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Ahmed, Z.E.[a] [b] , Hashim, A.A.[b] , Saeed, R.A.[c] , Saeed, M.M.[d]

Enhancing Smart City Mobility Using Software Defined Networks
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[a] University of Gezira, Department of Computer Engineering, Sudan

[b] International Islamic University Malaysia, Department of Electrical and Computer Engineering, Malaysia

[c] School of Electronic Engineering, Sudan University of Science and Technology, Khartoum, Sudan

[d] University of Modern Sciences (UMS), Faculty of Engineering, Department of Communications and Electronics Engineering, Yemen

Abstract
Smart cities face challenges in mobility management, such as scalability, latency, resource allocation, security, and energy efficiency, which traditional methods struggle to address effectively. Software Defined Networking (SDN) is a rapidly evolving field that provides centralized control and programmability of network devices. SDN-based MM can advance sustainable urban development by centralizing control, adapting to changes, optimizing resource allocation, reducing energy consumption, and improving urban mobility. This paper investigates SDN's role in enhancing urban sustainability and analyzes its implications for sustainable cities. The paper categorizes the use of SDN technology to improve various aspects of smart cities into three categories: Emergency Services and Traffic Management, Security and DDoS Defense, and Network Performance. Results showed a 20% reduction in average travel times and a 33% improvement in emergency response times. Future research should focus on advanced real-time traffic management algorithms, integrating emerging technologies like 6G, and artificial intelligence to improve SDN-based systems' scalability and efficiency in smart cities. © 2024 IEEE.

Author Keywords
Mobility Management (MM); Network Optimization; Smart Cities; Software Defined Networking (SDN); Urban Sustainability

Index Keywords
Energy, Mobility management, Network optimization, Resources allocation, Software defined networking, Software-defined networkings, Software-defined networks, Traffic management, Urban sustainability; Sustainable city

References

- Al-Heety, O.S., Zakaria, Z., Ismail, M., Shakir, M.M., Alani, S., Alsariera, H.
  A comprehensive survey: Benefits, services, recent works, challenges, security, and use cases for SDN-VANET
  (2020) *IEEE Access*, 8, pp. 91028-91047.

- Aljeri, N., Boukerche, A.
  Mobility management in 5G-enabled vehicular networks: Models, protocols, and classification
  (2020) *ACM Comput. Surv. (CSUR)*, 53 (5), pp. 1-35.

- Aljohani, S.L., Alenazi, M.J.
  MPResiSDN: Multipath resilient routing scheme for SDN-enabled smart cities networks
  (2021) *Applied Sciences*, 11 (4), p. 1900.

- Ahmed, Z.E.
  Mobility management enhancement in smart cities using software defined networks
  (2023) *Scientific African*, 22, p. e01932.

- Reddy, M.G.S., Sahoo, K.S.
  Software-defined industrial IoT for smart city applications

(2021) *Software-Defined Networking for Future Internet Technology*, pp. 237-253.
Apple Academic Press

- Shah, S.D.A., Gregory, M.A., Li, S., Dos Reis Fontes, R., Hou, L.
  SDNbased service mobility management in MEC-enabled 5G and beyond vehicular networks
  (2022) *IEEE Internet Things J*, 9 (15), pp. 13425-13442.

- Saeed, M.M.
  Task Reverse Offloading with Deep Reinforcement Learning in Multi-Access Edge Computing
  (2023) *2023 9th International Conference on Computer and Communication Engineering (ICCCE)*, pp. 322-327.
  Kuala Lumpur, Malaysia

- Kumar, R., Agrawal, N.
  A survey on software-defined vehicular networks (SDVNs): A security perspective
  (2023) *J. Supercomput*, 79 (8), pp. 8368-8840.

- Saeed, M.M.
  Attacks Detection in 6G Wireless Networks using Machine Learning
  (2023) *2023 9th International Conference on Computer and Communication Engineering (ICCCE)*, pp. 6-11.
  Kuala Lumpur, Malaysia

- Bagheri, N., Yousefi, S., Ferrari, G.
  Software-defined traffic light preemption for faster emergency medical service response in smart cities
  (2024) *Accident Analysis & Prevention*, 196, p. 107425.

- Alani, M.M.
  HoneyTwin: Securing Smart Cities with Machine Learning-Enabled SDN Edge and Cloud-Based Honeypots
  (2024) *J. Parallel Distrib. Comput*, p. 104866.

- Oubbati, O.S., Atiquzzaman, M., Lorenz, P., Baz, A., Alhakami, H.
  SEARCH: An SDN-enabled approach for vehicle path-planning
  (2020) *IEEE Trans. Veh. Technol*, 69 (12), pp. 14523-14536.

- Holik, F.
  Development environment for software-defined smart city networks
  (2021) *Int. Conf. Intell. Technol. Appl*, pp. 93-104.
  Cham: Springer Int. Publ

- Rani, P., Sharma, R.
  Intelligent transportation system for internet of vehicles based vehicular networks for smart cities
  (2023) *Comput. Electr. Eng*, 105, p. 108543.

