


Focus | [Published: 12 July 2021](#)

DTCR: delay time aware controlled rebroadcasting mechanism for intelligent transportation systems

[Banar Fareed](#) , [Mehmet Toycan](#) & [Amin Salih Mohammed](#)

Soft Computing **25**, 12537–12549 (2021)

90 Accesses | **1** Citations | [Metrics](#)

Abstract

Mobile ad hoc networks include VANETs (vehicular ad hoc networks) characterized to enhance vehicles' wireless connectivity. In intelligent transportation systems (ITS), information can be exchanged over long distances as long as a means of retransmission exists. ITS uses the broadcasting technique for message transmission, and the network should have characteristics to overwhelm duplicate packets. Because of broadcasting, there is a higher chance of packet loss because of bandwidth utilization by the messages, which is a severe issue. Delay time-aware controlled rebroadcasting (DTCR) routing protocol is presented in this research study which inherits hybrid probabilistic and parametric broadcasting mechanisms. The algorithm is characterized to analyze the probabilistic-temporal characteristics of

traffic applications by using Omnet++, SUMO, and Veins simulation tools. The optimal TTL rate is evaluated by considering the density and location of nodes with the network topology. SINR performance metric is used for the control of message broadcasting. The transmitted messages are stored in the transmission queue for a particular time based on latency. Once the timer is expired, the vehicle decides whether to retransmit the packet or not based on the duplicates found or not. The proposed mechanism improves the maximum successful transmission of messages while avoiding duplications for the stability of road traffic safety against failures. Analytical and simulation results demonstrate that DTCR offers an improvement on system performance characteristics in terms of throughput, delivery ratio, and delay time when compared with other routing protocols. These results lead to improve the average network throughput by 1%, 22%, and 30% as compared with DABFS, LOA, and NBP, respectively.

This is a preview of subscription content, [access via your institution](#).

Access options

Buy article PDF

34,95 €

Price includes VAT (Iraq)
Tax calculation will be finalised during checkout.

Instant access to the full article PDF.

[Rent this article via DeepDyve.](#)

[Learn more about Institutional subscriptions](#)

References

Arellano W, Mahgoub I (2013) Traffic modeler extensions: a case for rapid VANET simulation using, OMNET++, SUMO, and VEINS. In: High capacity optical networks and emerging/enabling technologies HONET-CNS, pp 109–115.

<https://doi.org/10.1109/HONET.2013.6729767>

Arena F, Pau G, Severino A (2020) A review on IEEE 802.11p for intelligent transportation systems. J Sens Actuator Netw 9:1–11.

<https://doi.org/10.3390/jsan9020022>

Bi Y, Shan H, Shen XS, Wang N, Zhao H (2016) A multi-hop broadcast protocol for emergency message dissemination in urban vehicular ad hoc networks. IEEE Trans Intell Transp Syst 17:736–750. <https://doi.org/10.1109/TITS.2015.2481486>

Darwish T, Bakar KA (2016) Traffic aware routing in vehicular ad hoc networks: characteristics and challenges. *Telecommun Syst* 61(3):489–513

Elbreiki W, Habbal A, Hassan S, Arif S (2015) Potential use of name data networking in vehicle-to-vehicle communication. *ARPN J Eng Appl Sci* 10:1270–1278

Haider S, Abbas G, Abbas ZH, Baker T (2019) DABFS: a robust routing protocol for warning messages dissemination in VANETs. *Comput Commun* 147:21–34.

<https://doi.org/10.1016/j.comcom.2019.08.011>

He R, Renaudin O, Kolmonen VM, Haneda K, Zhong Z, Ai B, Hubert S, Oestges C (2016) Vehicle-to-vehicle radio channel characterization in crossroad scenarios. *IEEE Trans Veh Technol* 65:5850–5861.

<https://doi.org/10.1109/TVT.2015.2473687>

Hisham A, Strom EG, Brannstrom F, Yan L (2019) Scheduling and power control for V2V broadcast communications with co-channel and adjacent channel interference. *IEEE Access* 7:67041–67058.

<https://doi.org/10.1109/ACCESS.2019.2916954>

Ibrahim BF, Toycan M, Mawlood HA (2020) A comprehensive survey on VANET broadcast protocols. In: Proceedings of 2nd international conference on computation, automation and knowledge management ICCAKM, pp 298–302.
<https://doi.org/10.1109/ICCAKM46823.2020.9051462>

Jiang H, Guo H, Chen L (2008) Reliable and efficient alarm message routing in VANET. In: Proceedings of international conference on distributed computing systems, pp 186–191.
<https://doi.org/10.1109/ICDCS.Workshops.2008.34>

Jiang H, Zhang Z, Dang J, Wu L (2018) A novel 3-D massive MIMO channel model for vehicle-to-vehicle communication environments. *IEEE Trans Commun* 66:79–90.
<https://doi.org/10.1109/TCOMM.2017.2751555>

