Chapter 26
Transport Protocol Performance for Multi-Hop Transmission in Wireless Sensor Network (WSN)

Farizah Yunus
Universiti Teknologi Malaysia, Malaysia

S. K. Syed-Yusof
Universiti Teknologi Malaysia, Malaysia

Sharifah H. S. Ariffin
Universiti Teknologi Malaysia, Malaysia

Nor-Syahidatul N. Ismail
Universiti Teknologi Malaysia, Malaysia

Norsheila Fisal
Universiti Teknologi Malaysia, Malaysia

ABSTRACT

The need for reliable data delivery at the transport layer for video transmission over IEEE 802.15.4 Wireless Sensor Networks (WSNs) has attracted great attention from the research community due to the applicability of multimedia transmission for many applications. The IEEE 802.15.4 standard is designed to transmit data within a network at a low rate and a short distance. However, the characteristics of WSNs such as dense deployment, limited processing ability, memory, and power supply provide unique challenges to transport protocol designers. Additionally, multimedia applications add further challenges such as requiring large bandwidth, large memory, and high data rate. This chapter discusses the challenges and evaluates the feasibility of transmitting data over an IEEE 802.15.4 network for different transport protocols. The analysis result highlights the comparison of standard transport protocols, namely User Datagram Protocol (UDP), Transport Control Protocol (TCP), and Stream Control Transmission Protocol (SCTP). The performance metrics are analyzed in terms of the packet delivery ratio, energy consumption, and end-to-end delay. Based on the study and analysis that has been done, the standard transport protocol can be modified and improved for multimedia data transmission in WSN. As a conclusion, SCTP shows significant improvement up to 18.635% and 40.19% for delivery ratio compared to TCP and UDP, respectively.

INTRODUCTION

In the last few years, *Wireless Sensor Networks (WSNs)* have raised a lot of attention of the research community such as the industry and the academic communities. *WSNs are multi-hop* networks that deploy hundreds or thousands of small sensor nodes with limited capabilities in term of power resources, processing and memory. Due to these limitations, *IEEE 802.15.4* standard represents a milestone in wireless sensor network. *IEEE 802.15.4* is a data communication protocol standard uniquely designed for low rate wireless personal area network (WPAN) (Adams, 2006). However, the issues of *multi-hop* communication and energy efficiency in WSN have imposed many challenges and need further specific research effort.

Typically, sensor nodes in *WSNs* have severe constraints in energy resources, processing ability and memory resources. The reason of these constraints is because of the effort to reduce the cost of the sensor node (Ai & Abouzeid, 2006). Furthermore, one of the characteristics of *WSNs* is the dense deployment, which is to increase the sensing coverage, connectivity and network lifetime (Costa & Guedes, 2010). But this characteristic limits the range of wireless communication because of energy constraint and thus, the transmission and processing function also needs to be controlled. Then, the *multi-hop* communication model is required to solve the problem of limited communication ranges by transmitting the data to the sink node using intermediate transmission nodes. Moreover, the WSNs communication protocol cannot fully apply buffering techniques due to the constraints on memory and processing. All of these constraints are crucial and need to be considered during designing a new protocol especially for multimedia applications, which involves the transmission of high traffic volume such as video.

There is an additional challenge imposed on multimedia transmission over WSNs, which is requiring a large bandwidth. This is due to the fact that *IEEE 802.15.4* standard is concerned with low data rate applications. The maximum allowable data rate in the *IEEE 802.15.4* standard is 250 Kbps with the *Maximum Transmission Unit* (MTU) for data transmission up to 128 bytes (Garcia-Sanchez, Garcia-Sanchez, & Garcia-Haro, 2008) compared to the IEEE 802.11 standard that offers data rates of several Mbps with *Maximum Transmission Unit* (MTU) up to 1500 bytes. For that reason, video transmission over IEEE 802.15.4 standard is more challenging, and should be given special attention due to its nature. The goal is hence to achieve video transfer over low complexity and cost networks at a satisfactory level of quality in terms of Peak Signal to Noise Ratio (PSNR) at the receiver side.

In **WSNs**, a communication protocol stack provides similar functionalities to those of the conventional computer network protocol stack. However, the earlier is designed to operate in a more dynamic environment (Zahariadis & Voliotis, 2007). This communication protocol stack consists of 5 layers which are application, transport, network, Medium Access Control (MAC) and physical layers as shown in Figure 1.

Nevertheless, this chapter is mainly concerned with the *transport protocol* provided by the transport layer and responsible to ensure end-to-end reliable data transfer from source to destination. The WSNs *transport protocol* is mainly designed to support congestion control, guaranteed end-to-end reliability or both services either for scalar data or multimedia applications. The reliable data delivery mechanism for multimedia applications will ensure reliability for packet level or application level in order to achieve significant energy consumption reduction with low end-to-end delay in congested scenario (Bonivento & Fischione, 2007). On the other hand, the congestion control

Related Content

Challenges and Advantages of Implementing Blockchain Internet of Medical Things (B-IoMT) in 6G Networks

Murugan K., Somasundaram R., Mythili Thirugnanam, Pousia S.and Sakthi U. (2022). *Handbook of Research on Design, Deployment, Automation, and Testing Strategies for 6G Mobile Core Network (pp. 248-265).*

www.irma-international.org/chapter/challenges-and-advantages-of-implementing-blockchain-internet-of-medical-things-b-iomt-in-6g-networks/302189

Wireless Interference Analysis for Home IoT Security Vulnerability Detection

Alexander McDaid, Eoghan Fureyand Kevin Curran (2021). *International Journal of Wireless Networks and Broadband Technologies (pp. 55-77).*

www.irma-international.org/article/wireless-interference-analysis-for-home-iot-security-vulnerability-detection/282473

A Resource-Efficient Approach on User Association in 5G Networks Using Downlink and Uplink Decoupling

Christos Bouras, Vasileios Kokkinosand Evangelos Michos (2020). *International Journal of Wireless Networks and Broadband Technologies (pp. 43-59).*

www.irma-international.org/article/a-resource-efficient-approach-on-user-association-in-5g-networks-using-downlink-and-uplink-decoupling/257778

Enhanced Priority Load-Aware Scheduling Algorithm for Wireless Broadband Networks

Aminu Mohammed, Abdulhakeem Abdulazeezand Ahmed Tambuwal Yusuf (2020). *International Journal of Wireless Networks and Broadband Technologies (pp. 94-114).*

www.irma-international.org/article/enhanced-priority-load-aware-scheduling-algorithm-for-wireless-broadband-networks/250909

MAC and PHY-Layer Network Coding for Applications in Wireless Communications Networks

Giulio Bartoli, Francesco Chiti, Romano Fantacci, Dania Marabissiand Andrea Tassi (2012). *Developments in Wireless Network Prototyping, Design, and Deployment: Future Generations (pp. 86-108).*

www.irma-international.org/chapter/mac-phy-layer-network-coding/67006