Abstract

Most recent VANETs routing protocols have neither taken into consideration security aspects nor the available resources at the mobile node. In this research, a security-aware road-side routing protocol with resource estimation methodology (SRSR_RE) for VANETs in a segmented road topology was proposed. The proposed algorithm was modelled by a distributed multi-agent system and to be installed at each road-side base-unit (RSU). The algorithm combines a congestion control unit that adopts a resource estimation mechanism with a secure-route discovery scheme. By such combination, both security and quality-of-service (QoS) requirements are guaranteed, and thus making our VANET robust against security threats besides protecting it from being congested. Compared to the insecure road-side (IRSR) and secure road-side (SRSR) protocols, extensive simulation results show the highest capability of the proposed protocol (SRSR_RE) in maximizing the secure delivery of the data packets and minimizing the end-to-end delays for VANETs with different network’s factors such as nodes density, number of malicious nodes and node’s buffer size.
References

1. Z. C. Taysi and A.G. Yavuz, "Routing Protocols for GeoNet: A Survey," IEEE Transactions on Intelligent Transportation Systems, vol.13, no.2, pp.939-954, Jun. 2012.
2. A. Bouhoute, I. Berrada, and M. El Kamili, "A formal model of human driving behavior in vehicular networks," International Conference on Wireless Communications and Mobile Computing (IWCMC), pp. 231-236, Aug. 2014.
3. M. J., Cobo, F. Chiclana, A. Collop, J. de Ona, and E. Herrera-Viedma, "A Bibliometric Analysis of the Intelligent Transportation Systems Research Based on Science Mapping," IEEE Transactions on Intelligent Transportation Systems, vol. 15, no. 2, pp. 901-908, Apr. 2014.
4. N. Sánchez, J. Alfonso, J. Torres, and J. M. and Menéndez, "ITS-based cooperative services development framework for improving safety of vulnerable road users," Intelligent Transport Systems, IET, vol. 7, no. 2, pp. 236-243, Jun. 2013.
5. C. Yung-Cheng and H. Nen-Fu, "An Efficient Traffic Information Forwarding Solution for Vehicle Safety Communications on Highways," IEEE Transactions on Intelligent Transportation Systems, vol. 13, no. 2, pp. 631-643, Jun. 2012.
6. M. Sood and S. Kanwar, "Clustering in MANET and VANET: A survey," International Conference on Circuits, Systems, Communication and Information Technology Applications (CSCITA), pp. 375-380, Apr. 2014.
7. H. Xu, X. Wu, H. R. Sadjadpour, and J. J. Garcia-Luna-Aceves, "A unified analysis of routing protocols in MANETs," IEEE Transactions on Communications, vol. 58, no. 3, pp. 911-922, Mar. 2010.
8. T. P. Venkatesan, P. Rajakumar, and A. Pitchaikkannu, "Overview of Proactive Routing Protocols in MANET," Fourth International Conference on Communication Systems and Network Technologies (CSNT), pp. 173-177, Apr. 2014.
9. M. K. Gulati and K. Kumar, "A review of QoS routing protocols in MANETs," International Conference on Computer Communication and Informatics (ICCCI), pp. 1-6, Jan. 2013.
10. S. Misra, S. K. Dhurandher, M. S. Obaidat, K. Verma and P. Gupta, "A Low Overhead Fault-Tolerant Routing Algorithm for Mobile Ad-Hoc Networks Based on Ant Swarm Intelligence", Simulation Modelling Practice and Theory (Elsevier), vol. 18, no. 5, pp. 637-649, 2010.
11. S. Misra, P. V. Krishna, A. Bhiwal, A. S. Chawla, B. E. Wolfinger, C. Lee, "A Learning Automata-Based Fault-Tolerant Routing Algorithm for Mobile Ad Hoc Networks", The Journal of Supercomputing (Springer), vol. 62, no. 1, pp. 4-23, Oct. 2012.
12. B. J. Oommen and S. Misra, "Fault-Tolerant Routing in Adversarial Mobile Ad Hoc Networks: An Efficient Route Estimation Scheme for Non-Stationary Environments", Telecommunication Systems (Springer), vol. 44, nos. 1-2, pp. 159-169, Jun. 2010.
13. S. Misra and D. Thomasinous, "A Simple, Least-Time, Energy-Efficient Routing Protocol with One-Level Data Aggregation for Wireless Sensor Networks", Journal of Systems and Software (Elsevier), vol. 83, no. 5, pp. 852-860, May 2010.
14. F. Zabin, S. Misra, I. Woun gang, H. Rashvand, N.-W. Ma and M. A. Ali, “REEP: A Data-Centric, Energy-Efficient and Reliable Routing Protocol for Wireless Sensor Networks”, IET Communications, vol. 2, no. 8, pp. 995-1008, 2008.
15. S. Misra, S. K. Dhurandher, M. S. Obaidat, P. Gupta, K. Verma and P. Narula, "An Ant Swarm-Inspired Energy-Aware Routing Protocol for Wireless Ad-Hoc Networks", Journal of Systems and Software (Elsevier), vol. 83, pp. 2188-2199, 2010.
16. S. Misra and G. Rajesh, "Bird Flight-Inspired Routing Protocol for Mobile Ad Hoc Networks", ACM Transactions on Autonomous and Adaptive Systems, vol. 6, no. 4, Article 25, Oct. 2011.
17. M. T. Barros, R. C. Gomes, and A. F. Costa, "A Top-down Multi-Layer Routing Architecture for Vehicular Ad-Hoc Networks," IEEE Latin America Transactions, vol. 11, no. 6, pp. 1344-1352, Dec. 2013.
