Available Online at http://www.journalajst.com

ISSN: 0976-3376

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology
Vol. 13, Issue, 02, pp.12043-12045, February, 2022

RESEARCH ARTICLE

A COMPARISON OF FOUR SYSTEMS RELATED TO THE ROUTING PROTOCOLS OF SENSOR NETWORKS

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ARTICLE INFO

Article History:
Received 15th November, 2021
Received in revised form
18th December, 2021
Accepted 07th January, 2022
Published online 28th February, 2022

Key words:
Sensor network, WSN, Routing, Routing Protocols, Asymmetric links, LayHet, EgyHet, ProHet, Energy Consumption, Overhead, Delivery Rate, Performance, Reverse Path.

ABSTRACT

Sensor networks, both wired and wireless, are popular, sensitive, and very useful in various real-time applications and processing. Routing in sensor networks is very difficult and complex because they are asymmetric and symmetric links. This paper compares four different systems and state the various criteria such as energy consumption, asymmetry, overhead, delivery rate, performance, etc. This is not a statement of superiority.

Citation: Dipu Jose, Jose James and Ratheesh Kumar, R. 2021. "A Comparison of Four Systems related to the Routing Protocols of Sensor Networks.", *Asian Journal of Science and Technology*, 11, 04, xxxx-xxxx.

INTRODUCTION

Sensor networks are popular and very useful in real-time applications. A sensor network connects several sensors that can detect information such as heat, pressure, and motion. With the rapid expansion of sensors, sensor networks are an important part of the Internet of Things (IoT) and the modern world. Sensors are everywhere today. We have sensors on our phones, workplaces, vehicles and the environment. A sensor network consists of a set of small, powered devices and a wireless or wired network infrastructure. They document conditions in any environment, including industrial facilities, farms and hospitals. The sensor network connects to the Internet or computer networks to transfer data for analysis and use. Sensor network nodes collaborate and understand the environment. They facilitate communication between individuals or computers and the surrounding environment.

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Sensor networks can be wireless or wireless. Wired sensor networks use Ethernet cables to connect sensors. Wireless sensor networks (WSNs) use technologies such as Bluetooth, Cellular, Wi-Fi, or Near Field Communication (NFC) to connect sensors. WSNs are easy to deploy and maintain and offer excellent flexibility of equipment. With the rapid development of sensors and wireless technologies, WSNs have become an important technology for IoT. They do not need to modify the physical network infrastructure. Sensor networks usually include sensor nodes, actuator nodes, gateways, and clients. The sensor nodes are grouped within the sensor field and the networks of different topologies are formed. The following steps presents the working of sensor networks: 1) A sensor node monitors the data collected by the sensor and transmits it to other sensor nodes, 2) In the transmission process, data may handle multiple nodes when it reaches a gateway node, 3) The data is then transferred to the management node, and 4) The management node controls the user, determines the required monitoring and collects the data being monitored. There are many nodes in a sensor network. These nodes are detection stations.

There is a sensor/transducer, microcontroller, transceiver, and power source. A sensor understands the physical condition, and if something changes, it generates electrical signals. The signals go to the microcontroller for processing. A central processor sends commands to the transceiver and transfers data to a computer. The sensor is the bond of a sensor network node. Sensors include temperature sensors, accelerometers, infrared detectors, proximity sensors, and motion detectors (5). Sensor networks may work on symmetric and asymmetric links. Routing of symmetric links is simple and easy, but the routing of asymmetric links is very complex and difficult. There are several protocols for routing in sensor networks. They all have their advantages and limitations. Here, this paper presents four systems, their characteristics, merits, and limitations.

