Performance Analysis of Network Topologies in Sensor based Housing

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ABSTRACT
Minimization of energy is a significant concern for wireless sensor networks as sensor nodes have limited energy. As a result energy efficient topology is required in sensor networks since the sensor network life time depends on appropriate network structure for communication of signals among sensor nodes. The performance analysis of network topologies for sensor based housing with respect to ZRP, IARP and IERP routing protocols has been evaluated using Qualnet 7.1 simulator in this paper. The simulation result shows that star topology consumes only 2.72% average total energy and is energy efficient for sensor based housing than other network topologies.

Keywords
Wireless Sensor Network, IERP, IARP, ZRP, Housing and Network Topology

1. INTRODUCTION
There are diverse number of low powered, little cost sensor nodes connecting together to construct Wireless Sensor Network (WSN).In WSN, all sensors are well organized to sense data from its surroundings. A sensor node composes of processor, sensor, battery and transceiver. There are numerous applications of WSNs like environmental monitoring, security, area monitoring and house monitoring etc. Sensor nodes have restricted power resources [1]. Data are lost in WSN on account of lack of power in sensor nodes or due to undesirable loss by any obstacle [2]. The idea of WSN is to disburse tiny sensor nodes for sensing and communicating with other devices over a large geographic area for some goals like target tracking, monitoring etc. [3]. Implementation of hybrid routing protocol is an important technique in wireless mesh network for extending the network lifetime [4].People give maximum time either in house or working place. The modern science and technology provides us to improve pleasure in housing environment [5].

This paper is formulated as follows: The motivation and contribution is in Section 2. The related works are presented in Section 3. Section 4 presents routing protocols. Housing and network topologies are in Section 5. The simulation parameters and scenario is in Section 6. Section 7 represents the simulation results and analysis .Finally Section 8 provides conclusion.

2. MOTIVATION AND CONTRIBUTION
- Any intelligent housing can not be intelligent without deployment of perfect network topology. To get the best reliability and effectuality of a network, network topology plays an important role. Energy minimization is an important factor in any type of sensor applications. The motivation of this research is analysis of different network topologies in sensor based housing by employing different routing protocols to show energy efficient network topology.
- Sensor based housing is designed with different network topologies using Qualnet 7.1. The IARP, IERP and ZRP routing protocols have been used in sensor based housing with different network topologies. The performance metrics have been analyzed to assess energy efficient network topology with IARP, IERP and ZRP routing protocols in sensor based housing.

3. RELATED WORKS
This section reviewed the Quality of Service (QoS) and energy absorption in the wireless sensor network. The authors in [6] analyzed the different MAC layer protocols scenario executed for sensor network. They showed that zigbee performs better as PAN coordinator. The authors in [5] sketched virtual smart home using qualnet and executed in real world environment as well as simulation environment. The authors in [7] presented an analytical model to anticipate the energy drain in wireless sensor network. The sensor nodes have been formulated as cluster based and grid based. The performance analysis provides that analytical model anticipates the energy draining better.

4. ROUTING PROTOCOLS
This section describes Intra-zone routing protocol (IARP), Inter-zone routing protocol (IERP) and Zone routing protocol (ZRP).

4.1 Intra zone routing protocol (IARP)
IARP is employed to communicate between nodes within the routing zones. In IARP, every node retains its own routing zone. It takes off repetitive routes as well as reduces of routes length for local route extension [8]. IARP can communicate between nodes if origin and destination is in same zone. IARP uses neighbor discovery protocol to get current information about neighbor.

4.2 Inter zone routing protocol (IERP)
IERP is utilized in various routing zones. It is a reactive routing protocol. IERP is the part of ZRP as the global reactive routing component. As a result IERP receives benefits of the identified topology of each nodes routing zone

using a reactive approach which allows communication with the nodes in other zones [9]. There are some functions of IERP like query control, broadcasting etc.

