

CONGESTION CONTROL AND EVENT BASED DATA ANALYSIS IN SDN USING D-ITG FOR SMART HEALTH CARE SYSTEM

Yastoor Ul Haq¹, Shahid Latif², Arif Khursheed³, Abdul Rauf⁴

^{1,2,3,4}Department of Computer and Information Technology, Sarhad University of Science & Information Technology, Peshawar, Pakistan

¹yastoorulhaq91@gmail.com, ²shahid.csit@suit.edu.pk, ³arifcst@hotmail.com, ⁴raouf2pk@gmail.com

DOI: <https://doi.org/10.5281/zenodo.18753106>

Keywords

SDN, WBAN, Health Monitoring, Packet-Level Classification

Article History

Received: 25 December 2025

Accepted: 09 February 2026

Published: 24 February 2026

Copyright @Author

Corresponding Author: *

Shahid Latif

Abstract

BACKGROUND: With the vast heterogenic traffic and distributed control of the forwarding devices of the conventional network, it is difficult to efficiently cope with the management of the network. It is a distributed view of control that causes progressive paradigm shift of network management. Thus, there is a centralized developed paradigm called SDN. SDN is essentially decoupling Control and management plane with the data plane. s. These aircrafts interface with each other through typical interfaces principally southbound and northbound.

OBJECTIVE: With health monitoring distributed applications there are sort of critical or emergency and normal patient data packets transmission. The proposed research study is the synthesis of both WBAN and SDN in practice whereby the classification is done by performing granular monitoring of each data packet level.

METHODOLOGY: The sources of the production packets that carry health information and deliver the inputs at controller are sensor to make alternation of flow rule entries installation instantaneously whenever failure or link congestion effects occur so that emergency event occurrence is provided at health server.

RESULT and CONCLUSION: Performance measurements in experimental evaluation are controller overhead in configuration in terms of normal and critical traffic, end to end delay and control transmission overhead. The interim of all the performance parameters indicated that our simulation was good.

INTRODUCTION

Internet of Things (IoT) is a technological structure whereby smart objects and devices are connected with the Internet and act independently with minimal or no human intervention [1]. The technology finds itself in many areas of life such as the smart energy systems, intelligent healthcare services, and automated traffic management amongst others. The unceasing growth of IoT applications poses very large proportions of data traffic that puts the traditional networking protocols under severe challenges that are not designed to effectively handle such massive communication [1]. Recent works in the field of failure protection and recovery

mechanisms have been revitalized by the increased use of cloud service models as well as the advent of the Software-Defined Networking (SDN) paradigm to ensure reliable service provisioning to network consumers[2].

The management of the massive traffic created by billions of devices is one of the problems of IoT. To resolve the issue, Software-Defined Networking (SDN) is a new method in networking that isolates the control mechanism and the data forwarding plane. Therefore, makes network management easier. The control plane has a role of preparing the flow tables and sending it to the data plane which serves

as forwarding device. The SDN may be applied to control the IoT data produced by billions of devices [3]. A Wireless Body Area Network (WBAN) is a collection of sensors attached to or located inside the human body to measure and record numerous physiological health indicators. The health parameters are sent to the PDA which serves as a gateway and the data is sent to the cloud where medical professional will track the health of the patients [4].

The given study is important as it is aimed at modeling the types of specialized data that are produced by smart healthcare systems and processing the data using Software Defined Networking (SDN). The suggested solution is meant to maximize the congestion control measures in the network. The results of this study will facilitate the smart healthcare environments by enhancing the efficiency of data, reliability, and general performance of the network.

The remainder of the paper is structured in the following way. Section II explains the proposed methodology in detail, the system model and assumptions and the research framework in general. Section III gives the experimental setup and states the results that were received through performance analysis and assessment. Section IV is going to thoroughly discuss the results comparing them with other studies and outline the main findings and implications of the proposed work. Section V wraps up the paper by giving a summary of the key contributions and findings of the study, and possible future research directions. Lastly, Section VI contains the references mentioned in the paper. Section

II :METHODOLOGY

Problem Formulation and Proposed Mechanism

We present a proposal of the solution to the WBAN network based on a centralized SDN paradigm with

out-of-band communication model and flow installation in response. The strategy is meant to support the health sector by effectively controlling the network traffic.

