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Enhancing IEEE 802.11p Protocol in Dense VANET Scenarios: Evaluating Performance and Detecting Selfish Nodes with TCM

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Abstract— ***Due to an increase in node collisions, the present IEEE 802.11p protocol is unable to guarantee optimal data transmission efficiency in dense networks of car nodes. This work proposes an improved IEEE 802.11p protocol that may be applied with TDMA to ensure effective packet delivery in networks designed on clusters suitable for densely populated areas. Concurrently, a two-dimensional Markov model is constructed to evaluate the performance of the updated mechanism and provide system performance metrics, including delay and transmission rate. In the end, the improved procedure is evaluated and tested, and the effect of node and cluster head numbers on the system's communication effectiveness is looked at. It can direct the placement of roadside facilities and the VANET cluster head optimization process to some extent. Last but not least, in order to increase network trust, we'll employ the Trust Computation Model to detect selfish nodes and remove them from routing as much as possible.***

Index Terms: IEEE 802.11p protocol, TDMA, VANET, Trust Computation Model, Selfish Nodes.

I. INTRODUCTION

A wireless vehicular ad hoc network is made up of roadside communication nodes, pedestrians, and automobiles. The network's nodes collaborate with one another to enhance road safety by averting accidents. They are also able to perceive the surrounding traffic environment and communicate in real time. Thus, by averting collisions, VANET increases road safety. Moving autos and individuals can construct on-board networks in VANET. The communication node or router can be any vehicle, pedestrian, or roadside object that is within the transmission range. With multiple hops, the node's transmission range can be increased to 500 meters, allowing for communication across that distance. As a result, data on the condition of the car and other road nodes can be sent to any node. By preventing accidents, the network's nodes cooperate with one another to improve road safety. They can converse in real time and perceive the traffic scene around them. Therefore, by reducing collisions, VANET raises traffic safety. On-board networks can be created in VANET by both moving cars and individuals. Any moving car in the transmission range, as well as any person or object by the side of the road, can serve as a router or communication node. The node permits communication within the transmission range of 100 to 500 m and can establish several hops to enhance the transmission range. Thus, information on the current state of broadcast communication technology can be obtained by any node. Which incorporates the identification number, position data, and speed of motion. These packages could also include relevant information for safe driving techniques and route planning. According to the protocol, when a node enters the back-off state, a data conflict results in an increase in the back-off window size. The binary exponential back-off approach used by the DCF mechanism may result in long node wait times and low collision probabilities. However, there are more car nodes fighting for limited bandwidth in a densely populated auto network, which increases the likelihood of collisions and decreases transmission rates. However, in a sparse vehicle network, choosing a larger competitive window could lead to extended channel idleness, and beacon transmission's efficacy cannot be Automobile Ad Hoc In recent years, networks have emerged as a practical paradigm to enhance traffic flow, road safety, and passenger comfort in modern transportation systems. Through the use of wireless communication technologies, VANETs allow cars to connect with roadside infrastructure and one another, facilitating the exchange of important information such as emergency notifications, traffic conditions, and road hazards. The The IEEE 802.11p protocol, which is based on the Wi-Fi standard and enables high-speed mobility and facilitates communication between infrastructure and vehicles, has attracted a lot of attention among the many communication techniques proposed for VANETs.

However, there is now ongoing discussion and study over IEEE 802.11p's efficacy in dense VANET scenarios. In dense traffic environments, such as urban areas or highways during peak hours, the proliferation of vehicles leads to increased contention for limited communication resources, resulting in packet collisions, channel congestion, and degraded network performance. Furthermore, the presence of selfish nodes, which may maliciously withhold or manipulate information

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to gain a competitive advantage, poses additional challenges to the reliability and security of VANET communication.

To address these challenges, this research focuses on two primary objectives: first, to propose improvements to the IEEE 802.11p protocol aimed at enhancing its performance in dense VANET scenarios; and second, to develop a mechanism for detecting and mitigating the impact of selfish nodes using Trust and Cooperation Management techniques. By integrating these advancements, we aim to enhance the robustness, efficiency, and security of VANET communication systems, ultimately contributing to safer and more reliable transportation networks.

