

Comparative Study of A3, EECDS, CDS Rule K and KNEIGH Tree Protocols in a Grid Manner

Glory Pachnanda¹ and Rajan Chaudhary²

*M.J.P. Rohilkhand University¹
Future Institute of Engineering and Technology²
Bareilly, Uttar Pradesh, India.*

Abstract

Node deployment in WSNs is a fundamental issue. A proper node deployment scheme can reduce the energy consumption, increases the coverage area and reduces the simulation time. In this paper, nodes are deployed in a grid manner and compared the four protocols (A3, EECDS, CDS Rule k and Kneigh tree protocols) in the terms of energy consumption, coverage and simulation time. Simulation results shows that Kneigh tree protocol is the better than other because it consumes less energy, area covered by this protocol is more and its take very less time to transfer the packet.

Keywords: A3, CDS Rule k, EECDS, Kneigh tree, energy consumption, Grid H-V.

1. Introduction

WSNs are composed of large number of sensor nodes that are densely deployed or sparse deployed. When the nodes are densely deployed that means the quantity of nodes increases in a particular area due to this connectivity and coverage increases. Today, coverage and lifetime of network in WSNs is most active research area. In WSNs, sensor nodes are battery powered, the life of the network depends on the battery of nodes, the life of the networks increases when the energy spent by the node is less. When the nodes do not have work then they should have gone in to the sleep mode otherwise they are in active mode, when the nodes consume less energy than the life of the network increases.

Topology control is the reorganization and management of certain node parameters and modes of operation from time to time to modify the topology of the network with the goal of extending its lifetime while preserving important characteristics such as lifetime, connectivity of network and sensing coverage. Topology control is categorized into two categories: Topology construction and topology maintenance. In this paper, a comparison of A3, EECDS, Kneigh tree and CDS Rule k topology construction protocol on the basis of energy consumption, coverage and simulation time is presented.

2. Definition of Topology Control

Geometric random graph (G) of WSNs is represented as $G = (A, E, R)$, in which A is the set of apex, E is the set of edges and R is the communication radius of the nodes. Every apex A represents a wireless sensor node and has a geometric coordinate associated to it.

The connections are set with nodes that are close enough for the radio signal to arrive with acceptable signal strength. In other words, connections are set between nodes that are within a communication radius of each other. However, in order to improve energy efficiency, topology control process helps in reducing the connections with other neighbors of the node in the network. Topology control is an insistent process in which there is an initialization phase which is common to all WSN deployments. In the initialization phase, nodes make use of the revelation process by using maximum transmission power to build the initial topology. The initial network topology includes connections and nodes that allow direct communication and every node communicates with a subset of the nodes according to the distance between them.

Topology control protocols work on two layers, data link layer and network layer. The data link layer allows nodes to find their neighbor and establish the corresponding links and the network layer is responsible for packet forwarding.

3. Topology Construction Protocols

In this section, three existing topology construction protocols CDS Rule k, A3, EECDS and Kneigh tree are used to evaluate the performance of these protocols when deploying the nodes in grid manner.

3.1 A3 Protocol

The A3 protocol uses four forms of messages: Hello message, Children recognition message, Parent recognition message and sleeping message. The sink node starts the protocol by transmitting an initial hello message to their neighboring nodes. Nodes which are not in the range of sink node then this node accepts the message has not been covered by another node; it sets its state as covered, selects the transmitter as its parent node and answers back with a Parent recognition message. If a parent node does not accept any Parent recognition messages from its neighbors, it also turns off.

The parent node sets a certain amount of time to accept the answers from its neighboring node. Once this time out, the parent node sorts the list in decreasing order according to the selection metric. Then, parent node broadcasts a children recognition message that includes the complete sorted list to all its candidates. Once the candidates nodes accept the list, they set a timeout period proportional to their position on the candidate list. During that timeout nodes wait for sleeping message from their brothers. If a node accepts a sleeping message during the time out period, it turns itself off.

