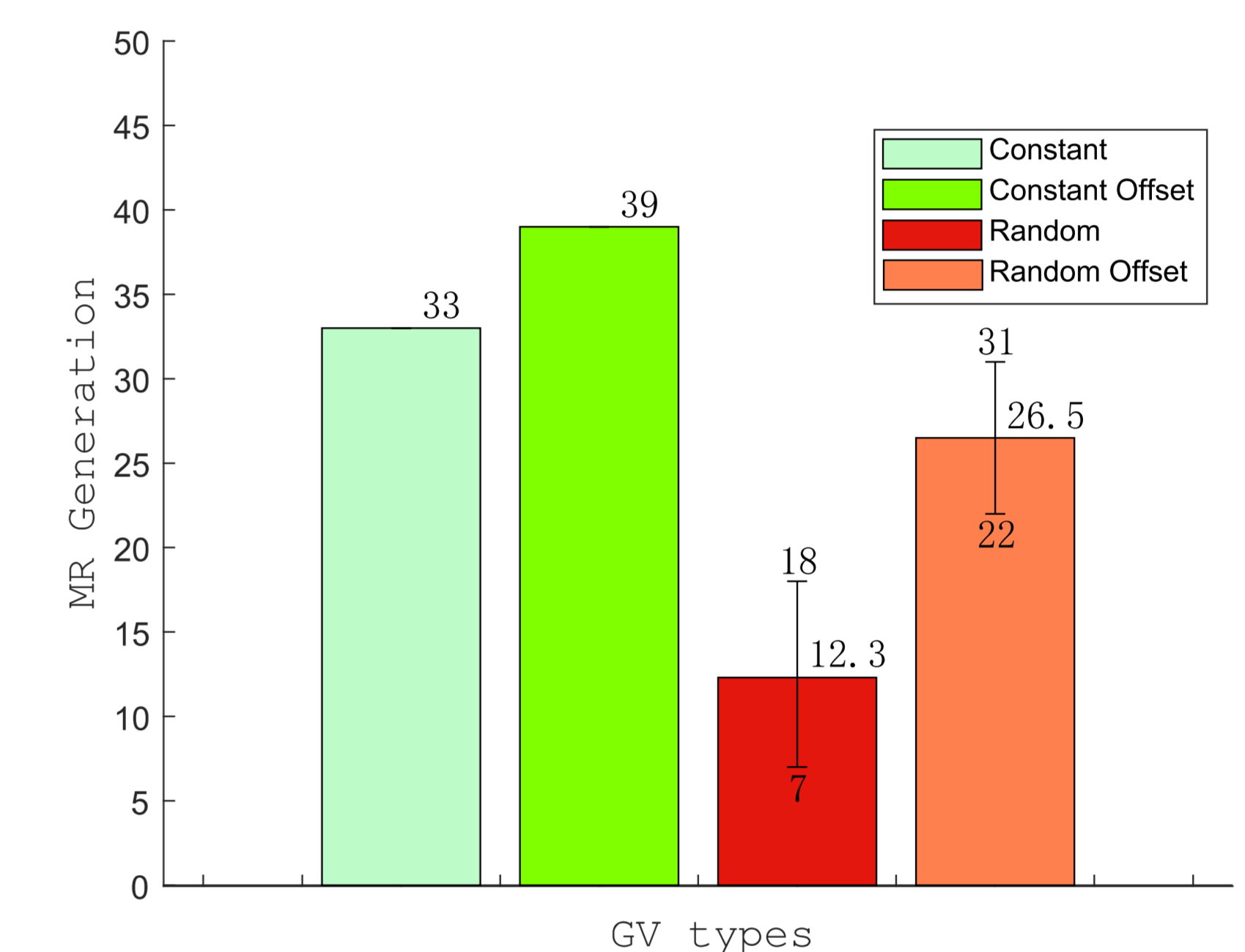


Figure 6. Comparison of detection rate of four CPM-based GV types

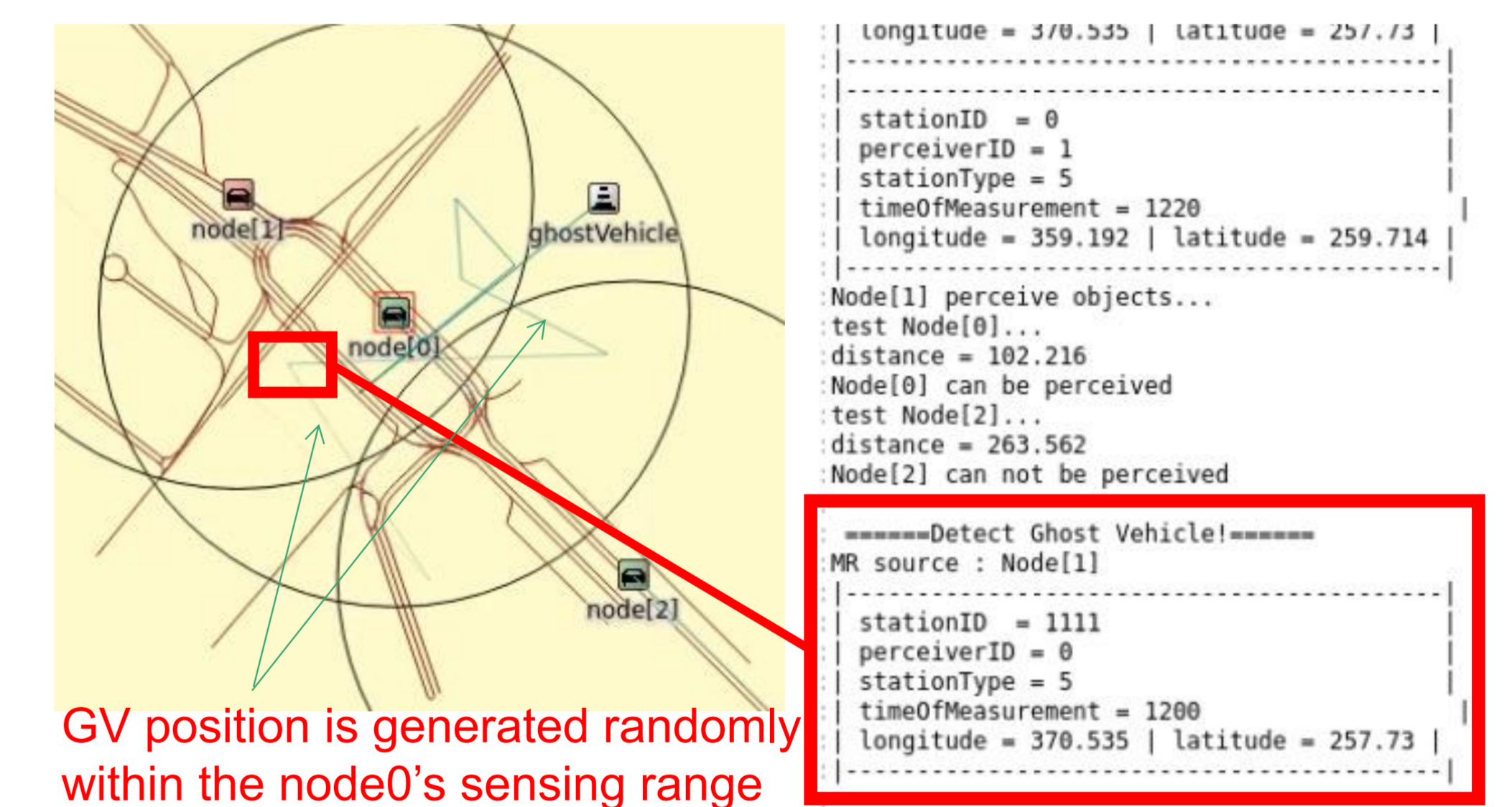


Figure 7. Random Offset GV and MR Generation

## References

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- [2] Hassan Farran and David Khoury. Performance improvements of vehicular pki protocol for the security of v2x communications. In 2023 46th TSP, pages 177-182, 2023.
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