4.3 Zone Routing protocol (ZRP)

ZRP conjugates one and the other properties of proactive as well as reactive routing. ZRP works on routing zone. ZRP is categorized into intrazone routing protocol (IARP) as well as inter zone routing protocol (IERP). A sensor node in ZRP discovers and identifies its zone through IARP. IERP is accountable for finding routes to destinations reactively [10].

5. SENSOR BASED HOUSING AND NETWORK TOPOLOGY

Wireless sensor based housing provides a better form of living. The sensor nodes are redistributed in accordance with individual environment provision. Network topology has an important role to redistribute the sensors in the house as sensor nodes have limited energy as well as to reduce complexity in terms of cost. The proposed scheme combines all of cluster based network in dynamic way. Different network topologies are discussed in this section.

5.1 Ring Topology

Ring topology forms as circular fashion to make a closed ring. The data travels around the ring. Each device exactly connects two neighbors.

5.2 Mesh Topology

All nodes are interconnected and transmit the data to the sink node. The data travels around interconnected mesh. Each device acts as a repeater in mesh and transmits data to the sink.

5.3 Star Topology

Each node is connected to a central node with a point-to-point connection. Each device is directly connected to the sink node for transferring data.

5.4 Tree Topology

Nodes arranged in a hierarchy and the data is transferred from peripheral nodes to sink node.

5.5 Hybrid Topology

It is formed after combining minimum of two network topologies in such a way that the resulting network does not exhibit anyone of single standard topologies.

6. SIMULATION PARAMETER AND SCENARIO

In this work, The Qualnet 7.1 simulator has been employed to assess the performance of network topologies for sensor based housing by employing IARP, IERP and ZRP routing protocols. Table 1 exhibits simulation parameter.

Table 1. Simulation Parameter

Parameter	Value
Terrain Size	1500m^2
Number of Nodes	6
Routing Protocol	IARP, IERP, ZRP
Simulation Time	300 Seconds
Traffic Type	CBR
Radio Type	802.15.4 Radio
Node Deployment	Random
Radio Energy Model	Mica-Motes

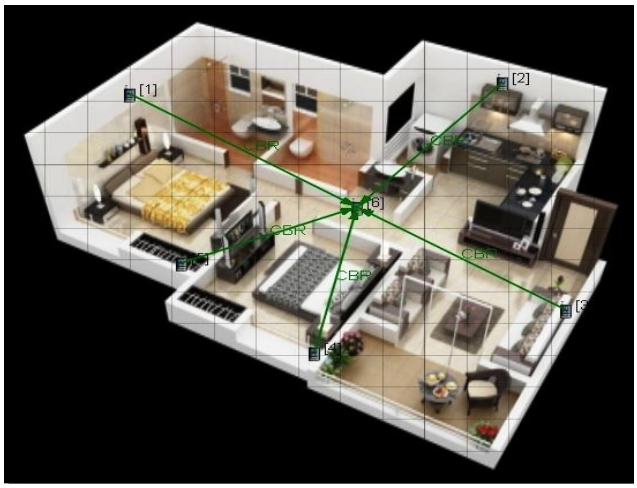

Fig 1: Schematic view of star topology for sensor based housing home using Qualnet Simulator

To design Fully Functional Devices (FFDs) as well as Reduced Functional Devices (RFDs) IEEE 802.15.4 is used. FFDs are again incorporated into three categories PAN coordinator, coordinator and devices. Sink node is PAN coordinator (FFD). Coordinators send data to the PAN coordinator. In Figure 1, there are 6 nodes. The PAN coordinator is centre node i.e. 6. The device nodes are 1, 2, 3, 4 and 5. Constant Bit Rate (CBR) is used in this scenario as traffic generator. Here all sensor nodes are static and are connected to sink for data transferring data.

7. SIMULATION RESULTS AND ANALYSIS

The performance evaluation of network topologies for sensor based housing with IARP, IERP and ZRP routing protocols in Qualnet 7.1 has been discussed in this section. Each designed topology in sensor based housing is evaluated with IARP, IERP and ZRP routing protocols.