2.1 Bootstrapping

OpenFlow messages are redirected between the switches and the controller when the network is started up so as to get a network-wide view. Switches do not initially know how to route in the reactive flow installation mode, but periodically the controller transmits Feature-Request messages and switches respond with Feature-Reply messages, and give their capabilities. Each time a data packet (PacketIn) is received the switch examines its flow table. In case of a match, the packet is sent out, otherwise, the controller calculates the necessary action. The controller implements network reachability policies - dropped denied flows or primary paths on accepted flows. The controller also relies on link-layer discovery protocols (LLDP between direct links and BDDP between devices in the same domain) to keep the network topology current.

2.2 Controller Event Composition Using Graph Theory

The network components (controllers, switches, sensors) are represented as a graph: $G=(V, E)$. E = edges (relationships between nodes, switches, controllers, with time of joining/leaving network) and V =MAC,IP, sensor connected, local sensor controller connected, time in network, event on addition or deletion).

The controller issues events and optimizes routing paths with the help of a hash-based structure and the use of the communication that is secured with the help of the SSL.

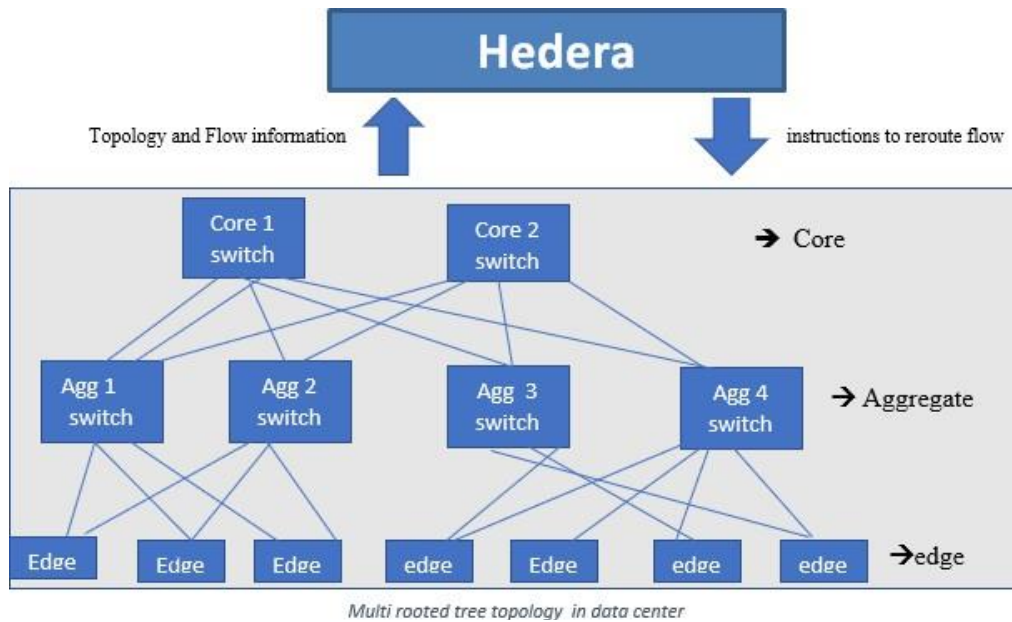


Figure 1- Hedera concerned Topology for rerouting and management

2.3 Another Path Calculation for Serious Sensor Traffic

In the case of critical sensor traffic, the controller calculates an alternative route that does not use switches being used by current flows. This guarantees the speedy transmission to the healthcare server to monitor patients in real-time. The flow rules are installed by the controller with the help of the OpenFlow OFPFCADD command. It synchronizes with the fields like the type of packet (dltype), protocol (nwproto), the source IP address (nwsrc) and the destination IP address (nw_dst), and controls priority and the time-out in order to control the flow effectively.

2.4 Tools and Performance Evaluation

The WBAN network was simulated with Mininet 2.2 EEL, which allows POX controller to perform control functions. The scene was executed with a Core i5 (HP 450 G5, 8 GB RAM, Ubuntu Linux). It consisted of 25 sensors and 10 OpenFlow switches in the network, and the controller controlled the flow rules and reachability. The controller overhead (time to compute paths) and average end-to-end delay (time to packet travel) and control traffic transmission (number of control packets to set up a flow) were used as performance metrics. These parameters assist to measure the data as well as the control plane efficiency in real time monitoring of patients.

