National Conference on Recent Trends in VLSI, Communication and Networks 2018 (RTVCN2K18) ISSN: 2454-4248
Volume: 4 Issue: 5 16– 20

Power Management in Content Centric Routing in Internet Of Things

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Abstract— The term 'IoT'(Internet of Things) refers to the interconnected global network of physical objects that contain embedded technology based on communication, sensory, processing and networking, which enables them to interact within themselves or the external environment. IoT networks consist of large heterogeneous wireless devices. IoT networks can be used for many applications include smart energy, smart health, smart buildings, smart transport, smart industry, smart city, etc. Gathering large amounts of data in IoT networks cause traffic congestion and reduce the energy efficiency in the networks. In order to solve this problem, the content centric routing (CCR) technology is used, where routing paths are determined by content. The main problem in existing CCR is power consumption. In this paper proposed new system having different modes to reduce the power consumption of existing CCR.The simulation of CCR protocol has been done using NetBeans.

IndexTerms-*IoT, Routing, Data aggregation, Content Centric*

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I. Introduction

Internet of things (IoT) is defined as ,the ability of network devices to sense and collect data from the world around us, and then share that data through the internet. The large-scale implementation of IoT devices promises to transform many aspects of the way we live. For consumers, new IoT products like home automation components smart home, smart cities etc. In fact, one of the most important elements in the IoT is wireless sensor networks (WSN). That helps in connecting both WSN and other IoT elements go beyond remote access, as heterogeneous information systems can be able to collaborate and provide common services. The idea of internet of things (IoT) was developed in parallel to WSNs. Internet of things was devised by Kevin Ashton in 1999. The emerging wirelessly sensory technologies have significantly extended the sensory capabilities of devices and therefore the original concept of IoT hence is extending to ambient intelligence and autonomous control. A number of technologies are used in IoT, such as wireless sensor networks (WSNs), barcodes, intelligent sensing, RFID, NFC, low energy wireless communications, cloud computing and so on. Evolutions of these technologies bring new technologies to IoT [3].

The IoT describes the next generation of internet, where the physical things could be accessed and identified through the Internet. In the last decade, the RFID-based identification has been widely used in logistics, retail, and pharmaceutics. Since 2010 with the advances in intelligent sensors, low energy wireless communication, and sensor network technologies, a large number of 'things' can be networked as an IoT. The success of IoT depends on the standardization, which provides interoperability, compatibility, reliability, and effectiveness of the operations on a global scale. Objects in an IoT must be able to communicate and exchange data with each other autonomously. When millions even billions of things can be integrated seamlessly and effective, IoT can be applied widely in numerous areas.

The remainder of this paper is structured as follows. In section II, provide a literature survey of different energy efficient routing protocols and related papers of IoT. Section III provide the comparison of different energy efficient routing protocols. Section IV describes the existing system. Section V describes existing CCR and its simulation results. The proposed CCR and its simulation results is provide in section VI. Finally the conclusion is given in section VII.

II. LITERATURE SURVEY

Routing Protocols

Jau-Yang Chang provide a Distributed Cluster Computing Energy-Efficient Routing Scheme for Internet of Things Systems.To provide reasonable energy consumption and to improve the network lifetime for the internet of things systems, efficient energy saving schemes must be developed. The proposed technique is to reduce the energy consumption and to extend the network lifetime for the internet of things systems.The main goal is to reduce the data transmission distances of nodes by using the cluster structure concepts. For selecting a suitable cluster head node, calculating the sensing nodes center of gravity and also calculating the residual energy of each sensing node in the cluster. Using cluster architecture,the data transmission distances between the sensing nodes can be reduced[7].

In 2014 Sang-Hyun Park,Seungryong Cho,et al.proposed an Energy-Efficient Probabilistic Routing(EEPR) Algorithm for Internet of Things.The proposed algorithm, which controlsthe transmission of the routing request packets stochastically in order to increase the network lifetime and decrease the packet loss under the flooding algorithm. The EEPR algorithm use energy-efficient probabilistic control ,the residual energy and ETX. EEPR algorithm stochastically controls the number of the RREQ packets using the residual energy and ETX value of a link on the path and thus facilitates energy-efficient route setup[9].