7.1 Performance Analysis of Ring, Mesh, Star, Tree and Hybrid Topologies with ZRP Routing Protocol

Performance of Ring, Mesh, Star, Tree and Hybrid network topologies with ZRP routing protocol have been analyzed with average power utilization in transmit, receive along with idle modes, total energy consumption as well as number of packets dropped.

7.1.1 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for ZRP Routing Protocol in Transmit Mode

Transmission energy of a node is defined as energy is needed to transmit packets from origin node to destination node. Star topology consumes less average energy in transmit mode with compare to other topologies, which is shown in Figure 2.

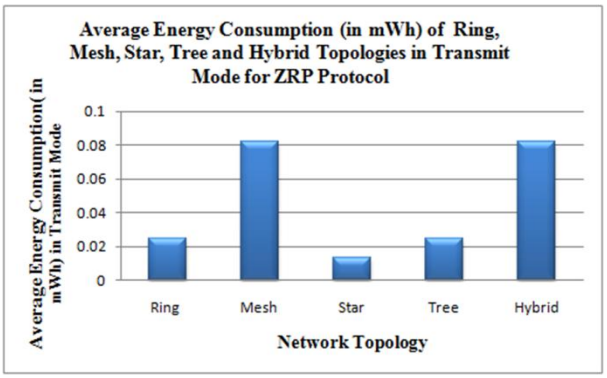

Fig 2: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Transmit Mode for ZRP protocol

7.1.2 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for ZRP Routing Protocol in Receive Mode

The energy is required to receive packet is called receive energy of a node. The star topology depletes less average power in receive mode with compare to other topologies, which is exhibited in Figure 3.

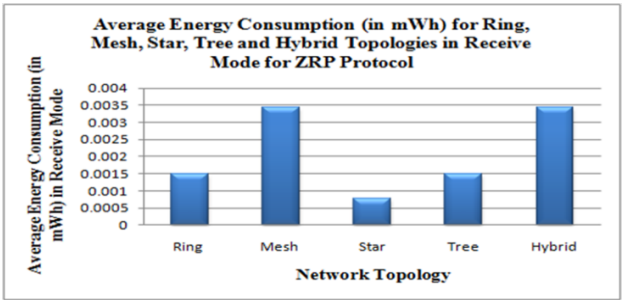

Fig 3: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Receive Mode for ZRP protocol

7.1.3 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for ZRP Routing Protocol in Idle Mode

In idle mode, a node does not send or receive any data packet. In Figure 4, tree, mesh and star topologies consume equal minimum average energy with compare to ring and hybrid topologies.

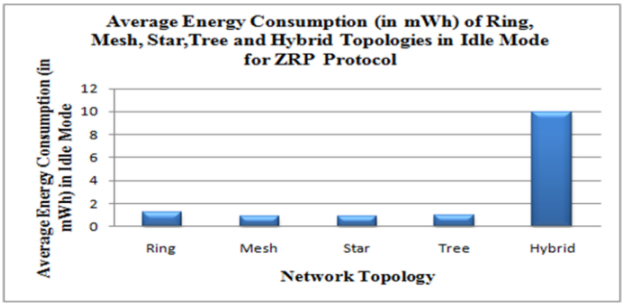

Fig 4: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Idle Mode for ZRP protocol

7.1.4 Average Total Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for ZRP Routing Protocol

The total energy consumption is the sums of power utilization in transmit, receive along with idle modes. The Figure 5 exhibits hybrid topology consumes maximum total average energy and star topology consumes minimum average energy.

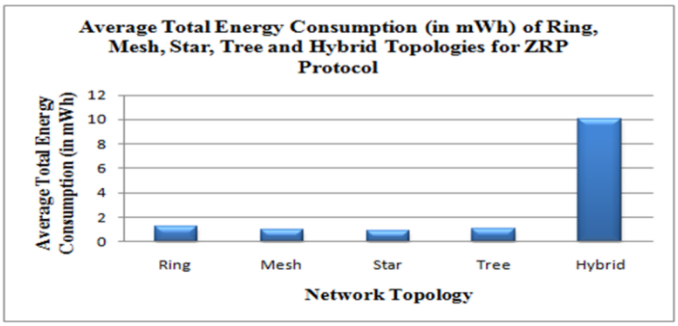

Fig 5: Average total energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology for ZRP protocol

7.1.5 Average Number of Packets Dropped for Ring, Mesh, Star, Tree and Hybrid Topologies for ZRP Routing Protocol

The Figure 5 shows hybrid topology dropped maximum average number of packets and star topology dropped minimum average number of packets than additional topologies.