Johnson D, Menezes A, Vanstone S (2001) The elliptic curve digital signature algorithm (ECDSA). *Int J Inf Secur* 1:36–63.
<https://doi.org/10.1007/s102070100002>

Kamakshi S, Sriram SVS (2019) Plummeting broadcast storm problem in highways by clustering

vehicles using dominating set and set cover. Sensors (basel, Switz). <https://doi.org/10.3390/s19092191>

Kenney JB (2011) Dedicated short-range communications (DSRC) standards in the United States. Proc IEEE 99:1162–1182.
<https://doi.org/10.1109/JPROC.2011.2132790>

Krajzewicz D (2010) Traffic simulation with SUMO —simulation of urban mobility. Int Ser Oper Res Manag Sci 145:269–293.
https://doi.org/10.1007/978-1-4419-6142-6_7

Kwon S, Kim Y, Shroff NB (2016) Analysis of connectivity and capacity in 1-D vehicle-to-vehicle networks. IEEE Trans Wirel Commun 15:182–8194.
<https://doi.org/10.1109/TWC.2016.2613078>

Lopez PA, Behrisch M, Bieker-Walz L, Erdmann J, Flotterod YP, Hilbrich R, Lucken L, Rummel J, Wagner P, Wiebner E (2018) Microscopic traffic simulation using SUMO. In: IEEE conference on intelligent transportation systems. Proceedings, ITSC 2018, pp 2575–2582.
<https://doi.org/10.1109/ITSC.2018.8569938>

Mahajan AN, Saproo D, Khedikar R (2013) Analysis and comparison of VANET routing protocols using

IEEE 802.11p and WAVE. *Int J Eng Res Appl*
3:1556–1561

Mahipal M, Batish S, Kakria A (2012) Efficient broadcasting protocol for vehicular ad-hoc network. *Int J Comput Appl* 49:38–41.
<https://doi.org/10.5120/7946-1288>

Mallikarjuna GCP, Hajare R, Mala CS, Rakshith KR, Nadig AR, Prathana P (2017) Design and implementation of real time wireless system for vehicle safety and vehicle to vehicle communication. In: International conference on electrical, electronics, communication, computer technologies and optimization techniques ICEECCOT 2017, pp 354–358.
<https://doi.org/10.1109/ICEECCOT.2017.8284527>

Manivannan D, Moni SS, Zeadally S (2020) Secure authentication and privacy-preserving techniques in Vehicular Ad-hoc NETWORKS (VANETs). *Veh Commun* 25:100247.
<https://doi.org/10.1016/j.vehcom.2020.100247>

Masrur MA, Skowronska AG, Hancock J, Kolhoff SW, McGrew DZ, Vandiver JC, Gatherer J (2017) Military-based vehicle-to-grid and vehicle-to-vehicle microgrid—system architecture and

implementation. IEEE Trans Transp Electrif 4:157–171. <https://doi.org/10.1109/TTE.2017.2779268>

Naja A, Boulmalf M, Essaaidi M (2018) Performance analysis of an improved probability-based and counter-based broadcast protocols for VANETs. In: Proceedings of 2017 international conference on electro information technology ICEIT 2017, pp 1–5. <https://doi.org/10.1109/EITech.2017.8255270>

Naja A, Boulmalf M, Essaaidi M (2019) Toward a new broadcasting protocol to disseminate safety messages in VANET. In: Advances in science, technology and innovation. Springer. https://doi.org/10.1007/978-3-030-05276-8_18

Najafzadeh S, Ithnin NB, Abd Razak S (2014) Broadcasting in connected and fragmented vehicular ad hoc networks. Int J Veh Technol. <https://doi.org/10.1155/2014/969076>

Nakagami M (1960) The m-distribution, a general formula of intensity distribution of rapid fading. In: Hoffman WG (ed) Statistical Methods in Radio Wave Propagation, Pergamon, pp 3–36. <https://doi.org/10.1016/B978-0-08-009306-2.50005-4>

Nguyen VD, Hong CS (2017) An efficient multi-channel MAC protocol for vehicular Ad hoc networks. In: Lecture notes in electrical engineering 415 LNEE, pp 822–830.

https://doi.org/10.1007/978-3-319-50904-4_83

Qin H, Yu C (2017) A road network connectivity aware routing protocol for vehicular ad hoc networks. In: 2017 IEEE international conference on vehicular electronics and safety, ICVES, pp 57–62. <https://doi.org/10.1109/ICVES.2017.7991901>

Sanguesa JA, Fogue M, Garrido P, Martinez FJ, Cano JC, Calafate CT (2016) A survey and comparative study of broadcast warning message dissemination schemes for VANETs. Mob Inf Syst. <https://doi.org/10.1155/2016/8714142>

Selvi M, Ramakrishnan B (2020) Lion optimization algorithm (LOA)-based reliable emergency message broadcasting system in VANET. Soft Comput 24:10415–10432. <https://doi.org/10.1007/s00500-019-04545-8>

Shieh WY, Hsu CCJ, Lin CH, Wang TH (2018) Investigation of vehicle positioning by infrared signal-direction discrimination for short-range vehicle-to-vehicle communications. IEEE Trans Veh

Technol 67:11563–11574.

