Correction to "Enhanced Position Verification for VANETs using Subjective Logic"

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This note corrects an error in the paper, "Enhanced Position Verification for VANETs using Subjective Logic" ([1]), which presents an enhanced version of a position verification mechanism called ART, and evaluates its' suitability for fusion with other detection mechanisms. In our paper, we described an opinion for the enhanced ART mechanism (eART). We chose the uncertainty with a Gaussian distribution normalized to be 1 at the threshold, and distributed the remaining belief mass using a factor of $\frac{\delta}{2\theta}$, where δ is the measured distance and θ is the threshold. We used the following equation to represent this:

$$\omega = (\frac{\delta}{2\theta} e^{-\frac{|\delta-\theta|^2}{2\sigma}}, (1-\frac{\delta}{2\theta}) e^{-\frac{|\delta-\theta|^2}{2\sigma}}, e^{-\frac{|\delta-\theta|^2}{2\sigma}})$$

However, further study has shown that this choice does not always result in a valid opinion. This issue was encountered because we re-implemented our scheme in a subjective logic library which had more extensive consistency checks. To correct for this error, we have modified our original simulation code, and modified it such that whenever $\delta \neq \theta$, the belief mass is assigned to either belief or disbelief (and the corresponding disbelief or belief is 0), depending on whether $\delta < \theta$. Formally:

$$\omega = \begin{cases} (1 - e^{-\frac{|\delta-\theta|^2}{2\sigma^2}}, 0, e^{-\frac{|\delta-\theta|^2}{2\sigma^2}}) & \text{if } \delta \leq \theta \\ (0, 1 - e^{-\frac{|\delta-\theta|^2}{2\sigma^2}}, e^{-\frac{|\delta-\theta|^2}{2\sigma^2}}) & \text{if } \delta > \theta \end{cases}$$

Also note that the variance given in the original paper was σ, but should have been σ^2.

We have repeated our simulation study with the new parameters to verify that our conclusions were not affected. First, we repeat our study of the threshold and variance parameters θ and σ, as shown in Figure 1.

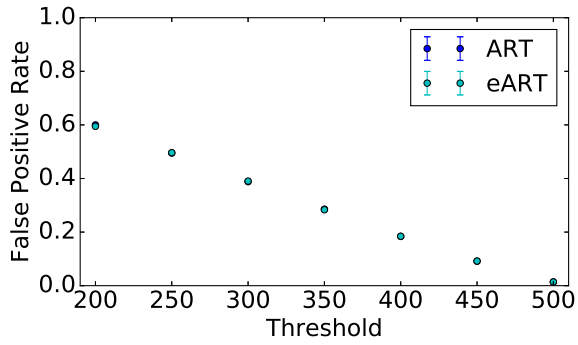
Choosing the same threshold values as in the original paper, i.e., $\theta = 400$ and $\sigma = 225$ (i.e., a variance of 225^2), the simulation results for the different attackers with the same settings as in the original paper can be found in Figures 2, 4, 3. Notable is that for a randomized attacker, the results are significantly better (higher TP and lower FP rates). For the fixed and randomized modification strategy, nothing significant changes: the true positive rates are still very low, and the results still show that this detection approach is not suitable to detect small modifications (up to 50 meters). Thus, our overall conclusions still hold.

Acknowledgment

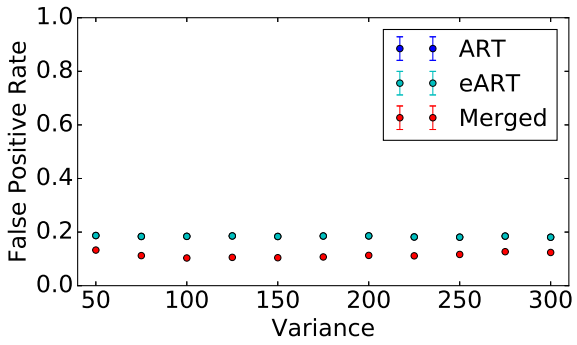
This work was performed on the computational resource bwUniCluster funded by the Ministry of Science, Research and the Arts Baden-Württemberg and the Universities of the State of Baden-Württemberg, Germany, within the framework program bwHPC.

References

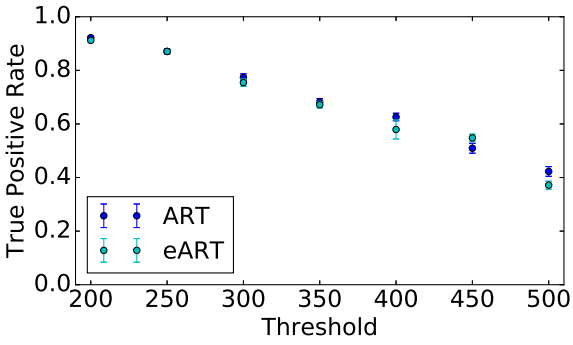
[1] R. W. van der Heijden, F. Kargl, O. M. F. Abu-Sharkh, and A. Al-Momani, "Enhanced position verification for vanets using subjective logic," in *Vehicular Technology Conference Fall*. IEEE, 2016.