In this paper, we offer creative fixes for IEEE 802.11p's drawbacks in dense VANET settings, along with a thorough examination of these problems. We also introduce TCM, a method to detect and minimize self-serving behavior in VANETs, and explain its operation with IEEE 802.11p as well as possible impacts on network performance. Furthermore, we outline the methodology for evaluating the proposed improvements through simulation experiments, providing quantitative assessments of key performance metrics such as packet delivery ratio, throughput, and latency.

In summary, this research aims to advance the state-of-the-art in VANET communication by addressing the dual challenges of dense scenarios and selfish nodes, offering novel solutions that can enhance the reliability, efficiency, and security of communication in vehicular networks.

II. LITERATURE SURVEY

[1] Around the world, there is now a lot of interest in vehicular network technologies. The need to assure safety and the requirement to take preventative measures for traffic accidents into consideration are two aspects that have influenced the conception, design, and implementation of the VN standards. Due to the nodes' high topological mobility and intrinsic dynamic nature, Automobile ad hoc networks provide several difficult problems for the standard. The Doppler Effect, which is brought on by the VANET nodes' high mobility, is one of the challenges. In order to compensate for the induced Doppler Shift and mitigate DE in a VANET, Automatic Doppler Shift Adaptation was developed recently. Regarding bit error rate, ADSA turned out to be more reliable and efficient.

[2] This paper describes the architecture and functional aspects of the dedicated short-range communications protocol. The DSRC provides a communication link between vehicles and roadside beacons for road transport and traffic telematics applications. The DSRC technology was proposed for standardization in Europe (CEN TC 278) and ENV-standards were developed. An overview of the three DSRC communication layers is given, with a special focus on the functional aspects provided by the application layer. Finally, a presentation of the European Telematics Applications Programmer research project VASCO, which deals with the validation of the DSRC ENV-standards, concludes this paper.

[3] In wireless sensor network applications, a retransmission mechanism with medium access control level acknowledgements is a standard technique to achieve reliable data delivery. The most advanced PHY/MAC standard for wireless sensor networks, IEEE 802.15.4 is well known for allowing MAC-level acknowledgements and retransmissions. In this study, we assess the IEEE 802.15.4 MAC protocol performance with retransmission and MAC level acknowledgements under unsaturated traffic conditions using a unique analytical model based on a three-dimensional discrete-time Markov chain. Further, we present a simplified version of the proposed analytical model with some approximations. Using the proposed analytical models we assess the network's performance using the following metrics: frame delivery ratio, average node power consumption, aggregate channel throughput, and frame discard ratio. Ns−2 simulations are used to validate the analytical results. The network's performance is evaluated in connection to the frame arrival rate. Node count, frame length, and different MAC parameters. When the outcomes of the two analytical models are compared, it becomes clear that the simplified model offers a reasonable level of accuracy at a lower computing cost.

[4] The Vehicle Ad-hoc Network is a newly developed intelligent transportation system that leverages multiple IEEE standards, including IEEE 802.11p, to provide car-to-car communication. Because of the high node mobility in VANETs, a variety of routing protocols must be used to route packets through the main target node while overcoming significant obstacles. Remember that. To explain this review, we look at three different aspects of this study. In the first section we'll explain what "data distribution" means. We shall categorize and describe the routing protocols for each of their variants in the second section. Lastly, we shall talk about data distribution. Routing protocols, and the challenges that VANETs face.

[5] Low transmission latency and good dependability are necessary for safety-critical car ad hoc network applications. The suggested standards for these kinds of car communication systems are IEEE 802.11p and IEEE 802.11bd. In this study, we propose to do a QoS analysis of IEEE 802.11p/bd driven VANETs for safety applications using an effective SINR-based model. Specifically, a semi-Markov process model with a D/G/1/1 queue can be tailored and altered to produce a channel access behavior characteristic of IEEE 802.11 broadcast networks with predictable message production rates. The distribution of signal-to-interference-to-noise ratio for each VANET receiver is then determined using a unique method based on generic node geometry distributions and generic channel fading/shadowing models. Thus, the Physical, MAC, and

Application layers of the VANETs define and evaluate.