3.2 EECDS Protocol

Energy efficient connected dominating set (EECDS) protocol use two aspects to build a CDS. The EECDS also uses a coloring way to build the MIS (Maximal Independent Set). The algorithm starts with all nodes being white. An initiator node selects itself as part of the MIS coloring itself black and sending a black message to intimate its neighbors that it is part of the MIS. Upon accepting this message, each white neighbor colors itself as gray and transmits a gray message to inform its own. White neighbors that it has been converted to gray. Therefore, all white nodes accepting gray message are neighbors of a node that does not pertaining to the MIS. These nodes required to go for to turn black nodes. For this, a node transmits an inquiry message to its neighbors to know regarding their state. If it does not take any black message in response and it has the highest weight, it becomes a black node and the process repeatedly. In EECDS, the second part of the protocol is to build a CDS using nodes that do not belong to the MIS. These nodes named connectors are chose in avid way by MIS nodes using three types of message namely Blue, Update and Invite messages.

3.3 CDS Rule k Protocol

The CDS Rule k algorithm utilizes the marking algorithm and the pruning rule. The idea is to start from a big set of nodes that produces a minimum criterion and prune it according to a particular rule. In the first stage, the nodes will interchange their neighbor databases. A node will remain progressive if there is at least one pair of separated neighbors. In the second stage, a node chooses to unmark itself if it determines that all its neighbors are covered by marked nodes with higher precedence, which is given by the degree of the node in the tree: lower level, higher precedence. The ultimate tree is a eliminated version of initial one with all redundant nodes with higher or equal priority removed.

3.4 Kneigh Tree Protocol

The sink node transmits a Hello message to all its neighbors at highest power, which contains its ID number and its tree level. The node that takes the Hello message keeps the ID of transmitted node and tree level, calculates the distance with the transmitting node and sets its state to reside. After accepting the HELLO message for the moment, a node transfers a HELLO message of its own to its own neighbors and sets a timer in order to listen for its messages of neighbor.

The Kneigh tree protocol assumes that the nodes have no knowledge of their locations, and they can change their transmission power in a regular manner. The computational complexity of the protocols depends directly on the selected sorting algorithm, although the message complexness is of 2 messages per node, which could be minimized to 1 message if the UPDATE message is not sent.

4. Simulation Results

A grid based deployment is considered as a good deployment in WSNs, particularly for the coverage accomplishment. Fig 1. Shows a grid deployment of 100 sensors in a field, the communication range and sensing range of nodes is 100m and 20m and the $1000 \times 1000 \text{ m}^2$ area, in which nodes are deployed.

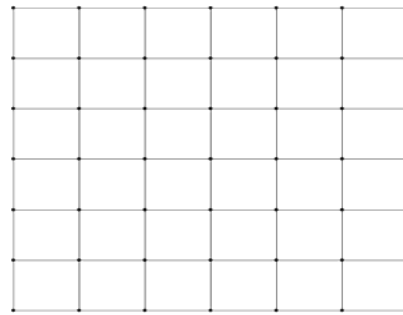


Figure 1: Deployment of nodes in grid manner.

Fig. 2 shows the area covered by the A3, EECDS, CDS Rule k and Kneigh tree protocols and the Fig. 3 shows that Kneigh tree protocol covered more area than other three. Kneigh tree protocol covered approximately 100 percent area. In the Fig. 2 the pink color shows the sensing area and the area covered by black color is communication range and the area which is shown white that means this area is not covered.

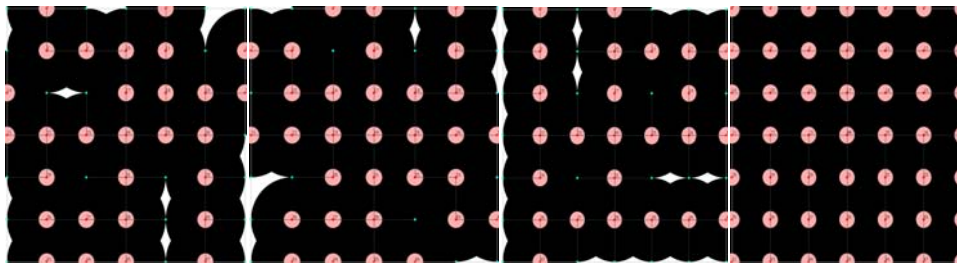


Figure 2: Coverage of A3, EECDS, CDS Rule k and Kneigh tree protocols.

