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# An Energy Efficient Device to Device Routing for Internet of Things

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**Abstract:** ***IoT application gain lots of popularity in recent time. Sensor node application with the internet access and connecting it with end users directly make it popular and convenient for the users also. Sensor nodes send the sensed data to cloud where data analyzed and computation is done end user get access of those data from cloud. As sensor nodes is an important part of this application and sensor nodes are powered by the battery has a network lifetime issues. Hence enhancement of sensor node life time is required for improving the IoT application. Cluster based routing protocol design is our approach for the IoT application. Gateway based cluster communication with other cluster head and sink is presented. Device to Device communication protocol for IoT application is also discussed. Simulation analysis is given for the sensor node and analyzed the network lifetime.***

**Keywords:** cluster, IoT, cloud

## 1. Introduction

In recent time demand of IoT technologies have been increased rapidly. Its attractive feature make it very popular among the users and how it make easily available at less cost with security make it popular among the researchers. It is expectation that by 2020 around 50 billion device connected to the internet.

IoT technologies generally comprise with sensor device, Internet, cloud and the end user. It combines the man machine with connecting the sensor device, to internet and user also connected with the internet. IoT based application used an specific communication like HTPP, known as MQTT [1] and CoAP[ 2]

Sensor is one of the most important part of the IoT expansion. Sensor device responsible for the collecting the data from physical environment and change it into raw data, which is further available for analysis and after analysis it is available for user access [3]. Growth in technologies and production of small devices and chip make it possible to design and produced tiny size senor devices. These devices are easily Integrated with smart devices and able to transmit the information via the internet. Sensor can easily measure the surrounding temperature, pressure, position, flow of water, intensity of light, it is also used for monitoring the agricultural land, fire, tracking of the vehicle, and widely used in tactical field. Acquisition of the huge amount of data by the sensor for many application required a huge storage capacity, which make cloud service attractive for the users. For monitoring the environment or battle field in which sensor nodes continuously senses the surrounding and generates huge amount of data, sends to the cloud storage via gateway where it is analyzed. End user or who have authority of data accessing is connected to the cloud through internet and access those data. In Figure 1 architecture of IoT is represented.

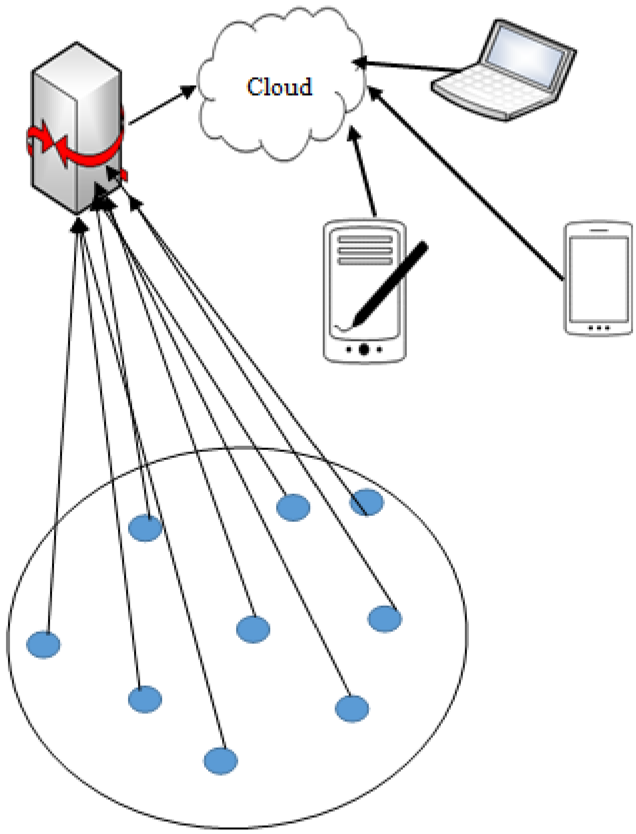


**Figure 1:** Architecture of IoT

In [4] author presented IoT based work for the agriculture filed. Sensor nodes are deployed in the agricultural land for monitoring the ecosystem and generated data send to the cloud computing system where data is analyzed and, farmer can use that information for feeding required water, spray insecticide on time.

