Challenges in Wireless Sensor Networks with Different Performance Metrics in Routing Protocols

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Abstract- **The routing protocols are playing a major role in the design and proper utilization of wireless sensor networks (WSN) that overcome all the limitation of interconnection networks. The role of routing protocols is become more challenging due to the real time applications in WSNs. The long life of sensor nodes is required for efficient use routing protocols which can be possible by preserving energy. Data Centric, Hierarchical and location are the three different kinds of categories is used in the design of routing protocols which is also approaches specific. Some other challenges are spoken of as contention in which many nodes access the medium. So the clash between packets would take place in this scenario. There is no method to find out these types of the collisions in WSN. Self-interference is also one of the challenges of the sensor network which is occurred in successive hops. The problem of dynamism is in that the links failure and catch up with for several times in lesser time and qualities of links are also changed during time. There are many numbers of the parameters which handles transmission rate, transmission power, etc. The data transmission time also impacts on the energy conservation and quality-of-service (QOS) in wireless sensor network.**

I. INTRODUCTION

A wireless sensor network is controlled and restrained by the restriction of data bandwidth and high error rate of the wireless channel limits the quantity of data that can move through over such channels and the communication consistency; the restricted processing command of sensor nodes limited by their physical scope; and limited size and potential of the sensors for group of data and the value of collected data [1]. These limitations are further emphasized by limited liveliness of the batteries [2]. By minimizing the redundant information for transferring the relevant information only that is possible on low bandwidth error leads towards maximizing the processing of sensor nodes, in addition least processing within the network is required for processing power and memory [3]. However, the small cost of processing (per bit cost) as compared to communication entails minimum possible data transfer in situ with maximization of processing [2]. The amount of limited processing potential and memory controls the processing of simple operations in network. This has provided for gathering and processing simple data in wireless sensor networks practical only.

Each sensor node is illustrated by low consistency, limited memory and computational capability, limited battery power and low precision. The cumulative effect enhances the accuracy and consistency of data, in the presence of huge numbers such sensor nodes deployment over a region. Due to huge redundancy as large number of sensors, this accuracy and consistency affects and sense the similar parameters at the similar place and time. If sent to a sink from the sensor nodes, this surge of redundant data stretch collected by sensors over space and time would drain the bounded energy of sensors. It is also quite familiar that energy requirement of communication is very high as compared to computation; hence, it is crucial that only useful data be extracted from the sensed data and communicated to the sink. This would conserve the energy of the sensor nodes to make longer the network lifetime.
It can be analyzed that divergence in the nature of the network of sensor nodes and each sensor node raises some challenges that require to be addressed [1] [7].

In this matter, the first difficulty occurs due to the low consistency of a sensor node. The deployment of sensors in a different environment, a changeable and unfamiliar kind of values is sensed. It is, therefore, exceptionally complex to differentiate between normal and abnormal sensor values readings. To recognize an inconsistent node is vital in the sensor network but quite difficult. The second difficulty occurs at the network level. As declared in advance, sensors have restricted by memory, processing capacity and battery life limitation. The communication protocols and processing methods must be able to adjust to failures of each node, adapt to changing environment, ensure sensor data integrity, mine useful information by aggregating spatio-temporal data with communicate among the reliable sensor nodes, and limited resources. The third issue is related to resolve the abnormality and unwanted information in the sensed data and lastly the final problem is to handle the query requirements from the sink by sending information at a desired resolution. The rest of the paper is structured as follows. Section II illustrates the related work. The analysis of the key challenges in WSN for performance metrics in the routing protocols is describes in section III. Finally, Conclusion section is stated in Section IV.

II. RELATED WORK

The mobility based applications are quite challenging in WSNs such as monitoring of health and wildlife, search and rescue operations that demands a reliable routing protocols to improve the limitations of mobile sensor nodes. GPS enabled network also helps to assign the location of node which further reduce the delay in switching from one cluster of one to another. It also helps to improve the packet delivery ratio in the case of data transmission for existing routing protocols. Even though the routing is applied only on the nodes, but the routing on the basis of cluster heads can be quite useful in the context of fault tolerance. It will be counted for the cluster heads only to analyze the packet loss in data transmission and reduce the impact of individual mobile nodes [2].