SECTION III

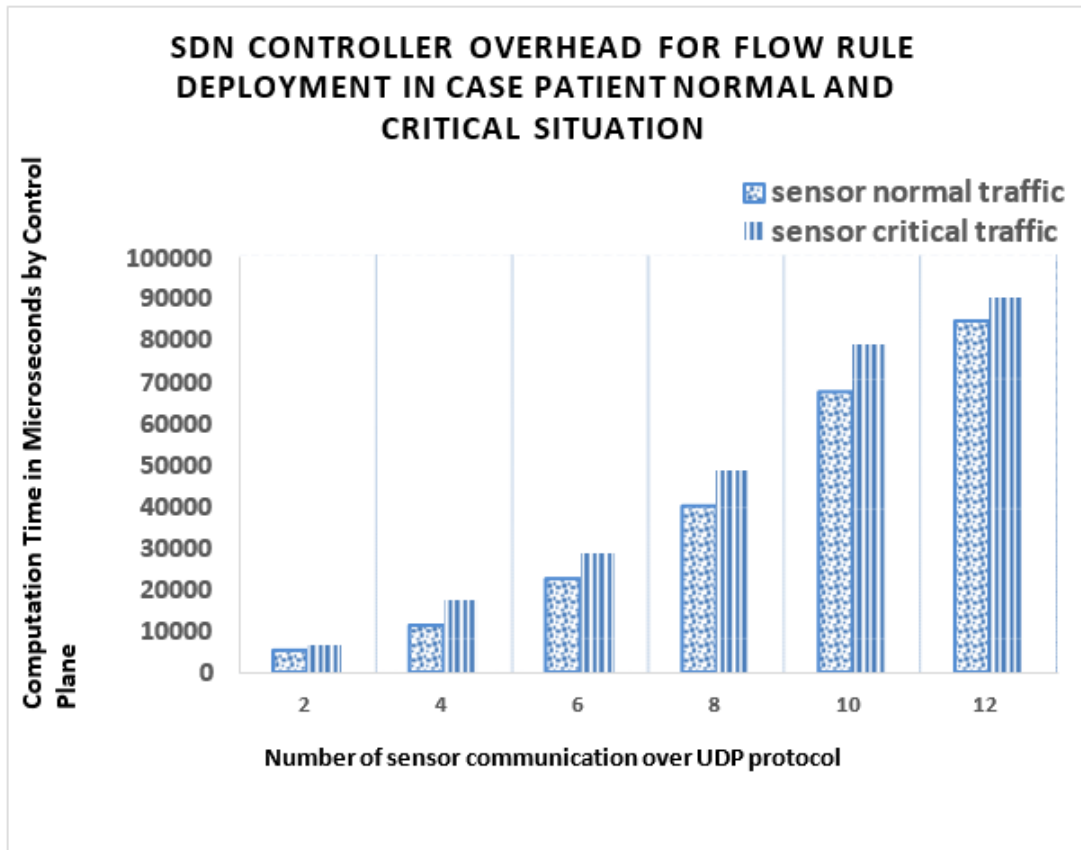


Figure 2-Controller Overhead for flow rule installation in SDN WBAN network

RESULT

Figure 2 will show the SDN controller time spent in analyzing the path between the source and the destination and installing the flow rule entries across all the devices on the path. It is illustrated that the

overhead of critical sensor traffic is a bit high in micro seconds. Rational behind this is of controller involvement of alternate path finding of the instant sensor packet delivery to the network health serve.