LITERATURE REVIEW AND COMPARISON: XIAO XIAO, et al (1): They suggest performance guaranteed routing protocols in asymmetric sensor networks (ASNs), where two end nodes do not use the same path to communicate with each other. ASNs are implemented by hardware equipment or the environment. Unlike most existing routing protocols in symmetry sensor networks, achieving the desired routing performance in ASNs poses significant research challenges due to asymmetry. To address these challenges, they first propose a general framework protocol called Reverse Path (RP) protocol to handle asymmetric links, and then introduce two efficient routing algorithms built into the RP to meet performance requirements. Lay Het is a performance guaranteed layer-based routing protocol that incorporates the smallest path information and saves energy by reducing the number of broadcasts and the possibility of forwarding.

Egy Het is its energy-upgraded version, which considers the residual energy of the nodes. Their simulation results show that LayHet and Egy Het can reach the desired delivery rate than they currently have, and can be surpassed in average hops, average packet replication overhead, and average control message overhead. In addition, as sensor energy decreases, the performance of Lay Het and Egy Het decreases as slower than the current one. They designed performance guaranteed routing protocols on asymmetric sensor networks that do not use the same path to communicate two end nodes. To address the difficulty caused by asymmetric links, they first proposed a general framework protocol that would find opposite paths for asymmetric links. They introduced two efficient routing algorithms, Lay Het and Egy Het, built on RP to meet performance requirements. Simulation results show that Lay Het and Egy Het can reach the desired delivery rate earlier than the existing protocol, and surpass it in the average hops, average packet replication overhead, and average control message overhead. They focused on designing efficient routing protocols at the top of the reverse path protocol RP. They believe that asymmetric links are very common in many wireless networks. In addition to spatial reasons, they may be the result of time dependence on nodes connections such as delayed networks, vehicle networks, and mobile social networks.

Pooja, et al. (2): Wireless sensor networks have received significant applications in military surveillance, health care, climate monitoring, and various civilian applications. The basic problem with wireless networks is the occurrence of unidirectional links where most existing protocols fail or operate at high overhead. They develop a new energy aware routing protocol that works well in asymmetric links. The proposed algorithm is a cluster-based protocol that groups nodes into different clusters. The cluster head is selected based on the residual energy and delivery probability of the nodes. The inverse path of unidirectional links is determined by the reverse path algorithm. Reducing energy consumption and reducing overhead can improve network performance.

Simulation results show that the proposed system has received higher delivery probability and better performance compared to the existing system. They designed an energy aware clustering protocol that could guarantee performance on asymmetric sensor networks that do not use the same path to communicate two end nodes. A reverse path protocol is used to detect the reverse path between two nodes connected by a unidirectional link, thereby utilizing an asymmetric link. The cluster head is selected based on the residual energy and the delivery probability of the nodes. The simulation results show that the proposed protocol guarantees the desired delivery rate with low energy consumption, thereby increasing network life.

Nishchita, et al. (3): Their system provides the transmission of energy efficient packets. Destination-Sequenced Distance-Vector Routing, DSDV routing protocols fail when the link fails. In the presence of unidirectional links in routing protocols on multihop wireless networks, routing performance fails in link failure and leads to multipath-fading overhead. Link-state routing on networks with unidirectional links routing protocol fails to use a lot of resources, such as energy consumption, more bandwidth usage, but less overhead. The energy-efficient communication protocol for routing protocols for wireless micro-sensor networks is energy efficient but more expensive.

ProHet routing algorithms provide guaranteed delivery rates and low overhead. Energy fails in consumption. Optimized Link State Routing Protocols for Adhoc Networks removes the frequency of the flood process, which can be a problem in networks with moderate to large packet loss rates. Performance Guaranteed Routing Protocols for Asymmetric sensor networks reduce energy-use, low overhead, and guaranteed delivery rates, and may be more efficient compared to all other routing protocols, such as when a node fails to re-route the path in the LayHet broadcast message. Routing protocols on asymmetric sensor networks that do not use the same path to communicate two end nodes and provide a performance guaranteed routing protocol.