In [5] author main focused on social IoT for improving the performance of that and presented a generic Social IoT architecture and discuss technologies related to it. In [6] author motive is to used the IoT in health care application.

author design a middleware that embraces the heterogeneity of IoT devices.

In [7] IoT has given us a promising way to build powerful industrial systems and applications by using wireless devices, Android, and sensors. A main contribution of this review paper is that it summarizes uses of IoT in industries with Artificial Intelligence to monitor and control the Industry. In this paper [8], author describe how Internet of Things and Cloud computing can work together can address the Big Data issues. We also illustrate about Sensing as a service on cloud using few applications like Augmented Reality, Agriculture and Environment monitoring. Finally, we also propose a prototype model for providing sensing as a service on cloud. The paper organization is as follows:In section two the proposed cluster based routing approach is presented. Section three experimental resultsare discussed. The last section consist of conclusion and future work.

## 2. Proposed Model

### a) Network Design

ArchitectureIoT based network consist of physical object which is made up of with the electronic devices, sensor, software and connectivity. Typically, it is needed to provide sophisticated and advanced connections between the devices for its proper communication and handles a variety of protocols, applications and knowledge bases. The communication between devices is expected to use in a virtually automated manner in almost all the countries. The general ideas, in the IoT, can refer to a broad usage of devices such as heart monitoring implants, electric clams in coastal waters, biochip transponders on farm animals, built-in sensors used in automobile systems.

Cloud computing enables IT and companies to utilize all the computing resources. Cloud computing consists of several advantages in commercial enterprises andindustries. Some of the advantages of cloud computing are: • Elasticity: If the computing demands increases,the companies scale up and if the computing demands decreases then the companies scales down. • Self-service provisioning: End users can use the computing resources for any type of work to be balanced on demand • Pay per usage: All the computing resources all given with a validity level allowing the customers for compensation of resources.

Sensors are the most important part of the IoT network which is responsible for the gathering the data from surrounding. Hence sensors lifetime and routing processing is also become an important part of the IoT network. Sensor devices are small in size and powered by the battery. Enhancement of sensor lifetime become a challenge for the IoT network also. Most of the energy sensor node utilize in routing the aggregated data from the surrounding. Hence here our approach is to enhance the routing of sensor data in IoT network.

### b) Cluster Based Routing Approach

Sensor nodes are deployed in network initially each node separately sending their data to the gateway which cause each node early death in the network. Hence a better mechanism is needed for enhancing the sensor node lifetime in the network for take more seamless connectivity with IoT network. Clustering approach of the sensor node represented in Figure 2.

Clustering is a mechanism in which deployed sensor nodes are divided into number of cluster. Each cluster has cluster head and cluster member. Member of the cluster transmitted the data to the cluster head and cluster head aggregated the data from all member and send to the server. A gateway node is used for connecting the two cluster head or node connecting the server and cluster head.

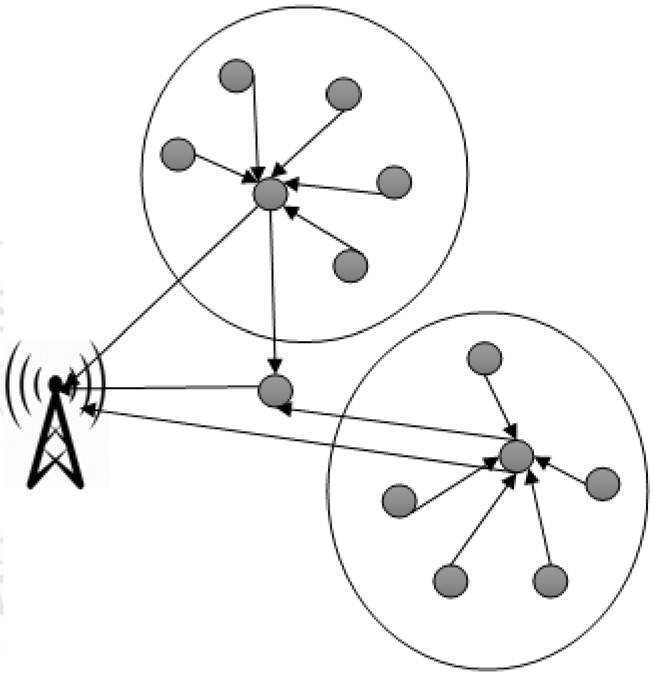

**Figure 2**: Clustering Architecture

Strategy 1 is one in which a Gateway appears that serves Link between sensor member and clusterhead $(CM \rightarrow GW \rightarrow CH \rightarrow SK)$. In second approach gateway is used for connecting the two cluster head $CM \rightarrow CH \rightarrow GW \rightarrow CH \rightarrow SK$.