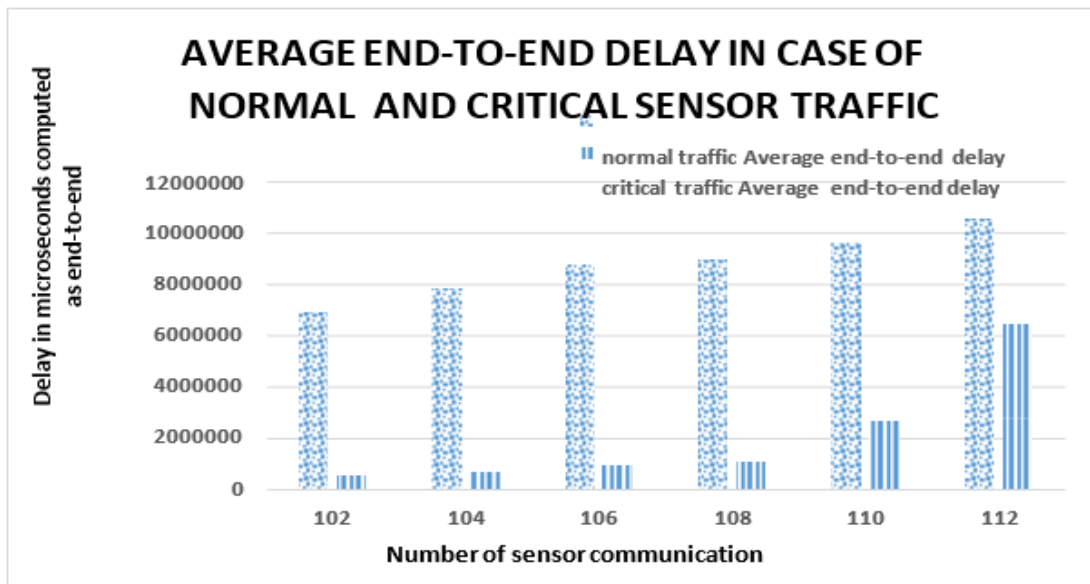


Figure 3-Average packet delay form sensor to Health server

The mean time taken by packets between sensors and health server is indicated in Figure 3. The findings show that critical data packet has lesser delay compared to normal packets, since priority-

based routing and alternative route selection by the SDN controller make the emergency health data to get delivered timely.

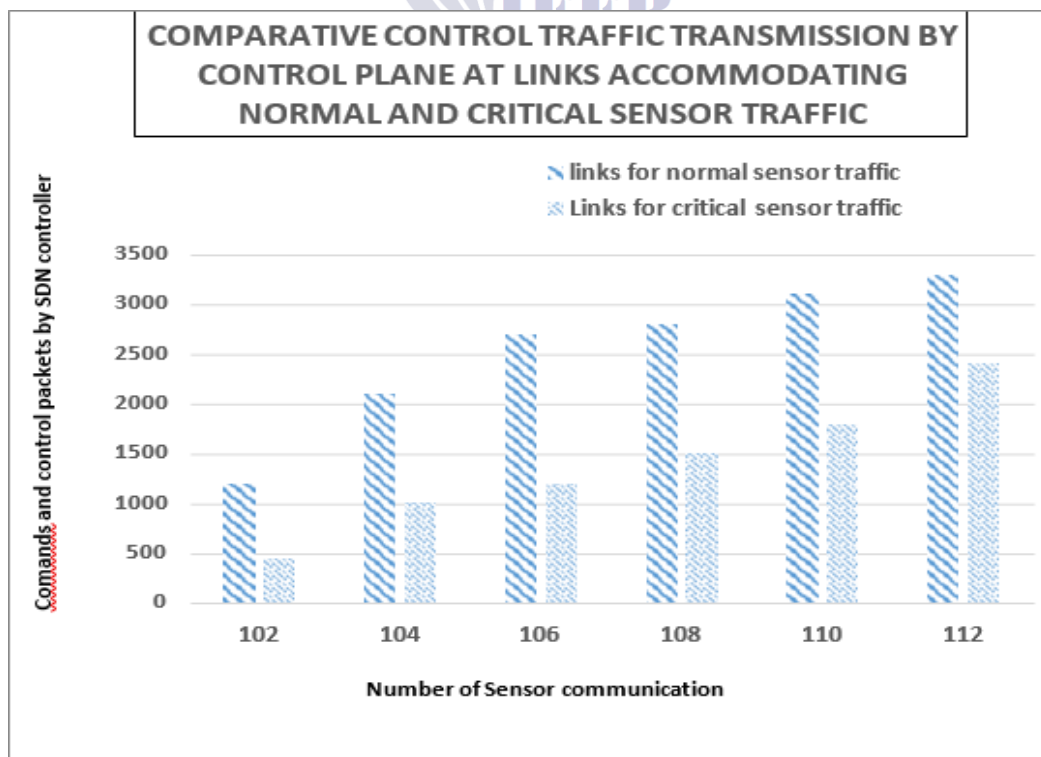


Figure 4-OpenFlow traffic for normal and critical data packets

Normal and critical packets generated Open Flow control traffic are shown in figure 4. Critical traffic generates greater control overhead due to the proactive installation of priority flow rules and the calculation of alternate paths permitted to efficiently deal with emergency events by the controller.

Section IV: DISCUSSION

This paper has shown that SDN implementation in combination with WBAN plays a considerable role in alleviating congestion and quality of services in smart healthcare systems. The findings indicate that the delay of important health information is reduced by priority-based routing and the use of dynamic flow rules, which justify previous research studies stating that traffic classification and the QoS is necessary in WBAN and IoT-based healthcare systems [58].