OanaIova,FabriceTheoleyre published a paper related to a multiparent routing in RPL .This routing increase the stability and the lifetime of the network.Energy is a very scarce resource in Wireless Sensor Networks. Most of the routing proposals concentrate on minimizing the energy consumption. To improve the network lifetime,each node should consume thesame quantity of energy.The Expected Lifetime metric, represents the residual time of a node. They design mechanisms to detect energy-bottleneck nodes and to spread the traffic load uniformly among them. Moreover they apply this metric to RPL,the de facto routing standard in low-power and lossy networks.In order to avoid instabilities in the network and problems of convergence,also they propose here a multipath approach. The proposed paper utilize the Directed Acyclic Graph (DAG) structure of the routing topology to probabilistically forward the traffic to several parents[4].

An Energy-Efficient Content-Based Routing in Internet of Things is introduced by SamiaAllaouaChelloug.The Internet,sensor networks,and Radio Frequency Identification (RFID) systems has shared to the concept of Internet of Things (IoT) which is capable of connecting daily things,making them smart through sensing, reasoning, and cooperating with other things.Further,RFID technology enables tracking of an object and assigning it a unique ID.IoT has the potential for a wide range of applications relating to healthcare, environment,transportation etc. The Energy-Efficient Content-Based Routing (EECBR) protocol minimizes the energy consumption in IoT networks.The proposed algorithm makes use of a virtual topology that is constructed in a centralized manner and then routes the events from the publishers to the intended interested subscribersin a distributed manner[10].

Tie Qiu,et al.provides a Efficient Tree-based Self-Organizing Protocol(ETSP) for Internet of Things in 2016.Tree networks are widely applied in Sensor Networks of Internet ofThings (IoTs).In ETSP, the nodes are divided into two kinds:network nodes and non-network nodes.Network nodes can broadcast their packets to neighboring nodes. Non-network nodes collectthe broadcasted packets and decided whether to join the network.During the self-organizing process,they use different metrics such as number of child nodes, hop,communication distance and residual energy to reach available sink nodes weight,the node with max weight will be selected as sink node. Non-network nodes can be turned into network nodes when they join the network successfully.Then a tree-basednetwork can be obtained one layer by one layer.The topology is adjusted dynamically to balance energy consumption and prolong network lifetime[8].

In 2016 YichaoJin ,SedatGormus,et al. proposed a Content centric routing(CCR) in IoT networks and its integration in RPL.Gathering large amounts of data inIoT networks including images and videos often cause traffic congestion in the central network area.The proposed (CCR) technology,where routing paths are determined by content.Hence effectively reducing the traffic in the network. As a result, significant latency reduction can be achieved.Moreover, redundant data transmissions can also be eliminated after data aggregation which reduces the energy consumption in the networks [1].

III. COMPARISON OF ENERGY EFFICIENT ROUTING PROTOCOLS

Table I. Comparison Of Energy Efficient Routing Protocols

Proposed Protocols	**Energy Efficiency**	**Network Lifetime**
Distributed Cluster Computing Energy-Efficient Routing	70%	1000s
Energy-Efficient Probabilistic Routing Algorithm	71%	1300s
Using Multiparent Routing in RPL	73%	1400s
Energy-Efficient Content-Based Routing	74%	1500s
An Efficient Tree-Based Self-Organizing Protocol	75%	1600s
Content Centric Routing	82%	2000s

By comparing different energy efficient routing approaches, on the basis of energy efficiency and network lifetime content centric routing is better among them, content centric routing is 82% energy efficient.

IV. EXISTING SYSTEM

Distributed computing in wireless networks has recently been attracting a lot of attention, especially in the emerging paradigm of the Internet of Things (IoT) communications where IoT devices are equipped with independent processing,communication,and storage capabilities.In many cases, data collected for the same application tends to be highly correlated and therefore can be combined or jointly processed while forwarding to the sink [11].