### c) Cluster Maintainance

Sensor nodes started two Timers one is DATA_TIMER and other is UPDATE_TIMER. Standard for data transmission is set by the DATA_TIMER for receiving data packets. Member coordination among the nodes is maintained by the UPDATE_TIMER. Once a node is active a message packets sent to the parent node. UPDATE_TIMER defines the coordinator node for each of the Members, the default value is 20 seconds. If both member and cluster head received the update message then they confirm their connection. In defined time line UPDATE.RESP_TIMER is not received any message then it is understood that the connection is not established.

### d) Cluster Head Selection and Gateway Node Selection Process

For the selection of cluster head first time or a node lost their connection with its cluster head, a HELLO_TIMER is activated by the cluster head for sending the HELLO packet. Sender identity is verified each time after receiving the response. TIMER select a node as a cluster head which has maximum connectivity with other nodes and which received signal strength is higher. To enhance the network coverage time we also focused on the routing techniques in Sensor network. Hop count is required between transmissions of data from source to destination. Meanwhile quality of link is also considered for the successful communication between transmitter and receiver.

Residual Energy: Most of the WSN applications are handled by battery operated devices, so energy is considered as an important resource. Lifetime of the entire network depends on energy usage. The nodes which are near to sink will be overloaded in multihop transmission, this leads to uneven energy drainage and node drainout its battery soon.To avoid this problem, energy of the node should be considered during route discovery process. The nodes with good energy level can be considered as Gateway nodes from Cluster head to destination or MN to CH.

### e) Communication Protocol

In the IoT applications sharing of information among the devices are important requirement.

In the computerized IoT systems, data transmission and data sharing between machines are critical parameters which affect the performance of the whole system, and investigations in this area are increasingly gaining research interests. The new emerging standards, protocols, and cost reduction of the commercially available sensing and communication modules has promoted the progress of Device to Device (D2D) in industry applications.

D2D is featured with more communication nodes, lower bandwidth, real-time processing, and many nodes are required to be energy efficient. Since data is the most important concern in D2D systems, the unobtrusive collection, reliable transmission, and effective use of machine-generated data are the main tasks to achieve. The D2D systems are highly dependent on the IT infrastructure for data collection, sharing, and decision making.

- Heterogeneity in hardware and software platforms
- Frequent notification and peer machine observation
- Collaborative automation between machines
- Real-time event handling and data processing
- Data of various format and size to transmit

Therefore, the communication between the connected machines is expected to be:

- Cross-platform interoperable with basic standards
- Machine discovery and presence capability
- Flexible data interaction and event notification
- Reliable, efficient, and fast in speed
- Failure handling and recovery capability

Since more and more computing devices such as sensor nodes, RFID readers, smartphones, and laptops are integrated

## 3. Experimetal Result and Analysis

Windows 10 with 64-bit operating system having CPU @ 2.90 GHz processor used for the simulation study. This system having 1GB NVIDIA CUDA dedicated graphic card for better flexibility in UI related program. Our simulator is designed using .Net framework 4.0 and C# is used for programming language. Simulation study is based on the maximizing the network coverage time, nodes death and communication overhead in WSNs. This study analyzed considering different node density and our result is compared with existing base algorithm. Simulation parameter shown in table1.

**Table 1**: Network Simulation Parameter

| *Parameter* | *Value* |
|---|---|
| Sensor Node Energy | 0.1j |
| Number of node considere | 100,200,400 |
| Network Area | 25*25m |
| Data Transmission Speed | 100 bits/ses |
| N/W Bandwidth | 5000 bit/sec |
| Data Packet Size | 2000 bits |

### a) Network Coverage considering First node death

In Figure 3, network lifetime analyze for the 50nodes considering initial energy of node as 0.1 j and lifetime analyze for 1st death of sensor for both proposed and existing system. We observed that the first sensor death for existing system occurred after 550 rounds while for proposed system first death of sensor occurred after 936 rounds.