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There are so many challenges in wireless sensor network such as Power control [5] [6], MAC, Routing, Transport. To choose the power levels of transmissions in wireless networks, It is defined on the basis of some constraints of power levels. Power level influences range and also affects the routes. Power levels determine interference. Conceptualization problem occurs for power control in three layers. First problem, Quality of reception occurs in Physical layer, then Network layer faces problem of Impact on routing and finally Transport layer struck due to higher power impacts congestion. Some of the global impact [8] also happens in Power Control. Such as Connectivity, which is global property and Clustering is regional based property. Clustering process is done. One more global impact of Routing is over network.

1. Physical Layer optimized for multi-hop wireless networking. Physical Layer restructuring has significance in terms of moving towards Route and Forward activities in physical layer, where routing is defined as to conclude which set of nodes send the packet from starting node to destination and forwarding is based on to the transport along this chosen path. The new physical layer has three structures 'Relay', 'Transmit' and 'receive'. Switching process done at physical layer itself.
2. Access to medium in network for entire path (as opposed to single hop) Path-Centric hops: In this Atomic unit of operation is equal to multiple hops. Medium Access Control is path-oriented. Packet does not have to re-complete at every hop. Harness unused resources to increase capacity of path. Cooperative Diversity is defined as "Nodes simultaneously retransmit the same packet on different channels and sets of frequencies are to be distributed over combined receivers. Reduced processing and removal of re-contending at every hop will reduce latency. Cooperative transport increases capacity. Path diversity increases path robustness.
3. Cooperative transport of packets Harness unused resources to increase capacity of path. Concept of "Cooperative Diversity" depends on nodes simultaneously retransmit the same packet on different frequencies/channels to be diversity combined at receivers. In [7], a general architecture is presented for NGNs which is shown in figure 1.

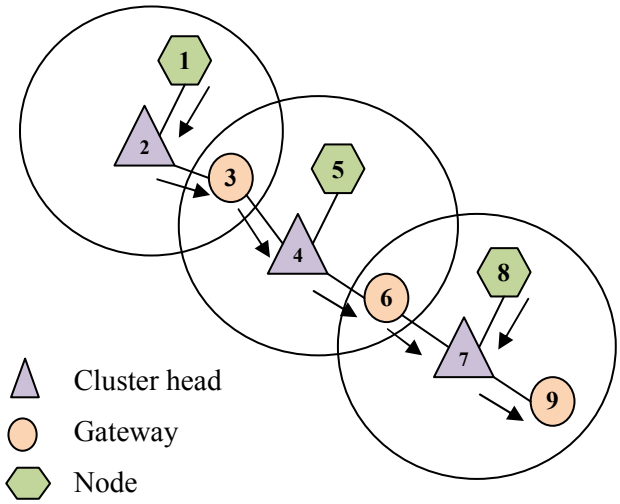

Fig.1 Block diagram of the routing using cluster head

III. PERFORMANCE METRICS BASED CHALLENGES OF ROUTING PROTOCOLS IN WSN

The important performance metrics in routing protocols that help to resolve the key challenges in WSNs are needed to address. These challenges are given in tables (1-3). The detailed description is given to consider the targeted challenges for further research work in the WSN. The performance metrics in routing protocols for key challenges in WSN are shown in figure 2 as detailed block diagram.

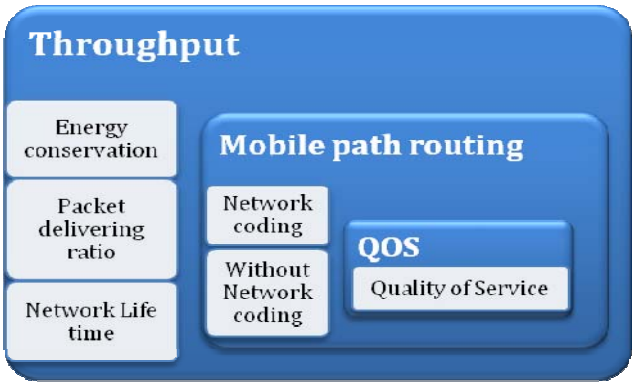

Fig.2 Block diagram of the challenges in WSN for performance metrics in routing protocols