<https://doi.org/10.1109/TVT.2018.2871468>

Srishti, Yadav S (2016) Execution and Analysis of Topology Based Routing Protocols in VANET. In Proceedings of the ACM Symposium on Women in Research 2016 (WIR '16). Association for Computing Machinery, New York, NY, USA, pp 87–91. <https://doi.org/10.1145/2909067.2909082>

Srivastava A, Prakash A, Tripathi R (2020) Location based routing protocols in VANET: issues and existing solutions. Veh Commun 23:100231. <https://doi.org/10.1016/j.vehcom.2020.100231>

Sulistyo S, Alam S (2018) SINR and throughput improvement for VANET using fuzzy power control. Int J Commun Syst 31:e3579. <https://doi.org/10.1002/dac.3579>

Tian D, Liu C, Duan X, Sheng Z, Ni Q, Chen M, Leung VCM (2018) A distributed position-based protocol for emergency messages broadcasting in vehicular ad hoc networks. IEEE Internet Things J 5:1218–1227. <https://doi.org/10.1109/JIOT.2018.2791627>

Ullah N, Kong X, Ning Z, Tolba A, Alrashoud M, Xia F (2020) Emergency warning messages

dissemination in vehicular social networks: a trust based scheme. Veh Commun 22:100199.

<https://doi.org/10.1016/j.vehcom.2019.100199>

Velmurugan V, Leo Manickam JM (2019) A efficient and reliable communication to reduce broadcast storms in VANET protocol. Cluster Comput 22:14099–14105. <https://doi.org/10.1007/s10586-018-2250-8>

Verma P, Singh N, Sharma M (2018) Modelling a vehicle-ID-based IEEE 802.11 OCB MAC scheme for periodic broadcast in vehicular networks. IET Commun 12:2401–2407.

<https://doi.org/10.1049/iet-com.2018.5488>

Won M, Park T, Son SH (2017) Toward mitigating phantom jam using vehicle-to-vehicle communication. IEEE Trans Intell Transp Syst 18(5):1313–1324.

<https://doi.org/10.1109/TITS.2016.2605925>

Zhang L, Orosz G (2018) Beyond-line-of-sight identification by using vehicle-to-vehicle communication. IEEE Trans Intell Transp Syst 19:1962–1972.

<https://doi.org/10.1109/TITS.2017.2747582>

Zhang H, Zhang X (2017) An adaptive control structure based fast broadcast protocol for vehicular ad hoc networks. *IEEE Commun Lett* 21:1835–1838. <https://doi.org/10.1109/LCOMM.2017.2699173>

Zhao W, Qin Y, Gao D, Foh CH, Chao HC (2017) An efficient cache strategy in information centric networking vehicle-to-vehicle scenario. *IEEE Access* 5:12657–12667. <https://doi.org/10.1109/ACCESS.2017.2714191>

Funding

This research work receives no funding from any organization.

Author information

Authors and Affiliations

Cyprus International University, Adana, Turkey

Banar Fareed

Department of Information Technology, Lebanese French University, Erbil, Iraq

Banar Fareed

Department of Electric and Electronic Engineering, Cyprus International University, Adana, Turkey

Mehmet Toycan

**Department of Computer Engineering,
Lebanese French University, Erbil, Iraq**

Amin Salih Mohammed

**Department of Software and Informatics
Engineering, Salahaddin University, Erbil,
Iraq**

Amin Salih Mohammed

Contributions

BF and MT contributed to conceptualization, formal analysis; BF was involved in methodology; BF and ASM contributed to implementation; BF, MT, and ASM were involved in validation, writing; MT contributed to supervision; All authors have read and agreed to the published version of the manuscript.

Corresponding author

Correspondence to [Banar Fareed](#).

Ethics declarations

Conflict of interest

Authors declare that no conflict of interest in publishing this article.

Additional information

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Communicated by Vicente Garcia Diaz.

Rights and permissions

[Reprints and Permissions](#)

About this article

Cite this article

Fareed, B., Toycan, M. & Mohammed, A.S. DTCR: delay time aware controlled rebroadcasting mechanism for intelligent transportation systems. *Soft Comput* **25**, 12537–12549 (2021). <https://doi.org/10.1007/s00500-021-06021-8>

Accepted	Published	Issue Date
01 July 2021	12 July 2021	September 2021

DOI

<https://doi.org/10.1007/s00500-021-06021-8>

Keywords

Vehicular ad hoc networks

Broadcasting protocols **Rebroadcasting**

Message dissemination

Intelligent transportation systems

Delay time aware controlled rebroadcasting (DTCR)

Not affiliated

SPRINGER NATURE

© 2022 Springer Nature Switzerland AG. Part of [Springer Nature](#).