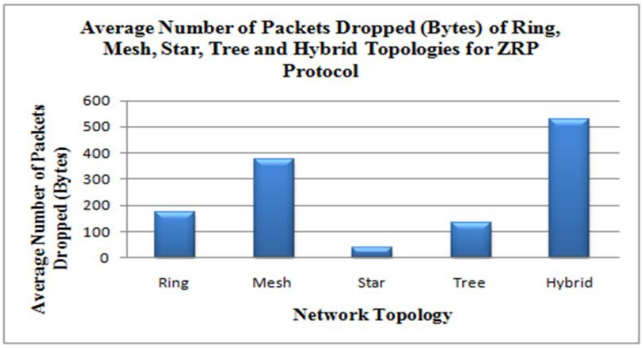

Fig 6: Average number of packets dropped of Ring, Mesh, Star, Tree and Hybrid Topology for ZRP protocol

7.2 Performance Analysis of Ring, Mesh, Star, Tree and Hybrid Topologies with IARP Routing Protocol

Performance of Ring, Mesh, Star, Tree and Hybrid network topologies with ZRP routing protocol have been analyzed with average power depletion in transmit, receive along with idle modes, total energy consumption as well as number of packets dropped

7.2.1 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IARP Routing Protocol in Transmit Mode

The Figure 7 shows star topology drains minimum average energy and hybrid topology drains maximum average energy in transmit mode with compare to other topologies.

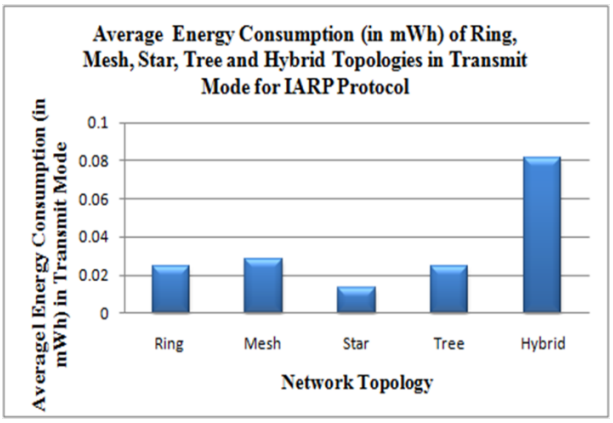

Fig 7: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Transmit Mode for IARP protocol

7.2.2 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IARP Routing Protocol in Receive Mode

The star topology consumes minimum average energy and hybrid topology consumes maximum average energy with respect to ring, mesh and tree topologies, which is shown in Figure 8.

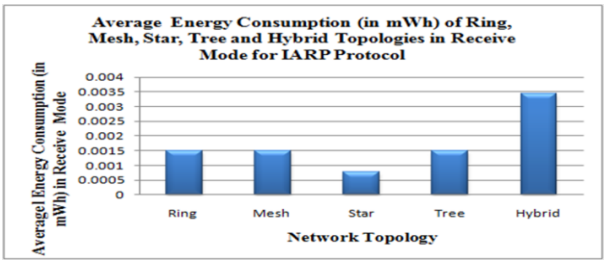

Fig 8: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Receive Mode for IARP protocol

7.2.3 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IARP Routing protocol in Idle Mode

In idle mode, the Figure 9 shows tree and ring network topologies deplete less average power than other topologies

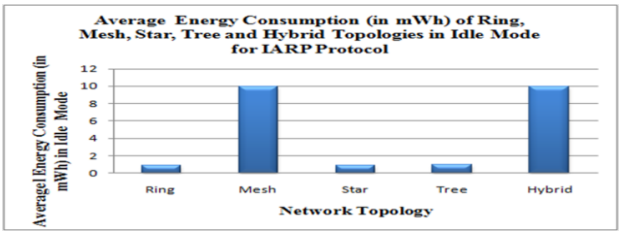

Fig 9: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Idle Mode for IARP protocol

7.2.4 Average Total Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IARP Routing Protocol

The total energy depletion is the sums of power depletion in transmit, receive along with idle modes. The Figure 10 exhibits mesh and hybrid topologies consume nearly equal average total energy.