III. EXISTING METHOD

The current IEEE 802.11p protocol cannot ensure optimal data transmission efficiency in dense networks of automobile nodes because to an increase in node collisions. This study's enhanced IEEE 802.11p protocol can be used with TDMA to guarantee efficient packet delivery in cluster-based networks appropriate for highly populated regions. Simultaneously, a two-dimensional Markov model is built to assess the updated mechanism's performance and offer metrics for the system's performance, such as transmission rate and delay. In the end, the improved procedure is evaluated and tested, and the impact of node and cluster head counts on the communication efficiency of the system is examined. It can direct the placement of roadside facilities and the VANET cluster head optimization process to some extent.

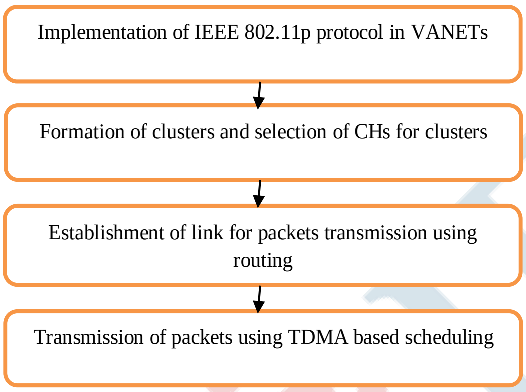

Fig 1: Implementation Process of Existing Method

Disadvantages:

- There are some self-centered nodes that negatively impact network performance and are often disregarded.
- The self-centered nodes are to blame for the network's decreased level of trust.

IV. METHODOLOGY

Due to an increase in node collisions, the present IEEE 802.11p protocol is unable to guarantee optimal data transmission efficiency in dense networks of automotive nodes. This paper proposes an improved IEEE 802.11p protocol that, when combined with TDMA, can offer effective packet delivery in networks constructed on clusters suitable for densely populated areas. Concurrently, a two-dimensional Markov model is constructed to evaluate the performance of the updated mechanism and provide metrics for the transmission rate and delay of the system. Ultimately, the updated process is assessed and put to the test. Additionally, the effect of node and cluster head counts on the system's communication efficiency is investigated. To a certain extent, it can control the VANET cluster head optimization process and the location of roadside facilities. Last but not least, in order to increase network trust, we'll employ the Trust Computation Model to detect selfish nodes and remove them from routing as much as possible.

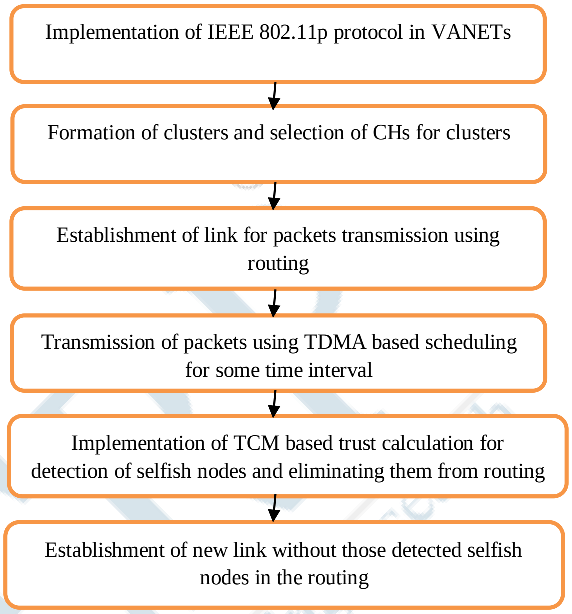

Fig 2: Implementation Process of Proposed Method

We first describe the necessary changes to the current protocol standards in order to implement the enhanced TDMA-based IEEE 802.11p protocol. These enhancements allow the medium access control layer and frame structure to be improved in conjunction with time-slotted communication techniques (TDMA scheduling). By introducing TDMA alongside IEEE 802.11p, we aim to allocate specific time slots for transmission within each cluster, thereby reducing the likelihood of collisions and contention, particularly in dense network environments.