18. F. Z. Bousbaa, N. Lagraa, and M. B. Yagoubi, "Novel geocast routing protocols for Safety and Comfort Applications in VANets," IEEE Globecom Workshops (GC Wkshps), pp.1308-1313, Dec. 2013.
19. F. Li and Y. Wang, "Routing in vehicular ad hoc networks: A survey," IEEE Vehicular Technology Magazine, vol. 2, no. 2, pp. 12-22, Jun. 2007.
20. H. Saleet, R. Langar, K. Naik, R. Boutaba, A. Nayak, and N. Goel, "Intersection-Based Geographical Routing Protocol for Vehicular Ad Hoc Networks: A Proposal and Analysis," IEEE Transactions on Vehicular Technology, vol. 60, no. 9, pp. 4560-4574, Nov. 2011.
21. S. Allal and S. Boudjit, "Geocast Routing Protocols for VANETs: Survey and Guidelines," Sixth International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), pp. 323-328, Jul. 2012.
22. C. Barba, L. Aguilar, and M. Aguilar, "Design and evaluation of GBSR-B, an improvement of GPSR for VANETs," IEEE Latin America Transactions, vol. 11, no. 4, pp. 1083-1089, Jun. 2013.
23. N. Kumar, S. Misra and M. S. Obaidat, "Collaborative Learning Automata-Based Routing for Rescue Operations in Dense Urban Regions Using Vehicular Sensor Networks," in IEEE Systems Journal, vol. 9, no. 3, pp. 1081-1090, Sept. 2015.
24. K. Pandey, S.K., Raina, and R.S. Raw, “Distance and direction-based location aided multi-hop routing protocol for vehicular ad-hoc networks”, Int. J. Communication Networks and Distributed Systems, vol. 16, no. 1, pp.71–98, 2016.
25. J. T. Isaac, S. Zeadally, and J. S. Camara, “Security attacks and solutions for vehicular ad hoc networks,” IET Communications, vol. 4, no. 7, pp. 894-903, Apr. 2010.
26. S. S. Tangade and S. S. Manvi, “A survey on attacks, security and trust management solutions in VANETs,” Fourth International Conference on Computing, Communications and Networking Technologies (ICCCNT), pp.1-6, Jul. 2013.
27. S. K. Dhurandher, M. S. Obaidat, A. Jaiswal, A. Tiwari, and A. Tyagi, “Vehicular Security Through Reputation and Plausibility Checks,” IEEE Systems Journal, vol. 8, no. 2, pp. 384-394, Jun. 2014.
28. M. Rajeswari, P. U. Maheswari, S. Bhuvaneshwari, and S. Gowri, “Performance analysis of AODV, DSR, TORA and OLSR to achieve group communication in MANET,” Fourth International Conference on Advanced Computing (iCoAC), pp.1-8, Dec. 2012.
29. T. Bouali, E. Aglzim, and S. Senouci, “A secure intersection-based routing protocol for data collection in urban vehicular networks,” IEEE Global Communications Conference (GLOBECOM), pp.82-87, Dec. 2014.
30. M. Pura, B. Ion, and V. Patriciu, “On modeling and formally verifying secure explicit on-demand ad hoc routing protocols,” International Conference on Software Technology and Engineering (ICSTE), vol. 2, pp. 215-220, Oct. 2010.
31. W. Xi, S. Liu, H. Zhu, Y. Zhao, and C. Lei, “Modeling and Verifying the Ariadne Protocol Using CSP,” IEEE International Conference and Workshops on Engineering of Computer Based Systems (ECBS), pp.24-32, Apr. 2012.
32. J. Toutouh, J. Garcia-Nieto, and E. Alba, "Intelligent OLSR Routing Protocol Optimization for VANETs," IEEE Transactions on Vehicular Technology, vol. 61, no. 4, pp. 1884-1894, May 2012.
33. S. Misra, P. V. Krishna, K. I. Abraham, N. Sasikumar and S. Fredun, “An Adaptive Learning Routing Protocol for the Prevention of Distributed Denial of Service Attacks in Wireless Mesh Networks”, Computers & Mathematics with Applications (Elsevier), vol. 60, no. 2, pp. 294-306, 2010.
34. P. Narula, S. K. Dhurandher, S. Misra and I. Woungang, “Security in Mobile Ad-Hoc Networks Using Soft Encryption and Trust-Based Multi-Path Routing”, Computer Communications (Elsevier), vol. 31, no. 4, pp. 760-769, 2008.
35. N. Al-Oudat and G. Manimaran. “Task scheduling in heterogeneous distributed systems with security and QoS requirements”, Int. J. Communication Networks and Distributed Systems, vol. 9, nos. 1/2, pp.21–36, 2012.
36. S. L. Spitler and D. C. Lee, "Integration of Explicit Effective-Bandwidth-Based QoS Routing with Best-Effort Routing," IEEE/ACM Transactions on Networking, vol. 16, no. 4, pp. 957-969, Aug. 2008.
37. M. Saleh and L. Dong," Real-time scheduling with security enhancement for packet switched networks," IEEE Transactions on Network and Service Management, vol. 10, no. 3, pp. 271-285, Sep. 2013.
38. M. Saleh, A. Aljaafreh, and N. Al-Oudat, "Secure Route Selection Based on Resource Estimation Methodology using Agent-Based Systems for Limited Resources WSNs," 9th International Conference on Computer Engineering and Applications, pp. 423-428, Feb. 2015.
39. M. Shah, V. Soni, H. Shah and M. Desai, "TCP/IP network protocols — Security threats, flaws and defense methods,"3rd International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, India, pp. 2693-2699, Mar. 2016.

Index Terms

Computer Science  Security

Keywords

Keywords Routing, Security, Agents, Distributed Systems, VANETs, QoS, Resource Estimation, ITS, Road Segmentation, Security Threats.