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Comparison and Analysis of Wireless Sensor Networks Routing Protocols

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ABSTRACT

In Wireless Sensor Networks (WSNs), the data transmission might be specified as a major challenge. Various protocols of routing were suggested for saving energy throughout the transmission of data in WSNs. The protocols of routing which are on the basis of data centric method were adequate in such regard which are performing data's in-network aggregations for yielding energy-saving data disseminations, such sensor nodes have a few of limitations because of their limited, computing power, storage capacity, and limited energy. The data have been routed between nodes with the use of various routing protocols. In addition, there are a few routing protocols for WSNs, all such protocols attempted on eliminating a few of such limitations. In this paper, a comparison and analysis is presented for Wireless Sensor Networks Routing Protocols according to estimated time.

Key Words: SPIN, Implosion, Wireless Sensor networks (WSN), Routing protocols.

1. INTRODUCTION

WSNs were majorly specified as a major technology for 21st century. Throughout the last decades, WSNs were of high importance from industries and academics globally. As can be seen in Fig 1, WSN generally includes a lot of low-power and low-costs as well as multifunctional wireless sensor nodes, with sensing, wireless communications in addition to computation abilities, such sensor nodes are communicating over short distance through wireless medium as well as collaborating for accomplishing certain task, for instance, industrial process control, military surveillance, and environment monitoring [1]. The major concept of WSN is that, whereas the ability regarding each one of the individual sensor nodes has been limited, the whole network's aggregate power is enough for the needed task. In various applications of WSN, using sensor nodes is achieved in ad-hoc fashion with no adequate engineering and planning. As soon as being used, the sensor nodes should have the ability for autonomously organizing themselves in wireless communication networks. Also, the sensor nodes were battery-powered as well as anticipated for operating with no attendance for fairly long time period. In the majority of conditions, it is considered to be very complicated and not possible for recharge or change batteries for sensor nodes. Furthermore, the WSN have been specified with the denser levels related to sensor node deployments, high un-reliability regarding the sensor nodes, as well as sever power, computations, and memory constraints. Therefore, the distinctive constraints and properties are presenting a lot of challenges for the applications and development of WSN [2].

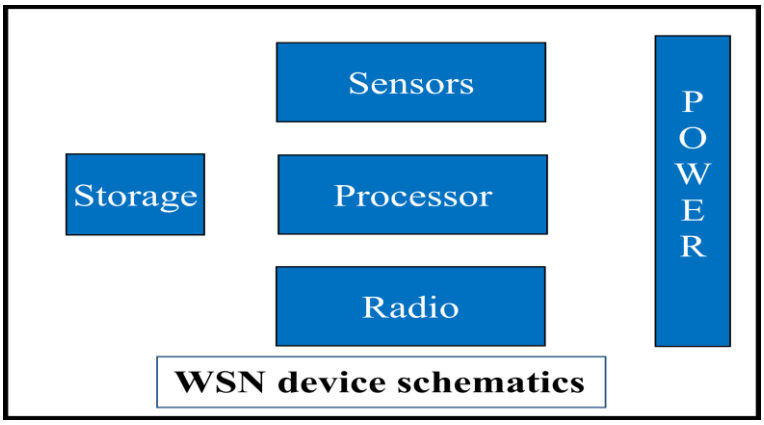


Figure1: The Architecture of Wireless Sensor Node

Because of the extreme energy constraints related to a lot of densely deployed sensor nodes, it is requiring set of network protocols for implementing different management and network control functions like network security, localization, and synchronization. The conventional protocols of routing have many limitations when utilized to the WSN that were majorly because of such network's energy-constrained nature. For instance, flooding can be defined as an approach where a certain node is broadcasting the data as well as controlling the packets which it received to the rest of network's nodes. The process will keep repeating till reaching the destination node. It must be indicated that such approach doesn't consider the energy constraints which are provided via WSN [3].