- Xu, C., Lin, H., Wu, Y., Guo, X., Lin, W.
  An SDNFV-based DDoS defense technology for smart cities
  (2019) *IEEE Access*, 7, pp. 137856-137874.

- Zhu, L., Karim, M.M., Sharif, K., Xu, C., Li, F.
  Traffic flow optimization for UAVs in multi-layer information-centric softwaredefined FANET
  (2022) *IEEE Trans. Veh. Technol*, 72 (2), pp. 2453-2467.

- Bawany, N.Z., Shamsi, J.A.
  SEAL: SDN based secure and agile framework for protecting smart city applications from DDoS attacks
  (2019) *J. Netw. Comput. Appl*, 145, p. 102381.

- El-Garoui, L., Pierre, S., Chamberland, S.
  A new SDN-based routing protocol for improving delay in smart city environments
  (2020) *Smart Cities*, 3 (3), pp. 1004-1021.

- Rego, Garcia, L., Sendra, S., Lloret, J.
  Software Defined Networkbased control system for an efficient traffic management for emergency situations in smart cities
  (2018) *Future Gener. Comput. Syst*, 88, pp. 243-253.

- Raja, G., Dhanasekaran, P., Anbalagan, S., Ganapathisubramaniyan, A., Bashir, A.K.
  SDN-enabled traffic alert system for IoV in smart cities
  (2020) *Proc. IEEE INFOCOM 2020-IEEE Conf. Comput. Commun. Workshops (INFOCOM WKSHPS)*, pp. 1093-1098.
  Jul

- Kurungadan, B., Abdrabou, A.
  Using software-defined networking for data traffic control in smart cities with WiFi coverage
  (2022) *Symmetry*, 14 (10), p. 2053.

- Singh, P.K., Sharma, S., Nandi, S.K., Nandi, S.
  Multipath TCP for V2I communication in SDN controlled small cell deployment of smart city
  (2019) *Veh. Commun*, 15, pp. 1-15.

- Ahmed, Z.E.
  TinyML network applications for smart cities
  (2024) *TinyML for Edge Intelligence in IoT and LPWAN Networks*, pp. 423-451.
  Academic Press

- Kuna, K.
  Self-organizing Algorithm for Fairness in Joint Admission and Power Control for Cognitive Radio Cellular Network
  (2023) *Sustainability Challenges and Delivering Practical Engineering Solutions. Advances in Science, Technology & Innovation*,
  In: Salih, G.H.A., Saeed, R.A. (eds), Springer, Cham

- Ahmed, S.A.
  Algorithms Optimization for Intelligent IoV Applications
  (2021) *Handbook of Research on Innovations and Applications of AI, IoT, and Cognitive Technologies*, pp. 1-25.
  edited by Zhao, Jingyuan, and V. Vinoth Kumar, Hershey, PA: IGI Global

- Mona, B.H.
  Machine Learning for Industrial IoT Systems
  (2021) *Handbook of Research on Innovations and Applications of AI, IoT, and Cognitive Technologies*, pp. 336-358.
  edited by Zhao, Jingyuan, and V. Vinoth Kumar, Hershey, PA: IGI Global

- Elfatih, N.M., Ali, E.S., Abdelhaq, M., Alsaqour, R., Saeed, R.A.
  A double threshold energy detection-based neural network for cognitive radio networks
  (2023) *Computer Systems Science and Engineering*, 45 (1), pp. 329-342.

- Nurelmadina, N., Kamrul Hasan, M., Mamon, I., Saeed, R.A., Akram, K., Ariffin, Z., Sayed Ali, E., Arif Hassan, Md.
  A Systematic Review on Cognitive Radio in Low Power Wide Area Network for Industrial IoT Applications
  (2021) *MDPI, Sustainability*,

- Mokhtar, R.
  Study on Energy Detection-based Cooperative Sensing in Cognitive Radio Networks
  (2013) *Journal of Networks (JNW, ISSN 1796-2056)*, 8 (6), pp. 1255-1261.
  June

- Elnaim, A.A.
  Energy Consumption for Cognitive Radio Network Enabled Multi-Access Edge Computing
  (2023) *2023 3rd International Conference on Emerging Smart Technologies and Applications (eSmarTA)*, pp. 1-5.
  Taiz, Yemen

- Saeed, R.A.
  Cognitive Radio Systems and Advanced Spectrum Management-Tutorial
  (2009) *The 5th international conference SETIT 2009: Sciences of Electronic, Technologies of Information and Telecommunications*,
  Tunisia, 22 to 26 March

- Mokhtar, R.A., Khatun, S., Ali, B.M., Saeed, R.A.
  Cognitive Radio Technology for Flexible Spectrum Sharing
  (2006) *4th Student Conference on Research and Development, 2006. IEEE SCOReD 2006. 4th Student Conference on Volume*, 27-28, pp. 44-48.
  June

- Amitava, M.
  Fault Tracking Framework for Software-Defined Networking (SDN)
  (2017) *Resource Allocation in Next-Generation Broadband Wireless Access Networks*, pp. 247-272.
  edited by Singhal, Chetna, and Swades De, Hershey, PA: IGI Global