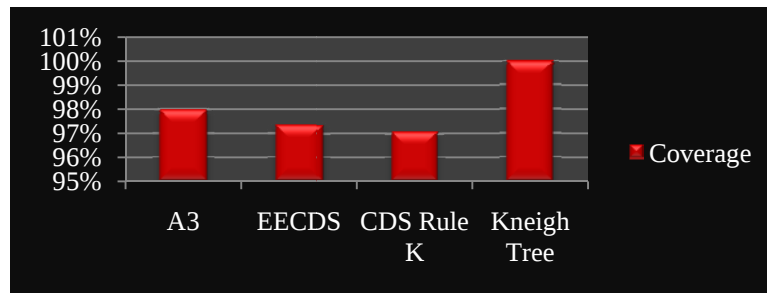


Figure 3: Comparison of A3, EECDS, CDS Rule k and Kneigh tree protocols on the basis of coverage.

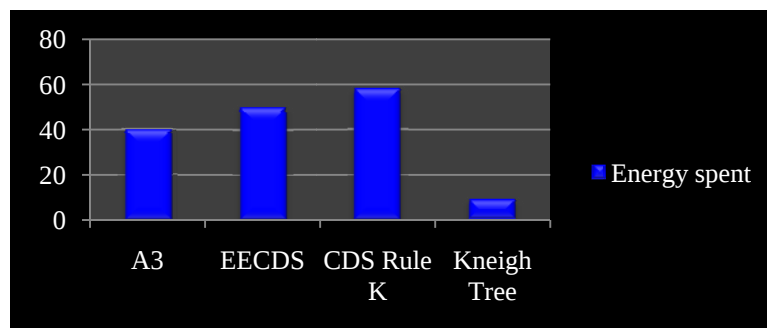


Figure 4: Comparison of protocols on the basis of energy consumption.

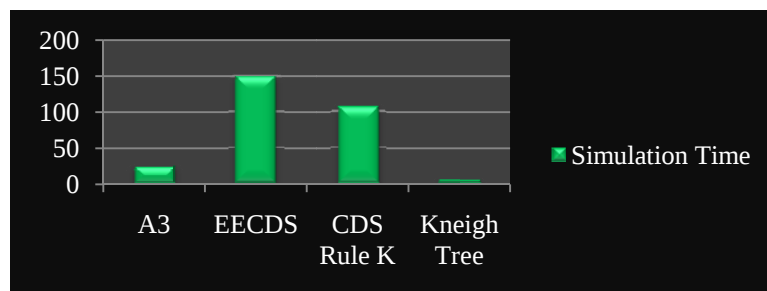


Figure 5: Comparisons of protocols on the basis of time.

Fig. 4 shows the energy consumption of sensor nodes when using A3, EECDS, CDS Rule k and Kneigh tree protocol. Using a grid deployment scheme, the energy consumption of Kneigh tree protocol is 8.674 mJ and it can extend the lifetime of WSNs. Fig. 5 shows the simulation time of protocols, out of these four protocols Kneigh tree protocol have very less simulation time approximately 4.334 seconds.

5. Conclusion

This paper presents the comparison of A3, EECDS, CDS Rule k and Kneigh tree protocols in which the nodes are deployed in a grid manner on the basis of energy consumption, coverage and simulation time. After comparing of these protocols, it is concluded that Kneigh tree protocol is the best protocol. A3 protocol covered 98% area, EECDS protocol covered 97.36% area, CDS Rule k covered 97.09% and Kneigh tree protocol covered approximately 100% area. Usage of energy in Kneigh tree protocol is very less than other three protocols.

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