The results are correlated with the studies on dynamic priority-based packet management and SDN multipath routing, which identified a decrease in

latency and a consistent provision of sensitive medical information with the help of a centralized control and the choice of alternative paths [9, 10]. The higher rate of controller and OpenFlow overheads in this research paper are related to these sources and will not be a problem in emergency healthcare.

Nonetheless, researches with an emphasis on wearable sensors, WBAN hardware design, and wearable sensors monitoring prototypes [11,12] do not deal with network-level congestion and traffic prioritization completely, thus, are partially supported by this research. Equally, the classic centralized architecture and verification processes [13, 14] enhance policy compliance and accuracy, however, there is no direct policy optimization of emergency data delivery.

In general, the findings substantiate the necessity of SDN-based traffic prioritization to facilitate effective and reliable healthcare monitoring and sensor-based or conventional networking mechanisms will not be sufficient to manage important medical information in massive smart healthcare systems.

Section V :

CONCLUSIONS

Our proposed work is an efficient SDN and health monitoring interoperability. One of the new contributions is A health unit network management through SDN state-of-art configuration model which helps in timely emergency call. Our prototype will be a contribution to further network management improvement in health monitoring cell and proactive network management plan is an area of our team work scaled health unit. In the evaluation of the research work, it is stated that SDN enabled health caring units are able to align a patient critical data very time-consciously in order to save a single patient.

Section VI : REFERENCES

- A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash, "Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications," IEEE Communications Surveys & Tutorials, vol. 17, no. 4, pp. 2347-2376, 2018.
- Velasco, L., & Rafique, D. (2019, March). Fault Management Based on Machine Learning. In Optical Fiber Communication Conference (pp. W3G-3). Optical Society of America
- S. K. Tayyaba, M. A. Shah, O. A. Khan, and A. W. Ahmed, "Software Defined Network (SDN) Based Internet of Things (IoT): A Road Ahead," presented at the Proceedings of the International Conference on Future Networks and Distributed Systems, Cambridge, United Kingdom, 2017.
- J. Gómez, B. Oviedo, and E. Zhuma, "Patient Monitoring System Based on Internet of Things," Procedia Computer Science, vol. 83, pp. 90-97, 2016/01/01/ 2016.
- Ullah S, Higgins H, Braem B, Latre B, Blondia C, Moerman I, Saleem S, Rahman Z, Kwak KS. A comprehensive survey of wireless body area networks. Journal of medical systems. (2012)

- M. Hämäläinen and X. Li, "Recent Advances in Body Area Network Technology and Applications," *International Journal of Wireless Information Networks*, journal article vol. 24, no. 2, pp. 63-64, June 01 2017.
- Sallabi, F., Naeem, F., Awad, M., & Shuaib, K. (2018, June). Managing IoT-Based Smart Healthcare Systems Traffic with Software Defined Networks. In 2018 International Symposium on Networks, Computers and Communications (ISNCC) (pp. 1-6). IEEE
- Salsano, S., Blefari-Melazzi, N., Detti, A., Morabito, G., & Veltri, L. (2013). Information centric networking over SDN and OpenFlow: Architectural aspects and experiments on the OFELIA testbed. *Computer Networks*, 57(16), 3207-3221. (2014, August)
- Papadimitratos, P., Fortelle, A. L., Evenssen, K., Brignolo, R., & Cosenza, S. Vehicular communication systems: Enabling technologies, applications, and future outlook on intelligent transportation. *IEEE communications magazine*, 47(11), 84-95. (2009).
- Venkatesh, K., Srinivas, L. N. B., Krishnan, M. M., & Shanthini, A. (2019). QoS improvisation of delay sensitive communication using SDN based multipath routing for medical applications. *Future Generation Computer Systems*, 93, 256-265.
- Jovanov, E., Milenkovic, A., Otto, C., & De Groen, P. C.. A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation. *Journal of NeuroEngineering and rehabilitation*, 2(1), 6. (2005)
- Anwar, M. W., Azam, F., Khan, M. A., & Butt, W. H. (2019, March). The Applications of Model Driven Architecture (MDA) in Wireless Sensor Networks (WSN): Techniques and Tools. In *Future of Information and Communication Conference* (pp. 14-27). Springer, Cham.
- Reference: Casado, M., Freedman, M. J., Pettit, J., Luo, J., McKeown, N., & Shenker, S. (2007, August). Ethane: Taking control of the enterprise. In *ACM SIGCOMM Computer Communication Review* (Vol. 37, No. 4, pp. 1-12). ACM.