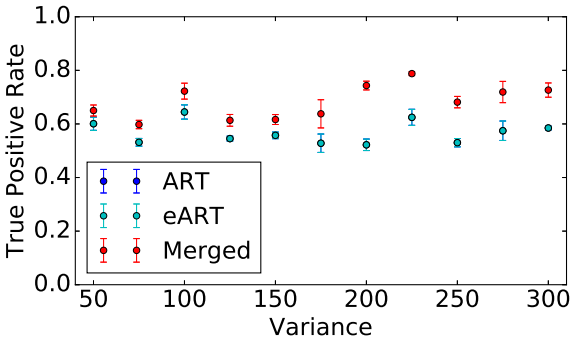
(a) False positives



(b) False positives

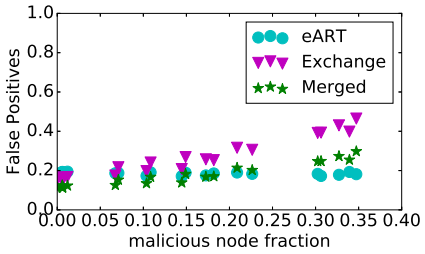


(c) True positives

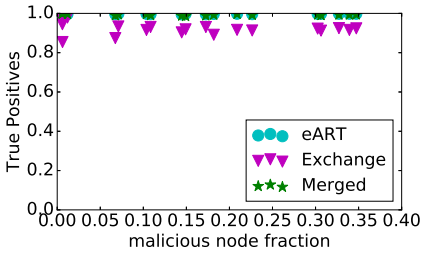


(d) True positives

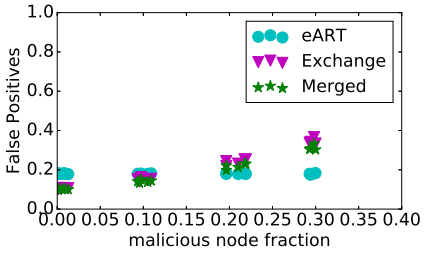
Fig. 1: Comparing different thresholds and variances to configure our enhanced detectors.



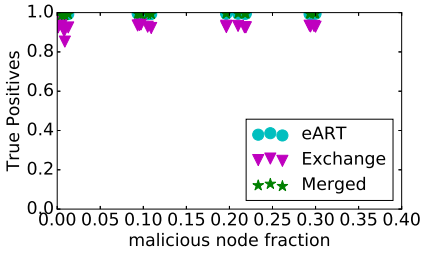
(a) Low density FP



(b) Low density TP

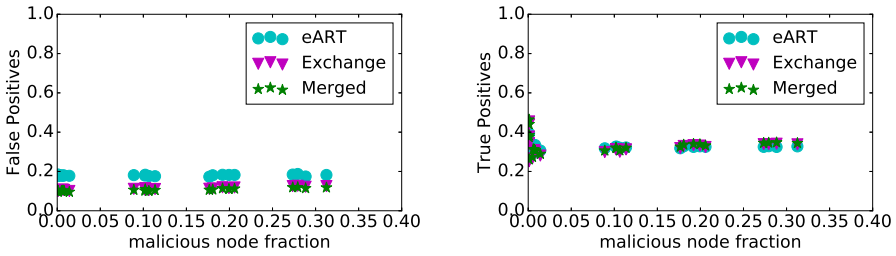


(c) High density FP



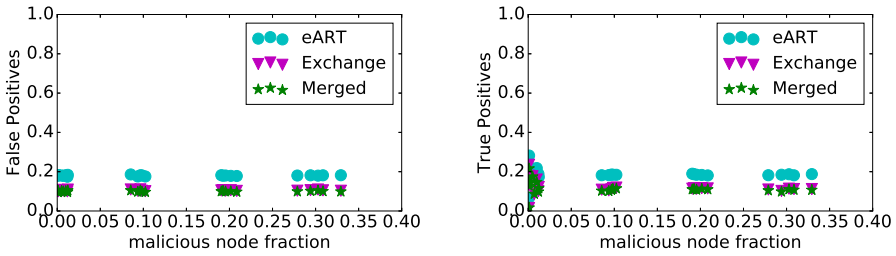
(d) High density TP

Fig. 2: True and false positives for low and high density networks against randomized attackers (i.e., transmitting random positions). Low density is after 2 hours of simulation, high density after 6 hours.



(a) (300,300) FP

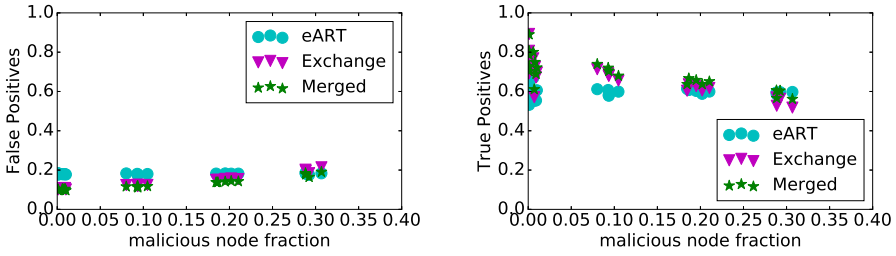
(b) (300,300) TP



(c) (50,50) FP

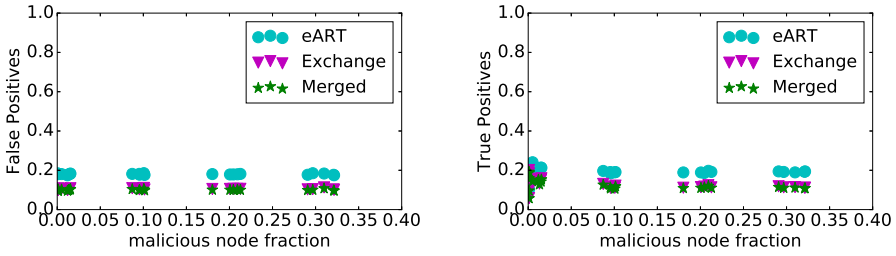
(d) (50,50) TP

Fig. 3: True and false positives for different extremes of the randomized modification strategy.



(a) (300,300) FP

(b) (300,300) TP



(c) (50,50) FP

(d) (50,50) TP

Fig. 4: True and false positives for different extremes of the fixed modification strategy.