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A Software Defined Network Based Energy-Efficient Model for Internet of Things

D. Helen, G. Jijilin Jebho Shebija

Abstract; Internet of Things (IoT) is a new platform that provides the communication among heterogeneous objects. The aim of theIoT is to allow anything can communicate with anywhere at any time to share the information. Generally, devices in IoT are equipped with limited power. The power failure of single node changes the entire network architecture in the IoT framework. To attain an efficient routing, there is a need to design energy-efficient routing algorithm for IoT heterogeneous objects. The proposed Software Defined Network based Energy-Efficient Routing Protocol (SD-EERP) takes care to reduce energy consumption and transmission overhead of monitoring every device in the IoT paradigm. The aim of the proposed SD-EERP algorithm is to enhance the lifetime of the devices by choosing the energy-efficient path to reach the target device. The proposed model implements the Software Defined Network (SDN) based cluster architecture. The cluster head selection is based on residual energy and speed.All the cluster heads connect to the SDN controller to manage the entire network architecture.The simulation results show the proposed algorithm can minimize the energy consumption and increase the packet delivery ratio when compared with SCBRP.

Keywords: Internet of Things, routing, heterogeneous, Software Defined Network, cluster head.

I.INTRODUCTION

The IoT connects several heterogeneous devices which use the internet as pillar to launch the smart communication between the human and objects [1]. The goal of the IoT is to connect the various objects through internet [2]. The IoT paradigm, allows to assist human-to-machine and machine-to-machine transmission [3][4]. The devices in IoT are connected through progressive communication technology such as LTE, Wi-Fiand Wi-Max[5]. The application of IoT includes smart home, smart city, smart energy and health care monitoring [6][7][8]. Generally, the SDN act as a centralized controller in the network and offer an efficient routing in the network. The SDN brings more convenient and flexibility to IoT by managing the network traffic and network resources in an intelligent way. The SDN can manage the network by decoupling the data plane and control plane [9].The incorporation of SDN with IoT makes it feasible to automatically organize the devices of various locations by implementing a centralized architecture so the devices are move and join the network spontaneously. In some times, the network is separated into smaller network (cluster) to eliminate the routing overhead and scalability issues in the network. The nodes in the cluster are categorized into three different roles.

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* Correspondence Author

Dr. D. Helen, Assistant Professor, Academy of Maritime Education and Training Deemed to be University (AMET University) Chennai, India.

G. Jijilin Jebho Shebija, Assistant Professor, Kings Cornerstone International College, Chennai, India.

First, the cluster head node which has controll access to all the nodes in the network. Second the gateway node which acts a gateway between two different clusters. Finally, cluster member which transmits the data packets through cluster head [10].

II.LITERATURE SURVEY

Samia Allaoua Chelloug [11] proposed Energy-Efficient Content-Based Routing(EECBR) mechanism for IoT objects which aims to minimize the node energy consumption in the network architecture. The EECBR uses the centralized virtual topology to route the packets between sender and receiver in a distributed manner.

Cheng et al. [12] proposed power-saving strategy, using clustering techniques. The author uses the node position to design the routing protocol. Thus the protocol increases the network lifetime and reduces the routing overhead.

J. Huang at al.[13] introduced the hierarchical routing method and cost-based-clustering strategy to improve the network performance and increases the cluster stability in the large network.

Luo et al.[14] described the Software Defined Wireless Sensor Networks SD-WSN. The Open Flow Protocol used in SD-WSN. The SDN separates the control plane and data plane. The data plane forwards the sensor packets and control plane controls the performance of the routing protocol.

Swain et al.[15] introduced aclustering platform for diagnosing the fault to balance the network load and reduce the energy consumption. The author implements the statistical technique and neural network for fault detection.

III.PROBLEM STATEMENT

In IoT there are various reasons which may slow down the transmission process. In a heterogeneous network different devices have various capacities, speed,location and energy consumption. Typically, the devices in IoT are equipped with limited power and less computation capacity. The energy-efficient routing plays an important role while transmitting the data in the network. The paper proposes SDN based clustering technique to route the packet through the energy-efficient path in IoT paradigm.

IV.ALGORITHM DESCRIPTION

The aim of the proposed SD-EERP is to enhance the network lifetime by implementing the clustering technique along with the SDN to choose the optimal path between the source node and destination node. The algorithm uses the node residual energy and speed to find anenergy-efficient path.

The Software Defined Network (SDN) provides a different service which creates the network more efficient and flexible.

The Open Flow protocol is launches the communication among SDN controller and devices. Initially, the devices in the network registered their information such as id, residual energy and location to the controller. The controller chooses the cluster head based on the device energy and speed for every cluster.The controller provides the forwarding decision to cluster head. The forwarding decision may change automatically based on the network condition. The SDN can update their routing entries based on device residual energy and position. The SDN checks the routing table if the current cluster head has less energy then the SDN controller elects the new cluster head for data transmission.

4.1 Estimation of Parameters

This section presents the routing parameters used in the SD-EERP model. The SDEERP uses the residual energy and speed to form a reliable cluster head.