Furthermore, in order to assess the effectiveness of the altered protocol, we construct a two-dimensional Markov model that embodies the fluid nature of communication within VANETs. This model considers factors such as node mobility, channel conditions, and transmission dynamics, allowing us to examine how the suggested improvements will affect system-level performance indicators. We analyze key performance measures, such as transmission rate, packet delivery ratio, and end-to-end delay, through comprehensive simulation tests using the Markov model. This provides insight into how well the proposed protocol performs in terms of improving communication efficiency. We also study the impact of node and cluster head counts on the system's communication efficiency. Through the manipulation of these parameters in our simulations, we examine the impact of variations in network density on the upgraded protocol's performance, enabling us to determine the best configurations for various deployment scenarios. Moreover, we explore the implications of our findings on VANET cluster head optimization processes and the strategic

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placement of roadside facilities, aiming to optimize network resources and infrastructure deployment.

Finally, to enhance network trust and security, we integrate a Trust Computation Model into the proposed system. TCM utilizes trust metrics and cooperative strategies to detect and mitigate the presence of selfish nodes within the network. By monitoring node behavior and interactions, TCM evaluates the reliability and trustworthiness of individual nodes, allowing us to identify and remove selfish nodes from routing processes. Through this approach, we aim to increase the integrity and resilience of VANET communication, fostering a trustworthy and cooperative network environment. In summary, the recommended course of action is to develop and implement an enhanced IEEE 802.11p protocol that makes use of TDMA as well as a two-dimensional Markov model for analysis and performance evaluation. By integrating TCM for selfish node detection and mitigation, we aim to improve communication efficiency, optimize network resources, and enhance network trust and security in dense VANET environments. Through comprehensive evaluation and testing, our objective is to exhibit the efficacy and feasibility of the suggested approach in actual VANET implementations.

Advantages:

- The network performed better after the removal of selfish nodes.
- The network's trust is increased when self-centered nodes are removed from the packet transmission path.

V. RESULTS AND DISCUSSIONS

Plotting the network's throughput over time reveals that the throughput will be expressed in bits per second.

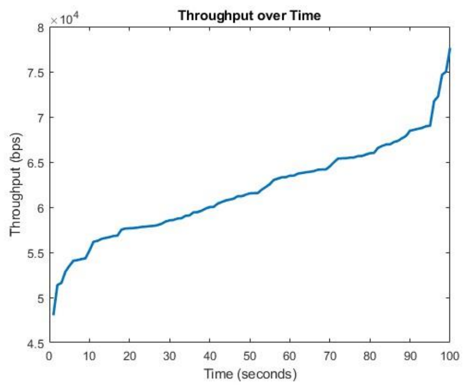

Fig 3: Throughput in terms of bps over time

When a dataset with 12 nodes is shown, the link between PC and cluster number can be noticed. That the quantity of clusters has increased in tandem with the quantity of PCs.

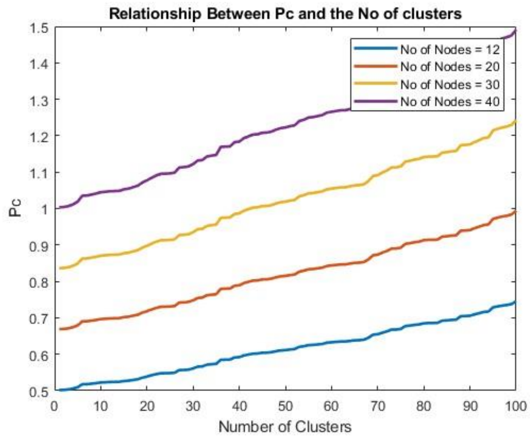

Fig 4: Relation between Pc and No of Clusters

Plotting the link between transmission delay and cluster count reveals that the transmission delay rises with the number of clusters.