The LayHet and EgyHet routing protocol is used to provide efficient energy and reduces energy consumption in the network. It provides a guaranteed delivery rate and reduce the overhead on the network of asymmetric sensor networks with high performance and provide excellent routing protocol for wireless sensor network. However, the performance of the routing protocol is related to the infrastructure of the network. The delay in transmission is high. Shailendra, et al. (4): They propose a Triangle Link Quality Metric and Minimum Inter-Path Interference Based Geographic Multipath Routing (TIGMR) protocol that detects multiple node-disjoint paths on the IEEE 802.15.4 compliant Wireless Multimedia Sensor Network. This cross-layer routing protocol selects a forwarding node based on a Triangle Link Quality Metric, residual energy, and distance.

Table 1. Comparison of four systems

Paper	(1) Xiao Chen, Zanxun Dai, Wenzhong Li, and Hongchi Shi, "Performance Guaranteed Routing Protocols for Asymmetric Sensor Networks", 2013	(2) Pooja Varma and Sajan Joy, "A Probabilistic Energy Efficient Routing Protocol for Asymmetric Sensor Networks", 2015	(3) Nischita Waddenkery and S.Visalini, "Energy Efficient Routing Protocols for Wireless Sensor Networks", 2015	(4) Shailendra Aswale and Vijay Ram Ghorpade, "Geographic Multipath Routing based on Triangle Link Quality Metric with Minimum Inter-path Interference for Wireless Multimedia Sensor Networks", 2021
Sensor Networks (wired or wireless?)	Wired	Wired	Wireless	Wireless
Asymmetric or symmetric?	Both	Both	Both	Both
Routing Protocols	Reverse Path, LayHet, EgyHet	Reverse Path, Cluster-based	LayHet, EgyHet, ProHet, Optimized Link State Routing Protocols, Performance Guaranteed Routing Protocols	TIGMR, TPGF, LQEAR, Multipath routing,
Energy efficient or not	Energy efficient	Energy aware		
Delay in transmission			The delay in transmission is high	
Applications				Multimedia data
Merits	1) reduces the number of broadcasts and the possibility of forwarding 2) energy efficient 3) guaranteed performance 4) desired delivery rate	1) guarantees the desired delivery rate 2) low energy consumption 3) increasing network life 4) cluster-based protocol 5) reducing overhead 6) better performance	1) reduces energy consumption 2) low overhead 3) guaranteed delivery rates	1) eliminates the Hidden Node problem 2) improves network lifetime 3) ensures high PDR 4) low end-to-end delay 5) low jitter at a reasonable energy Cost 6) Multipath routing 7) interference aware 8) Quality of Service
Demerits	slower		The delay in transmission is high	

Additionally, TIGMR protocol eliminates the Hidden Node problem (HNP) in the sink node without using the request-to-send/clear-to-send (RTS/CTS) handshake system.

Simulation results indicate that the TIGMR protocol optimizes overall performance and improves network life compared to the most advanced two-phase geographic forwarding (TPGF) and link quality and energy aware routing (LQEAR) protocols. The growing demand for WMSN in a wide variety of applications makes QoS routing an important topic in the sensor network. Multipath routing is a good solution to complete the desired level of QoS in WMSN. However, the overall performance of the network is significantly affected by the inter-path interaction effect. As a result, the cross-layer multipath QoS routing protocol introduces link quality and engagement awareness for managing multimedia data in WMSN. TIGMR detects multiple node-disjoint minimum interference paths for a single pair of source and sink. The forwarding node is selected based on a Triangle Link Quality Metric, (TILM), residual energy and distance. During the multipath exploration, TIGMR selects 1-hop sink neighbours on different paths to avoid HNP on the sink node in the 802.15.4 compliant network. TILM provides the link quality features needed to select a reliable forwarding node. Advanced simulations are performed with/without data frame retransmission. The proposed TIGMR protocol improves network life and ensures high PDR, low end-to-end delays and low relaxation at reasonable energy costs. In addition, selecting a reliable Next Hop and optimized performance of the routing protocol depends on the link quality and the intensity of the intervention.

CONCLUSION

This paper defines sensor networks and its types, reviews four systems, states their characteristics, merits, limitations, and applications, and compares them. It gives us a picture of routing in sensor networks.

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