4.1.1 Residual Energy

In IoT devices are equipped with the limited power. The route between the origin and the target devices are considered as efficient if the devices on the route proposes longer live and consume less energy to deliver the data packets. Based on the residual energy the device can join in the routing in order to transmit the data packets. The highest residual energy of the device is elected as a cluster head, to transmit the data packet between source and destination node. The residual energy value is calculated in Equation (1):

$$RE = E_i\text{-}((Tn * E_{tx}) + (R_n * E_{rx}))$$

Here, E_i - Initial energy, Tn - number of data packets transmitted, E_{tx} - transmission power, R_n - number of received data packets. E_{rx} - total energy consumption of receiving packets.

4.1.2 Speed

Speed is denoted by the distance travelled by time. The speed is considered as an important parameter in cluster formation because the chosen cluster head may not be too mobile that lead to routing overhead. The speed of the device is depending on the movement of the device from one position to another position.

4.2 Cluster Formation

Step 1: The devices (d_i=1,2,…n) in the network register with the SDN controller. Itallocates a unique id for every device in the network.

Step 2: Each $d_i$partitions the set of member devices into set of clusters.

Step 3: Each neighboring device d_i calculates node the residual energy and speed.

Step 4:Estimating device value each d_i SDN selects one of its neighboring devices as cluster head.

Step 5:Each d*i* sends the Join_Request to the selected cluster head.After getting the Join_Request, the cluster head respondsback with an acknowledgement message to all the nodes in the cluster.

V.PERFORMANCE COMPARISON

The performance of the proposed algorithm SD-EERP is examined with SCBRP for packet delivery ratio and energy consumption.

Packet Delivery Ratio (PDR): The PDR denotes the number of packets, successfully delivered to the target node.

$$PDR=\frac{(No.of.Pkt.Rcd)}{(No.of.pkt.send)}$$

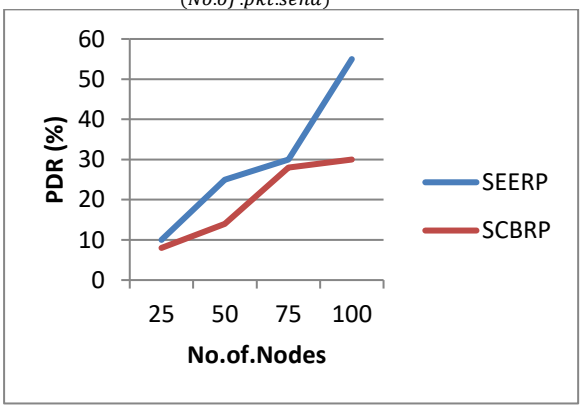

Figure 1.1 PDR Vs No.of.Nodes

Figure 1.1 shows the packet delivery ratio by varying the number of nodes. The SD-EERPmodel works well when the number node increases because the congestion is reduced by choosing the optimal cluster head for data transmission.

Energy Consumption: The energy consumption denoted by the amount of energy consumed by the nodes in the network.

$$\text{Energy Consumption} = \frac{\sum(Total\ consumed\ Energy)}{\sum(No.of.Nodes)}$$

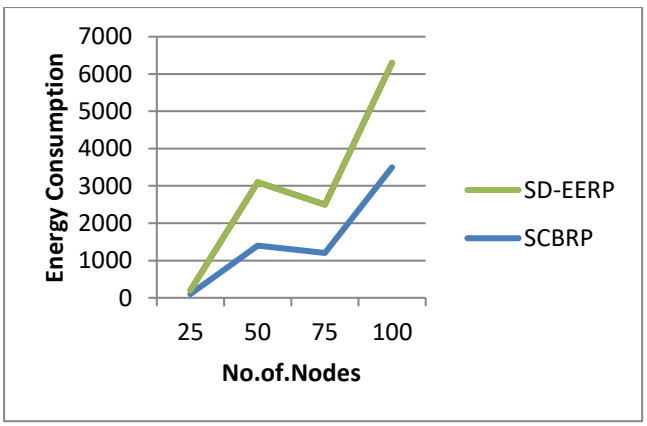

Figure 1.2 Energy Consumption Vs No.of. Nodes

Figure 1.2shows the energy consumption when the number of nodes rises, theaverage energy consumption of the node also increases because number of nodes participating in transmitting the data packets.The SD-EERP reduces the energy consumption because theeffective cluster head selection minimizes the packet loss and the retransmission of data packets.

VI.CONCLUSION

The paper presents the cluster based SDN routing for IoT applications.

The proposed SD-EERP achieves an energy-efficient routing by identifying an optimal cluster head which stabilize the network architecture. The SD-EERP algorithm increases the packet delivery ratio and minimizes average energy consumption.

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AUTHORS PROFILE

Dr.D.Helen, working as Assistant Professor, Academy of Maritime Education and Training Deemed to be University (AMET University) Chennai, She obtained her doctoral degree from AMET University, Chennai. Her area of research interest is Wireless Networking, Routing Protocols and MANET. She published number of articles in Scopus, UGC listed and high impact factor journals. She presented number of research articles in National, International conferences/ seminars. She got received best paper award in the International Conference..

Ms. G.Jijilin Jebho Shebija, working as Assistant Professor in Kings Cornerstone International College, Chennai. Holding 3 years of teaching experience in UK educational system [Pearson] to the Bachelor of Computing who progress to foreign countries such as UK, Ireland and Australia. A specialist programmer and trainer in emerging technologies delivering simulated real world situations to create innovative and creative ideas.