The key factors related to the performance metric throughput and the relevant improvement in energy conservation, network life time and packet delivering are described in details with [3] [13] [7] are given in table 1. In table 2, the specific metrics is required for link-quality indication (LQI) and Received signal strength indication (RSSI), which is key factor related to the quality of service and the relevant improvement in routing protocol in reference of sending packets are illustrated [6]. In table 3, The key factor related to the performance metric multi-path routing using Network coding in routing protocol and the relevant improvement in Routing protocol are described in details [13] [14] [9].

Table 1. Performance metric throughput in Routing protocol

Performance metric in Routing protocol	Key factor	Improvement
Throughput	cross-layer operation model	The model utilizes a mechanism to restrict the neighbor discovery for broadcasting the dynamic routes only[3]
	A random linear network coding approach towards the code and data packets. The next hop link status and also the quantity of current packets on the receiving end which are sent by the upstream node together help	Even though a extended propagation delay and high bit error rate of space information networks [4].

	to determine it.	
Energy consumption	cross-layer operation model	In route discovery process, the routing operations embedded the location of the mobile nodes. To adjust the transmission range of the node, it is further utilized by the MAC layer for controlling the transmission power. It helps to decrease the energy consumption of the node(s) which is possible due to the minimize power utilization of the network interface [3]
	Two different kinds of strategies such as flooding delaying and hop penalty are utilized by Energy-efficient Survivable Routing Protocol (ESRP).	The simulation outcomes demonstrate that the energy utilization of traditional routing protocol is less efficient than ESRP. At same time, the number of energy depletion nodes is reduced for load-balancing and the first energy exhaustion node is also postponed in the appearance. [7]
	In wireless sensors, the maximum energy is consumed by the radio-frequency (RF) modules. To determine the routing paths and also preserving the quality of service in routing protocols, routing metrics are significant. In the metric, link-quality measurement is	To find the distributions for the fittest one, the statistical analysis was tested on link-quality indication (LQI) and received signal strength indication (RSSI). Statistical tests on the collected data shows a significant correlation between RSSI and short distance in such scenarios. It makes RSSI a routing protocol link-quality
	maintained for sending packets using the RF module.	metric that could be used in devices with limited energy. [8]

Table 2. Performance metric quality of service in routing protocol

Performance metric in Routing protocol	**Key factor**	**Improvement**
Quality of service	Two important metrics are used for the link-quality such as link-quality indication (LQI) and Received signal strength indication (RSSI).	To sustain the measurement of link-quality using the RF module, an efficient metrics is to be needed for sending the packets [8].

Table 3. Performance metric multi-path routing using Network coding in routing protocol

Performance metric in Routing protocol	**Key factor**	**Improvement**
Multi-path routing using Network coding	Adding redundant packets	On reducing the delay of packet transmission, the consistency of network transmission can be increased.
	A random linear network coding approach towards the code and data packets. The next hop link status and also the quantity of current packets on the receiving end which are sent by the upstream node together help to determine it.	Even though a extended propagation delay and high bit error rate of space information networks [13].
	The performance of the wireless system has been improved effectively using Network coding.	To identify wormholes in rigorous manner and also the correctness, a centralized algorithm is required. Distributed detection Algorithm against Wormhole in wireless Network coding systems (DAWN) is proposed for this distributed wireless network

		which adaptively detects the wormholes and decide the direction movement of the innovative packets [14].
Multi-path routing using without Network coding	The stiffness of attacks in hypothetical model, due to mobile nodes of multi-path routing protocols	Resiliency against blocking and node isolation-type attacks [9]

Wireless mobile ad-hoc networks based routing protocols such as Ad hoc On-Demand Distance Vector Routing (AODV) [15], Dynamic MANET On-Demand (DYMO) [16] and Optimized link State Routing (OLSR) [17], that comes in the category of specific Engineering Task Force (IETF) related to Internet. WSNs are to be used these protocols [18] which keeps similar characteristics in the context of wireless. In the category of multi-hop wireless ad hoc networks, Distributed On-demand Multi-Optional (DOMO) protocol is a single path routing protocol. DOMO is the advanced version of AODV.