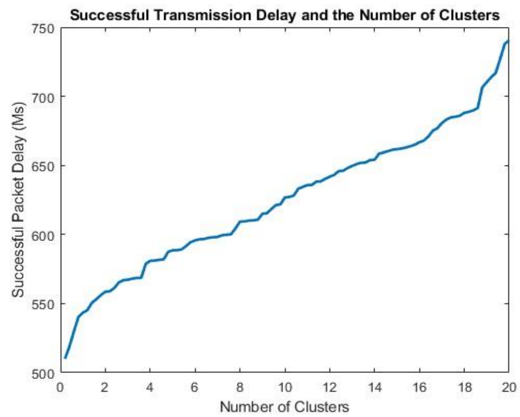

Fig 5: Transmission Delay Vs No of Clusters

The vehicle adhoc network and all of its nodes are depicted in the graphic below.

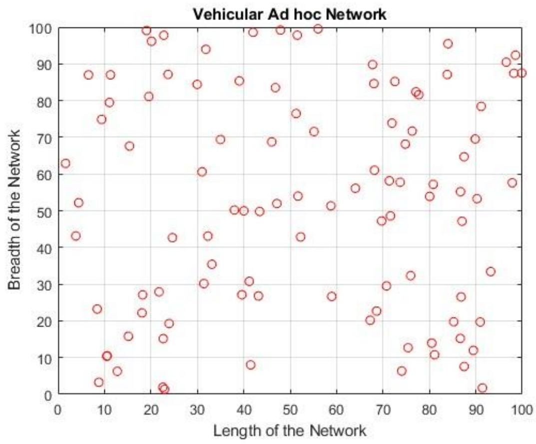

Fig 6: VANET Network

Plotting the link between the two variables shows that the recognition % rises in direct proportion to the number of mal nodes.

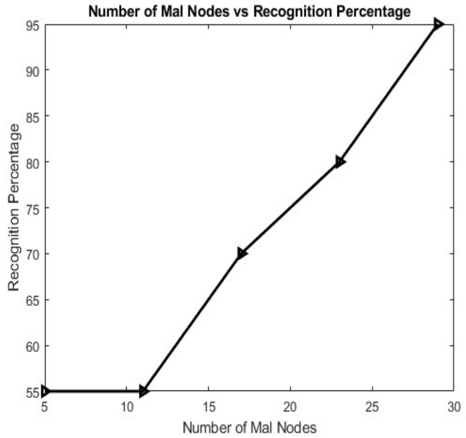

Fig 7: Number of Mal Nodes Vs Recognition Percentage

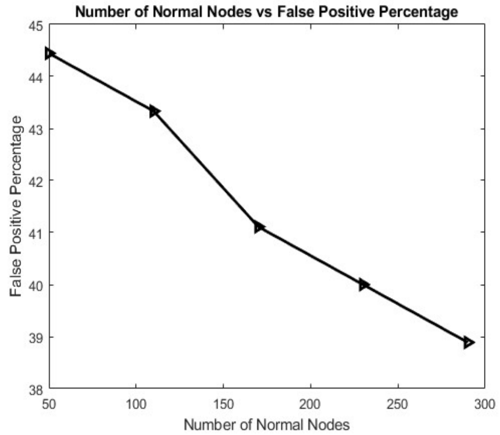

Fig 8: Number of Normal Nodes Vs False Positive Percentage

Plotting the false positive percentage against the number of normal nodes indicates that as the number of normal nodes rises, the false positive percentage falls. Lastly, the figure 9 below will display the regular and malicious nodes that have been found.

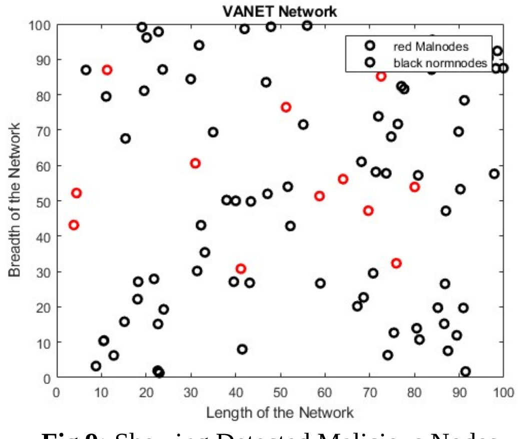

Fig 9: Showing Detected Malicious Nodes

VI. CONCLUSION

In conclusion, In order to solve the issues of communication efficacy and network trust in dense scenarios of vehicle ad hoc networks, In order to detect selfish nodes, This study has enhanced and assessed the IEEE 802.11p protocol's performance while integrating a Trust Computation Model.