2. WIRELESS SENSOR NETWORKS (WSNs)

A few hundreds or thousands of bones are what constitute the WSNs, each one of the nodes will be connected to single (or often many) sensors, each one of the nodes will generally have many parts: microcontroller, source of energy, typically a battery or embedded form related to the harvesting of energy, electric circuit to interface with sensors as well as a radio transceiver with internal antenna or connection to external antenna. Sensor nodes might have different sizes from dust's grain to a shoebox, even though the functioning "motes" related to the genuine microscopic dimensions are yet to be formed. In addition, the sensor nodes' costs are similarly variable in range of some hundreds of dollars, on the basis of the complexity related to individual sensor nodes. The costs and size constraints on the sensor nodes might lead to corresponding constraints on the resources including communication bandwidth, memory, energy, and computational. Also, the WSN topology might be varying from between simple star networks to advanced multi-hop wireless mesh networks. Furthermore, the propagation approach between network hops might be flooding or routing [4].

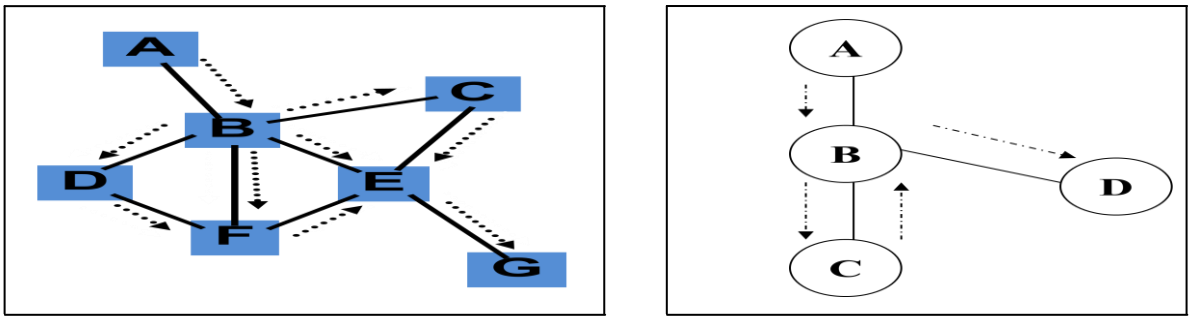
3. WSNs ROUTING PROTOCOLS

Over the passage of time and the development of wireless sensor networks, wireless sensor networks were divided into two major types: conventional and Sensor Protocols for Information via Negotiation (SPIN) protocols.

3.1 Conventional Protocols

a. **Classic Flooding:** in this protocol data is sent data to all neighbors, this protocol suffers from implosion, when data is sent to all neighboring nodes, some nodes receive two copies of the data (which causes waste of bandwidth), and data overlap, if there are two sensing devices cover overlapping area and each sensor is sent to all its neighboring nodes, therefore, each node receives two copies (which causes reduction in data delivering accuracy) as in figure (2.a).

b. **Gossiping:** in this protocol data is forwarded to a one random neighbor, this will avoids implosion but disseminates information at a slower rate as in figure (2.b) [5, 6].



(a) **(b)**

Figure2: a. Classic Flooding Protocol, b. Gossiping Protocol

3.2 Sensor Protocols for Information via Negotiation (SPIN)

A study conducted by Heinzelman et.al. [7] suggested a family related to the adaptive protocols which is referred to as the Sensor Protocols for Information via Negotiation (SPIN) which is disseminating all information at each one of the nodes to each nodes in a network indicating that all network's nodes were possible base-stations (as can be seen in the Fig-3), this allow the users to query any of the nodes and immediately getting the needed information, such protocols are using the fact that the nodes which are in close proximity have comparable data, and thus there is a requirement for just distributing the data which is not possessed via the other nodes [8]. In addition, the SPIN protocol's family use the data negotiation as well as resource adaptive

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algorithms, while there are 3 messages DATA, REQ, and ADV were utilized in SPIN. ADV packets is broadcasted via a node to all other nodes which has some data, such advertising node ADV message involves attributes regarding the data it has. Also, the nodes have interests in the data, that the advertising node has required through sending REQ, to advertising node. The advertising node will send the data to the node after receiving REQ, such procedure will continue in the case when the data reception grantee ADV message as well as send it [9, 10].