Fusing together multiple sensor readings related to the same physical event.Such data aggregation process can reduce the total amount of messages to be sent over expensive wireless links, which has a significant impact on energy consumption as well as overall network efficiency[1].On the other hand, uncorrelated packets might not be simply aggregated from the processing point of view.

Take the tunnel monitoring system as an example which is shown in Fig.1 variety of sensor nodes and cameras are installed to monitor two key tunnel assessments: tunnel structure safety and traffic management, where a huge amount of real-time sensory data including images and video streams needs to be delivered to a remote control center.Traditionally, the server first collects all the data via the same routing topologyregardless of whether the data is used for tunnel safety or traffic management.This case is illustrated in Fig.1 (A). Take Node 1 for example, it sends both Tunnel safety data A and traffic data B to node 5 as they are treated as the same.Once all data reaches the destination, the final results are computed at the server side. However, this is very likely to create a hot-spot problem, where heavy network traffic in the central area results in higher energy consumption on the neck nodes and is also prone to traffic congestion events.This is due to the fact that the neck nodes are geographically closer to the access point/server.

By using content centric routing(CCR) this problem can be rectified[12].CCR differentiate data by its content while routing information, and correlated data are termed as the data of the same content. In Fig.1(B), since both Node 1 and Node 3 provide information for traffic conditions, rather than sending content B to Node 5 as shown in Fig.1 (A), Node 1 sends it toNode 3 where they can be combined or aggregated while forwarding to the server. Intermediate results such as heavy traffic warnings can be computed within the network.

As a result,two distinctive routing topologies based on content A and B are created in CCR. This can help to reduce the amount of redundant data sent over the network and also the time lag in the communication system, saving limited node energy and extending the network lifetime.CCR provides a paradigm shift from traditional ways of data collection to content oriented data aggregation and retrieval.This change could bring several attractive advantagessuch as energy efficiency,fast system response,long network lifetime etc.and provides a way to solve the data explosion problem for the future IoT network.

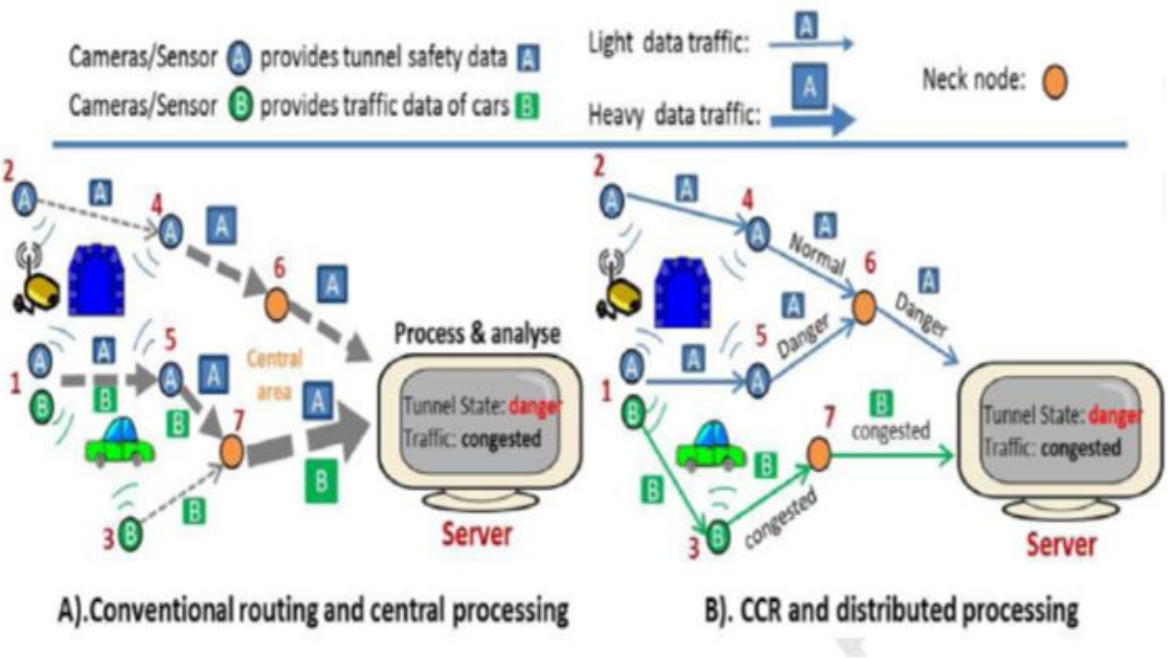

Fig. 1. Conventional routing vs. CCR [3]