Time Division Multiple Access has been proposed and incorporated into the IEEE 802.11p protocol as a way to lessen node conflicts and congestion for communication resources in dense VANET environments. Effective packet delivery is ensured when IEEE 802.11p and TDMA are integrated, especially in cluster-based networks suitable for highly populated areas. Transmission rate, delay, and other system performance metrics could be computed with the help of the two-dimensional Markov model, which also offered a methodical framework for evaluating the upgraded mechanism's performance. Through comprehensive simulation testing, we assessed how node and cluster head counts affected communication efficiency in addition to the results demonstrated that the refined protocol significantly improves packet delivery efficiency, even in highly dense VANET scenarios. Furthermore, insights gleaned from the simulations have implications for VANET cluster head optimization processes and the strategic deployment of roadside facilities, contributing to the optimization of network resources and infrastructure.

REFERENCES

[1] J. B. Kenney, "Dedicated short-range communications" ,IEEE, vol. 99, no. 7, pp. 1162–1182, 2011.

[2] Q. Wu, H. Ge, P. Fan, J. Wang, Q. Fan, and Z. Li "Time-dependent performance analysis of the 802.11p-based platooning communications under disturbance Transactions on Vehicular Technology",IEEE vol. 69, no. 12, pp. 15760 – 15773, 2020.

[3] L. Cheng and S. Panichpapiboon, "Effects of intervehicle spacing distributions on connectivity of VANET: a case study from measured highway traffic," IEEE Communications Magazine, vol. 50, no. 10, pp. 90–97, 2012.

[4] Asefi, M. C′espedes, S. Shen, X. , & Mark, J. W. (2011). "A seamless quality-driven multi-hop data delivery scheme for video streaming in urban VANET scenarios" Conference on communications, Kyoto". (pp. 1–5).

[5] Chung, S. , Yoo, J. , Kim, C. 2009. "A cognitive MAC for VANET based on the WAVE systems" Conference on advanced communication technology, Phoenix Park", (pp. 41–46).

[6] Fonseca, A. , & Vaz~ao, T. (2012). "Applicability of position-based routing for VANET in highways and urban environment, Journal of Network and Computer Applications", 36 , 961–973.

[7] Francisco, J. M. , Toh, C. K. , Cano, J. C. , Calafate, C. T. , & Manzoni, P. (2009). "A survey and comparative study of simulators for vehicular ad hoc networks, Wireless Communications and Mobile Computing" , 11 , 813–828.

[8] Mokda, L., Ben-Othman, J., and Hamieh, A. (2009). "Radio interference attack detection in VANET", the proceedings of the Honolulu, Hawaii, 28th IEEE conference on global telecommunications. (pp. 5077–5081)."

[9] Jia, D., Wang, J., and Lu, K. 2014. "An adaptive design for a vehicle platoon with vanet capabilities Vehicular Technology Transactions", IEEE, 527–539.

[10] Chang, Y. C., Alias, M. Y., Loo, J., and Lim, J. M. Y. 2015, June."Joint optimization and threshold structure dynamic programming with better priority scheme for adaptive VANET MAC Wireless Networks", 1–17.

[11] In 2010, Luo, C., Yu, F. R., Ji, H., and Leung, V. C. M. "Using cross-layer design to enhance TCP performance in cognitive radio networks." Transportation Systems, IEEE Transactions, 59, 2485–2495.

[12] Shah,N.Habibi,D.&Ahmad,I.(2012). "Multichannel cognitive medium access control protocol for VANET". (pp. 222–233). Conference in vehicular technology, New York , NY.

[13] Li, S., Asefi, M., Tom, H. L., & Shen, X. (2012). "Experience-focused, high-quality video streaming in A case study, protocol design, and analysis of wireless networks facing challenges. IEEE Communications Society," 7 (September 9–12).