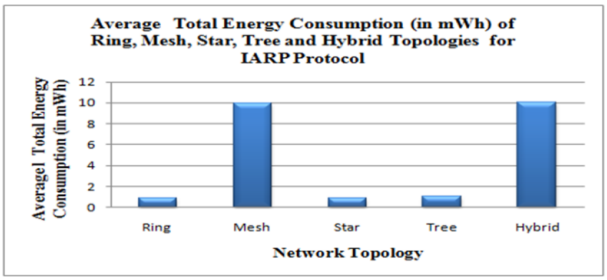

Fig 10: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Idle Mode for IARP protocol

7.2.5 Average Number of Packets Dropped of Ring, Mesh, Star, Tree and Hybrid Topologies for IARP Routing Protocol

The Figure 11 shows hybrid topology dropped maximum average number of packets and star topology dropped minimum average number of packets than additional topologies.

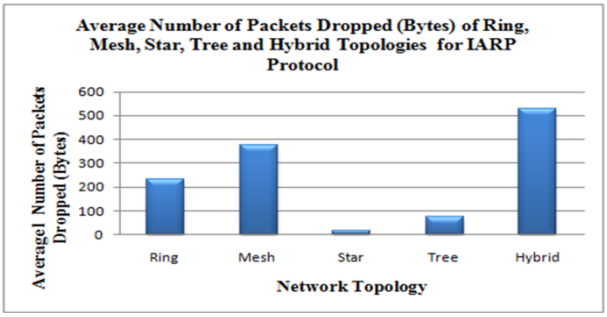

Fig 11: Average number of packets dropped of Ring, Mesh, Star, Tree and Hybrid Topology in Idle Mode for IARP protocol

7.3 Performance Analysis of Ring, Mesh, Star, Tree and Hybrid Topologies with IERP Routing Protocol

Performance of Ring, Mesh, Star, Tree and Hybrid network topologies with IERP routing protocol have been analyzed with average power depletion in transmit, receive along with idle modes, total energy consumption as well as number of packets dropped.

7.3.1 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IERP Routing Protocol in Transmit Mode

In transmit mode, the Figure 12 shows star topology drains minimum average energy and hybrid topology drains maximum average energy.

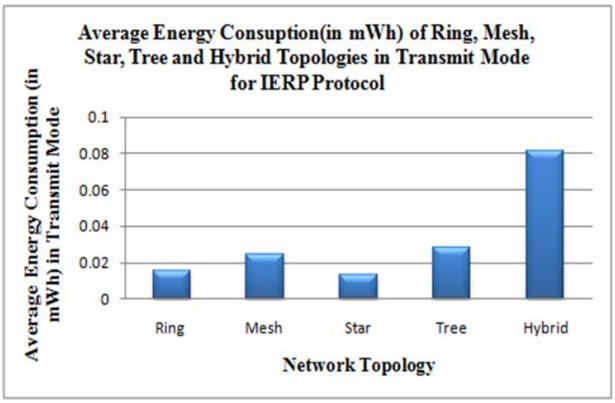

Fig 12: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Transmit Mode for IERP protocol

7.3.2 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IERP Routing Protocol in Receive Mode

The star and mesh topologies consume almost minimum average energy and hybrid topology consumes maximum average energy, which is shown in Figure 13.