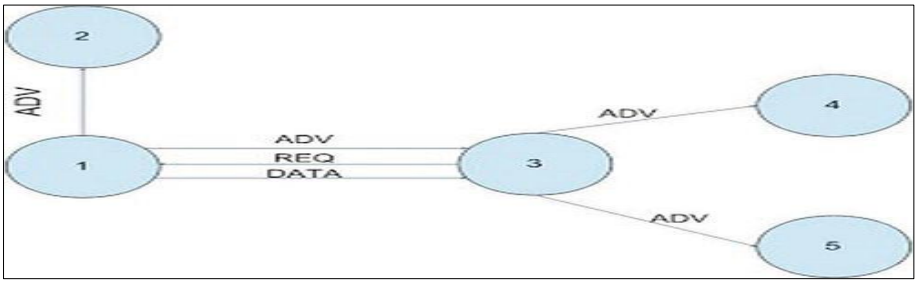

Figure3: SPIN Architecture

3.2.1 SPIN Protocols

A. SPIN – PP:

Point-to-point communications network with 3 -step handshake protocol (figure-4) [11].

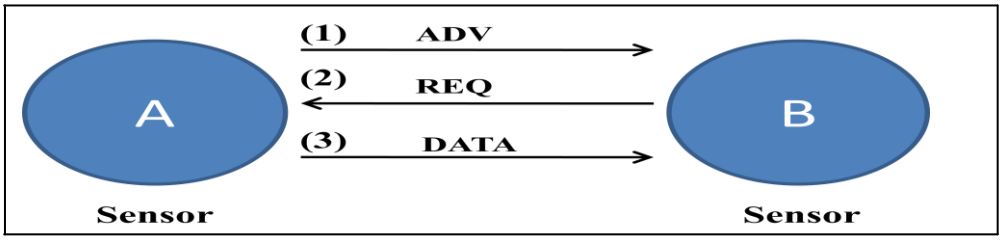

Figure 4: SPIN-PP

B. SPIN-EC:

Developed for point-to-point communications related to the threshold-based resource-awareness approach for completing data negotiation as shown in the Fig (5), the node will be engaging in the protocol operations just if it is concluding that it might be completing all the stages related to protocol operations without resulting a decrease in energy level below the threshold [12].

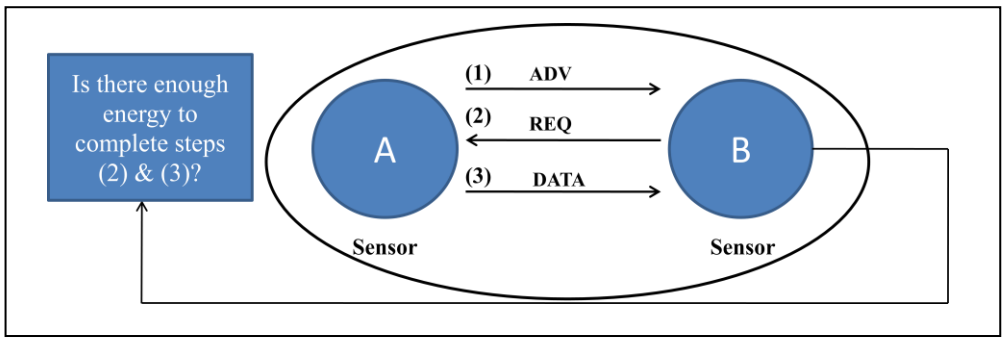

Figure 5: SPIN-EC

C. . SPIN-BC:

The nodes are sharing single channel with regard to communications. As can be seen in Fig (6), in the case when a node is sending out the data packet on broadcast channel, the packet will be received via all other nodes in specific range of sending node. In addition, the nodes that received (ADV) doesn't immediately respond with (REQ). In the case when the node hears (REQ) that

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is issued via other node that want to receive the data, it will cancel its request. Furthermore, the advertising node will be sending the data message just one time, even in the case of receiving multiple requests for the same message [13].