IV. Simulation Analysis in Routing Protocol with Network Coding

In the simulation results, Distributed On-demand Multi-Optional routing (DOMO) and Ad hoc On Demand Distance Vector (AODV) algorithms are shown which plays a key role for communication in WSNs. DOMO is compared one of the most effective AODV protocol algorithms for analysis throughput and packet loss with respect to the execution time are the metrics. Both protocols are compared on behalf of these parameters performances. Figure 3 depicts throughput is higher in DOMO in comparison to the AODV routing.

After the few seconds of execution time, throughput is almost zero, due to less traffic at network. Thereafter, throughput sudden rises near about to 70-80sec. Later, this time destination node will start to receive the data from sources. Figure 4 depicts the packet loss in the respective of execution time which shows that the packet loss in AODV is less in comparison to DOMO.

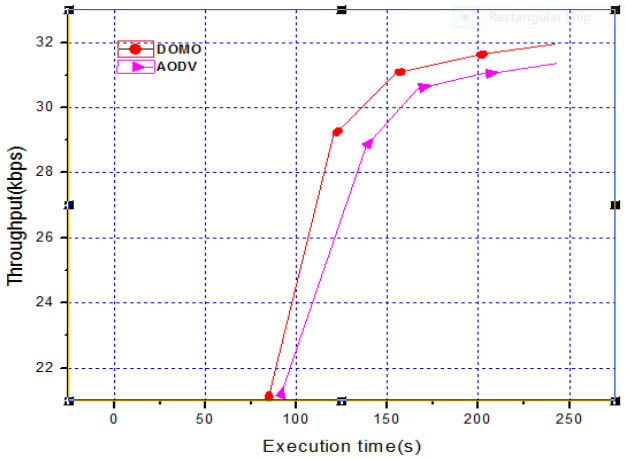

Fig.3 Throughput with respect to the execution time

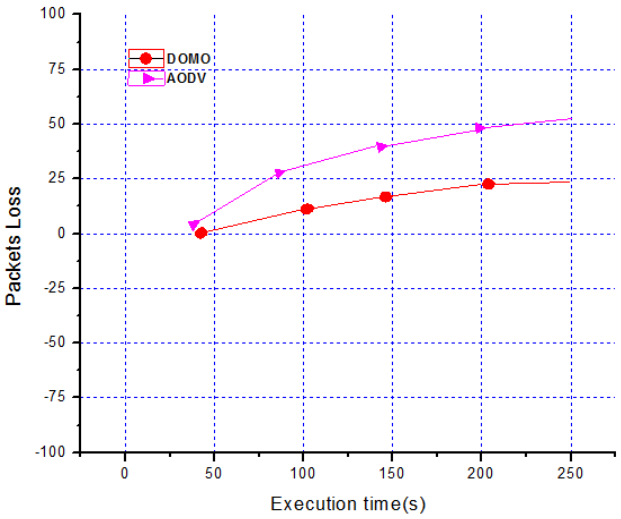

Fig.4 Packet Loss with respect to the execution time

On the basis of this experimental analysis, DOMO shows the improved results in comparison to the AODV. In the DOMO, a combination of metrics can improve the results in better way to reduce the packet loss and also the improvement in throughput. This demo also helps to analyze the importance of the role of throughput and packet loss in the area of WSN. On the basis of this analysis, the key role of individual approach is noticed for routing protocol with network coding. The detailed description related to the performance metrics in routing protocols that help to resolve the key challenges in WSNs are described in detail in tables (1-3).

V. Conclusion

In this paper, we present a survey on different kind of performance metrics in routing protocols for WSNs. Even though different kind of work has been carried out in this field, but further analysis on other metrics are also required to continue the improvement in routing protocols. This kind of analysis on the other metrics is also required to implement the routing protocol in WSN which is also a good scope for the researcher in the area of WSN. To utilize the routing protocol with the better performance metrics can play a great role in WSN. Next, we significantly mentioned some key factor, which are essential to do research for improving the routing protocols in WSNs.

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