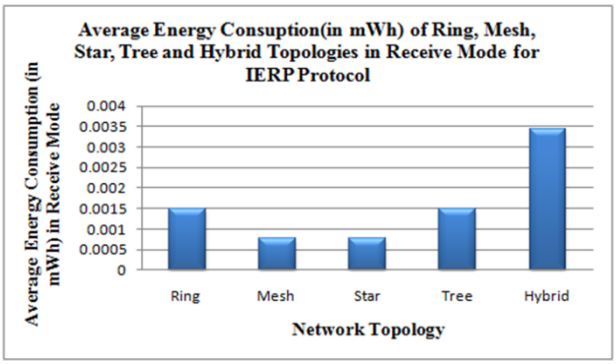

Fig 13: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Receive Mode for IERP protocol

7.3.3 Average Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IERP Routing Protocol in Idle Mode

The Figure 14 shows tree and ring topologies consume minimum average energy when compare to other topology.

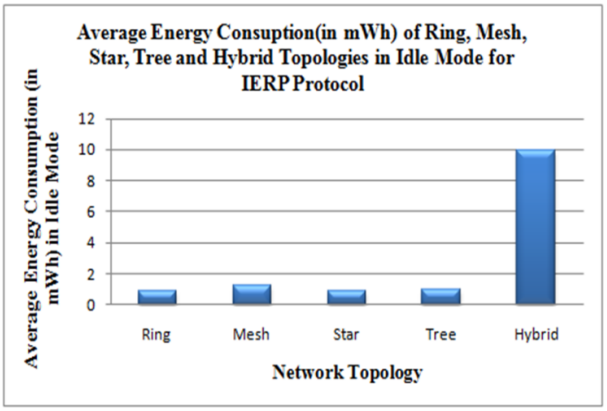

Fig 14: Average energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology in Idle Mode for IERP protocol

7.3.4 Average Total Energy Consumption for Ring, Mesh, Star, Tree and Hybrid Topologies for IERP Routing Protocol

The Figure 15 shows hybrid topology consumes maximum average total energy with compared to other topologies.

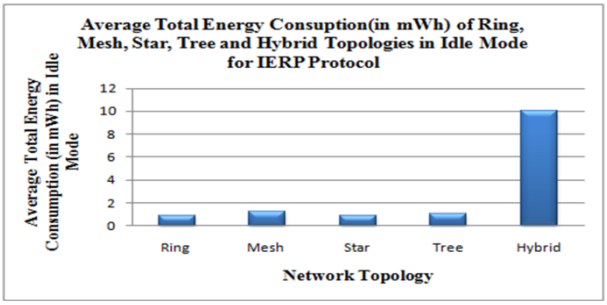

Fig 15: Average total energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology for IERP protocol

7.3.5 Average Number of Packets Dropped for Ring, Mesh, Star, Tree and Hybrid Topologies for IERP Routing Protocol

The Figure 16 shows hybrid topology dropped maximum average number of packets and star topology dropped minimum average number of packets than additional topologies.

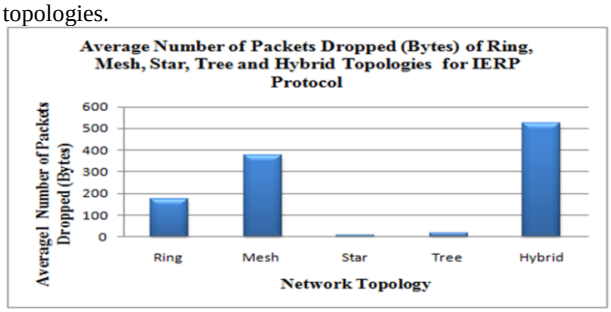

Fig 16: Average total energy consumption of Ring, Mesh, Star, Tree and Hybrid Topology for IERP protocol

8. CONCLUSION

In this paper hybrid, tree, star, mesh and ring network topologies have been employed using sensors in house. The simulation result shows that star topology consumes only 2.72% total average energy but hybrid topology consumes 30.89% total average energy in sensor based housing. Star topology also dropped less number of packets. The performance of hybrid topology is worst than other topologies in sensor based housing. Therefore star topology is very much suitable for adopting in sensor based housing.

9. ACKNOWLEDGMENTS

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