CCR's operation includes three main functions: trigger function,objective function, and routing updates with loop detection function. The trigger function decides how frequently to execute the CCR objective function. The objective function constructs a separate routing entry for each content in the routing table.Lastly, an effective loop avoidance mechanism is designed in order to detect communication loops and conserve the limited amount of energy stored at each node[2].

V. EXISTING CCR AND SIMULATION RESULTS

Here NetBeans tool is used to simulate CCR. This tool is an open source integrated development environment and also itis a framework for simplifying the development of java applications.The Fig.2 shows the simulation of existing CCR in NetBeans.

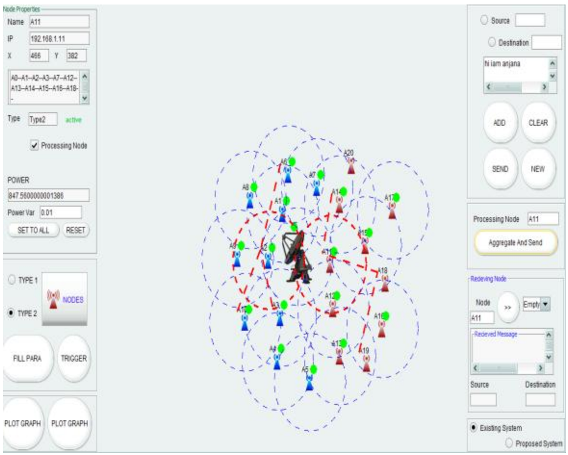

Fig. 2. Existing CCR evaluation in NetBeans

In existing CCR, all the nodes are active. The green color in simulation result of CCR shows the active nodes. The blue and red color indicates the two different types of nodes which have two different types of contents. The content is named as Type 1 and Type 2.The central black color indicates the base station.

From the Fig 2,multiple routing path is shown, same type of content is send through the same routing path. After getting the data the corresponding processing node aggregated the data's and forwarding to the server. So here the routing path is selected based on the contents. The contents may be images, videos, text etc.

By routing based on contents can be effectively reducing the traffic in the networks. One of the main limitation of the existing CCR is power consumption, because all the nodes are active in whole-time. Fig.3 shows the power consumption of nodes vs simulation time.

From Fig.3graph it can be understand that ,as the simulation time increases the power consumption of the nodes also increases

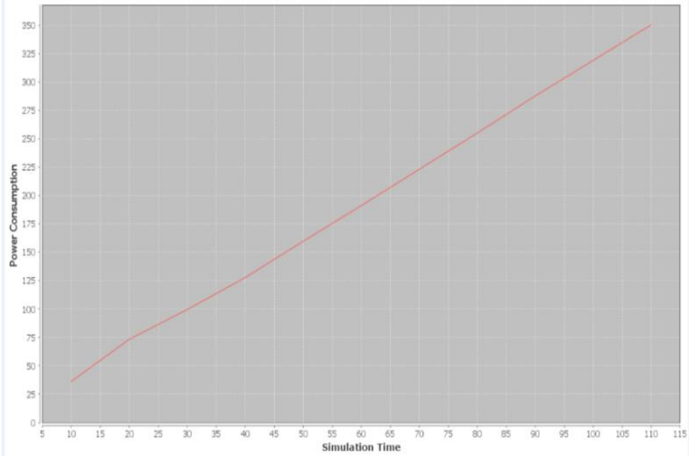

Fig. 3.Power consumption vs. simulation time

VI. PROPOSED CCR AND SIMULATION RESULTS

One of the main limitation of existing CCR is power consumption. So to reduce the power consumption , here applying three modes in CCR: active mode ,semi sleep mode , sleep mode. So in proposed CCR, first all nods are initialized as in semi sleep mode. The nodes in semi sleep mode consume only 50% of the total power. The semi sleep node have a sensing channel, this channel is always on so when an event arrived the semi sleep nodes become active and transmit the data to the destination. Some of the nodes in the network is sleep only when they have neighboring nodes, so when an event occur, the data is send through these neighboring nodes.