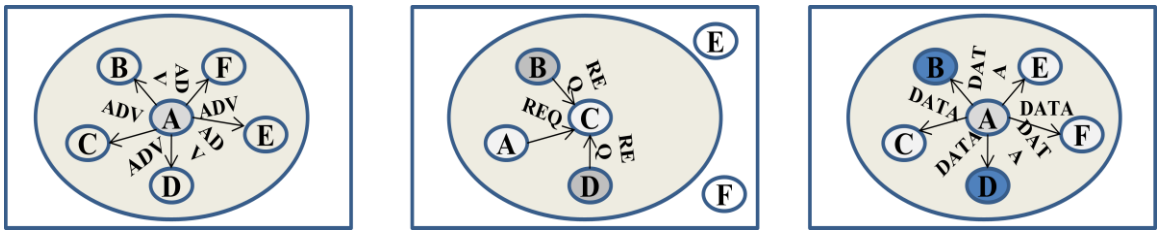

Figure 6: SPIN-BC

D. SPIN-RL:

Extending the abilities of SPIN-BC for enhancing its reliability as well as overcoming the message transmission errors resulting from lossy channel (Fig -7). B-Enhanced reliability will be reached via periodic broadcasting regarding REQ and ADV messages. C- In the case when a node request certain data doesn't receive the data which is requested in specific time period, it will be sending the request again. D- Enhanced reliability through periodically re-advertising the metadata. Following sending out the data message, a node will wait for specific period of time prior to responding to other requests for the same data message [14].

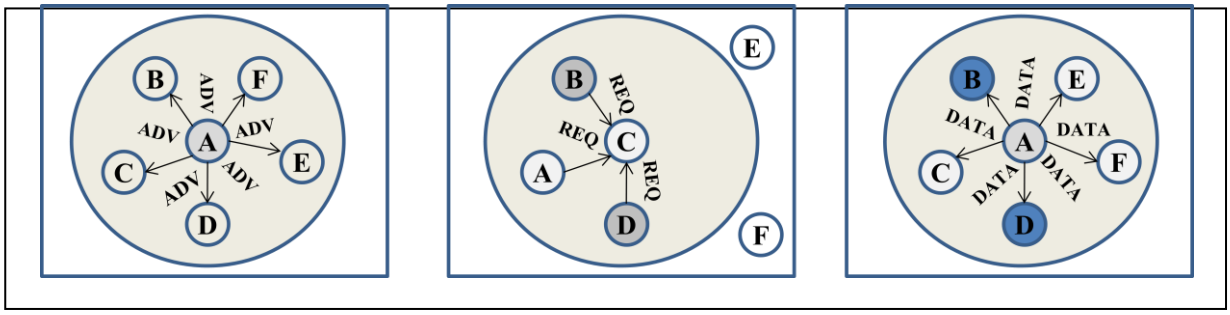

Figure 7: SPIN-RL

4. IMPLEMENTATION AND RESULTS

For the purpose of evaluating the efficiency of the above mentioned algorithms, performance analysis of conventional protocols (Classic flooding and gossiping) and SPIN protocols (PP, EC, BC and RL) were compared by calculating the estimated time in Millisecond (ms) of each technique. Four different sensor networks were creates of (55, 61, 65 and 70) nodes for the evaluation process with a specific start and destination nodes. As in table (1), the following results were obtained:

Table 1: Conventional and SPIN Protocols

No. of Network Nodes	55-nodes	61-nodes	65-nodes	70-nodes
SPIN-PP	0.668 ms	0.653 ms	0.592 ms	0.335 ms
SPIN-EC	0.828 ms	0.839 ms	1.005 ms	1.203 ms
SPIN-BC	0.690 ms	0.699 ms	0.774 ms	0.895 ms
SPIN-RL	0.922 ms	1.103 ms	1.532 ms	1.272 ms
Classic flooding	1.319 ms	1.750 ms	1.646 ms	1.497 ms
gossiping	1.805 ms	3.002 ms	2.217 ms	1.880 ms

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5. CONCLUSIONS

According to (table1) and results based on working mechanism we conclude that:

1. SPIN protocols (PP, EC, BC and RL) is faster than (SPIN-PP) and (SPIN-EC) in delivering the information.
2. SPIN protocols achieving Minimum bandwidth usage.
3. SPIN protocols consuming Minimum energy.
4. SPIN protocols avoiding implosion and data overlap.

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