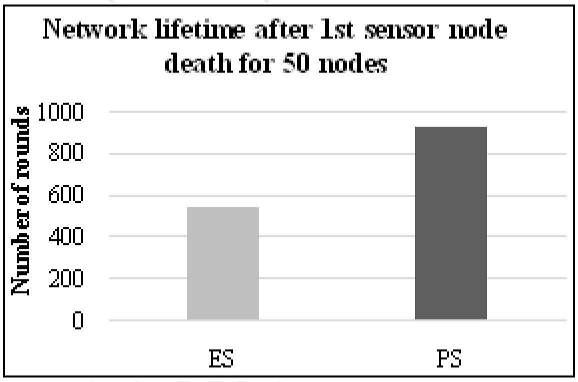


**Figure 3:** Network lifetime for 50 nodes considering 1st node death

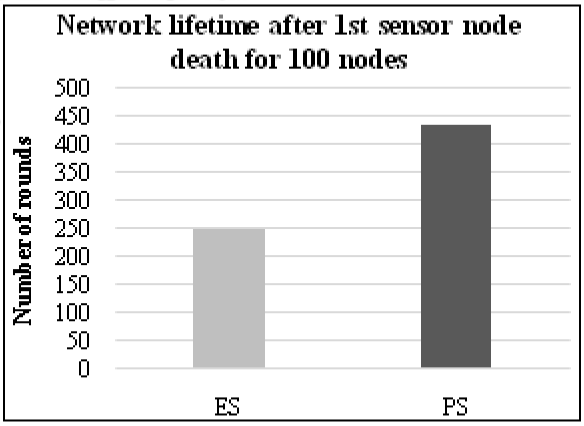


**Figure 4:** Network lifetime for 100 nodes considering 1st node death

In Figure 4, network lifetime analyze for the 50 nodes considering initial energy of node as 0.1 j and lifetime analyze for 1st death of sensor for both proposed and existing system. We observed that the first sensor death for existing system occurred after 250 rounds while for proposed system first death of sensor occurred after 436 rounds. From Figure 2 and 3 we can analyzed that as number of sensor nodes increases in the network, lifetime of the network reduced. This is a concerned for the IoT system.

**b) Network Coverage considering After 50% node death**

Figure 5 represent the lifetime analysis for 100 nodes and initial energy is consider as 0.1j. we analyzed that system performed well for 100 nodes considering 50 node death, total number of rounds for existing system after 50% node death is 436 while for proposed system 50% node death analyzed after 1048 rounds. IoT application require stable network which is able to send the sensed data to cloud for more time.

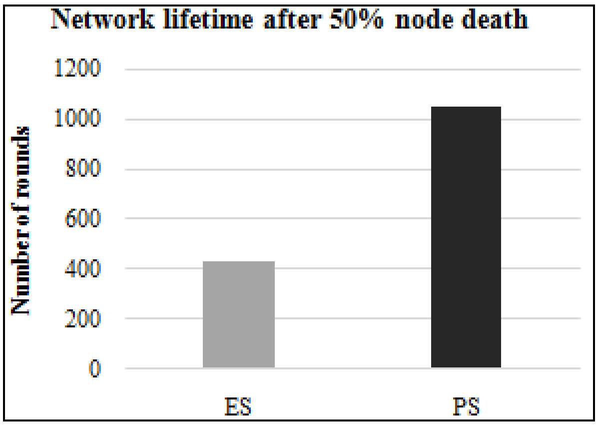


**Figure 5:** Network lifetime after 50% node death

## 4. Conclusion

IoT application require robust network for performing the required operation. IoT network root is the sensor nodes which is performed the sensing operation. The approach uses the combination of IoT and cloud computing that promotes the fast development of many application such as security, home automation, agricultural application, industrial application etc. for this sensor node network lifetime is required to be enhanced and hence in this paper we focused on the sensor node network lifetime and we analyzed that network lifetime of proposed system is better than existing system. In future we will configure sensor with cloud and end user devices such as mobile.

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