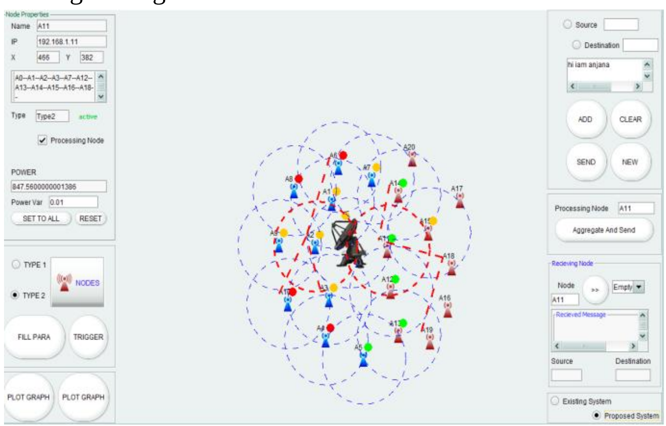

Fig. 4. Proposed CCR evaluation in NetBeans

The Fig 4 shows the proposed content centric routing. Here the green colour indicate the active node, yellow colour indicate the semi sleep node and red colour indicate the sleep node. So in the proposed system the nodes become active only when the necessary situations, and all other time the nodes are in semi sleep and sleep mode. So this can reduce the power consumption in the network.

In the proposed CCR the power of each node is initialized a 1000 W and the power variable is set as 0.01. The power variable is the value of decrementing power in active mode. In the proposed system the routing of content is carried out by the routing table. A routing table contains the information necessary to forward a packet along the best path toward its destination. Each packet contains information about its origin and destination. When a packet is received, a network device examines the packet and matches it to the routing table entryproviding the best match for its destination. The table then provides the device withinstructions for sending the packet to the next hop on its route across the network. Fig 5 shows the power consumption vs simulation time of existing and the proposed CCR.

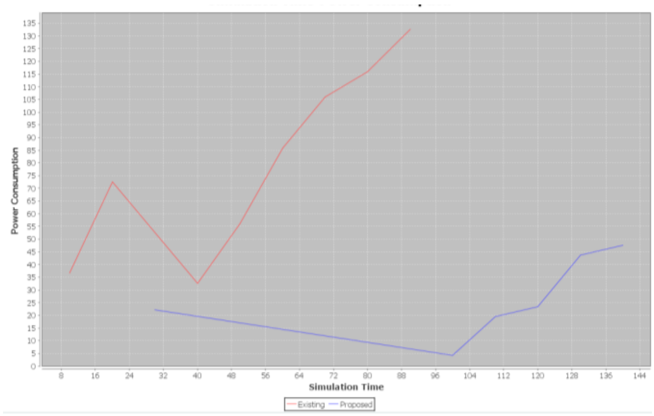

Fig. 5. Power consumption vs simulation time

The above graph shows the simulation time vs power consumption of existing and proposed CCR. Here the red line indicates the existing system and blue line indicates the proposed system. The above graph shows the power consumption of nodes in the network at various time. From the graph it clearly shows that the nodes in proposed system consume less power than existing system.

VII. CONCLUSION

Content centric routing is distributed approach which considers the traffic reduction gain achieved through content centric data aggregation. Based on the content of a message, each node constructs a separate routing path for each content type by using a novel objective function. The content centric routing greatly reduces the communication traffic. The main limitation of the existing CCR is power consumption. This power consumption is reduced by the proposed CCR by setting the nodes in three modes: active mode, semi sleep mode, sleep mode. The simulation results confirm that proposed CCR consume less power than existing CCR.

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