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IoT Integrated Energy Efficient Wireless Sensor Networks Application for Healthcare

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ABSTRACT

In the Internet of Things, smart objects communicate with each other, data are gathered and certain requests of users are satisfied by different queried data. The development of energy efficient schemes for the IoT is a challenging issue as the IoT becomes more complex due to its large scale the current techniques of wireless sensor networks cannot be applied directly to the IoT. Since energy efficiency is of utmost importance to these battery constrained IoT devices, IoT-related standards and research works have focused on the device energy conserving issues.

This paper presents a comprehensive survey on energy conserving issues and solutions in using diverse wireless radio access technologies for IoT connectivity. To achieve the green networked IoT, this paper addresses energy efficiency issues by proposing a novel deployment scheme. The simulation results show that the new scheme is more energy efficient and flexible than traditional WSN schemes and consequently it can be implemented for efficient communication in the IoT.

The development of energy efficient schemes for the IoT is a challenging issue as the IoT becomes more complex due to its large scale the current techniques of wireless sensor networks cannot be applied directly to the IoT. To achieve the green networked IoT, this paper addresses energy efficiency issues by proposing a novel deployment scheme.

Keywords: *IoT, Wireless Sensor Network, Battery, Energy efficiency*

I. INTRODUCTION

The Internet of Things (IoT) has been visualized as the communication and integration of smart objects (things). The dominance of IoT leads to a novel context of upcoming services and applications. These sensors and actuators (e.g., surveillance cameras, home appliances, and environment monitoring sensors) are typically equipped with different kinds of microcontrollers, transceivers, and protocols for communication of sensing and control data.

These real life objects, either sensors or actuators, are connected with each other to transfer their sensed data to centralized servers, where information is collectively stored and made available for particular users with proper access rights.

Devices in such IoT networks will typically operate based on battery power sources, and hence, energy efficiency is naturally of utmost importance in device management. Looking into a particular Wireless Sensor Network (WSN) domain, energy efficiency for battery operated sensor nodes and lifetime prolongment have been research issues for so long, where Medium Access Control (MAC) layer protocols focus on adjusting the duty cycle for sensor nodes, and routing layer protocols are designed for data aggregation and many-to-one transmission. Similarly, since IoT devices operating in the IoT network paradigm are also battery operated, battery consumption should be kept in mind during IoT network deployment.

This paper examines the literature with a specific focus on wireless networking aspects for IoT energy conservation. The remainder of the paper is organized as follows. In Section 2, we provide basic information about IoT network architectures, IoT device structures, and various applications. In Section 3, we discuss some possible issues that can cause battery drainage of IoT devices and hence affect the lifetime of IoT devices and networks. In Section 4, we review energy conserving solutions provided in different kinds of literature. In Section 5, we propose important research directions regarding energy conserving issues for wireless networking- based IoT and we give concludingremarks.

Internet of Things (IoT):

IoT is an emerging technology used in various applications such as, home automation, health care, industries, market, etc. It is attracting considerable attention from both public and private sectors. IoT network is referred as smart network, because the availability of intelligent and low cost devices, which works autonomously with its sensing, computation and communication capabilities.

Also the proliferation of IoT offers opportunities but may also bear risks. A hither to neglected aspect is the possible increase in power consumption. IoT devices are expected to be reachable by other devices at all times. This implies that the device is consuming electrical energy even when it is not in use for its primary function. Billions of such devices therefore raise concerns regarding excessive standby energy consumption, even if the individual device has only moderate power needs.

This paper investigates the standby power of novel mains connected IoT devies and their estimated impact on the worldwide standby energy consumption. Traditional network-enabled devices like personal computers, tablets, mobile phones, game consoles, set-top boxes, and smart TVs, as well as network infrastructure equipment and data centers, are not covered. The scope of this study is highlighted in yellow in figure 1 below. The report further assesses the related IoT communication technologies as well as the relevant standardization activities.

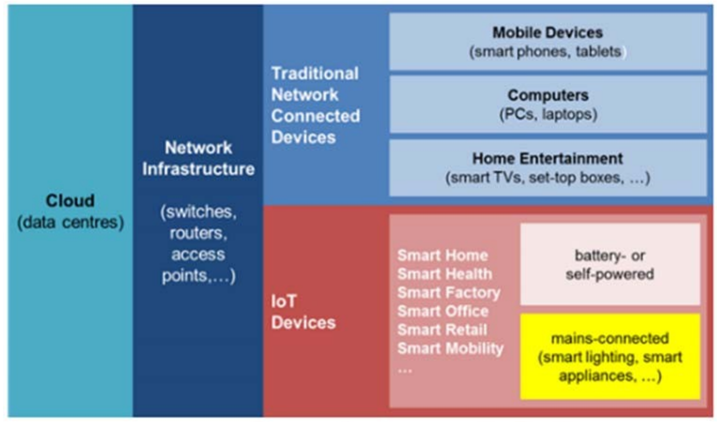

Figure 1.System overview and scope of study (yellow)

Since IoT comprises a very wide variety of industries and applications, we have first structured the IoT space according applications. Then they have been prioritized regarding their standby energy potential based on the estimated proliferation.

The IoT is a term that's bandied around quite a bit these days, simply put, the IoT consists of a patchwork of hardware, software and services all working together to gather and transport information, analyze data, and then use that data to make decisions that improve the efficiency of specific tasks The devices that populate the IoT ecosystem range from smart appliances and automobiles, to wearable and everything in between. While they may differ in application and use, each of these devices makes use of four critical components: sensing,

The project had the following objectives: Provide an overview of the structure of IoT and priorities the categories with the highest energy impact potential based on expected proliferation. Assess energy consumption for prioritised categories based on current technologies and measurements, including analysis of the impact of options to reduce energy consumption. Develop initial high-level recommendations for policy objectives and measures. Identify the most important topics, which should be investigated in further work.

The energy efficient based IoT

A lot of research has already been reported for efficient communication in WSNs for the deployment of a green IoT but little work is found concerning energy efficient communication for a scalable IoT. Routing protocols can be categorized into three types.

- Energy efficiency-based;
- Reliability and network operation-based
- Network operation-based.

The traditional technologies like home automation, wireless sensor networks and control systems will become more efficient and smarter due to involvement of IoT. IoT is having a wide range of application areas. Such as Medical applications for monitoring the health of a patient and sends the information wirelesses.

The present developing Wearable instrumentation is also based on IoT. The example wearable instrumentation is Smart wrist bands, navigation pills, etc. All this methods require an internet interface to update the health info or to control the device with a smart phone. The IoT also plays a vital role in media applications for advertising and exchanging the information worldwide. The manufacturing processes also requires IoT for supply chain management, digital control systems for monitoring the manufacturing processes. IoT in automobile applications and traffic maintenance became a most using area of automation. The automated devices in a vehicle should be connected to a cloud to update the car health within a period of time. By connecting the vehicles and traffic signalling systems to the internet, people can easily find the shortest path for their destination from the traffic monitoring systems and can navigate automatically by checking all other directions

Energy Monitoring of IoT

We realize that buildings can be very different from each other and it is extremely important to find the common “thing” or pattern among them in terms of energy efficiency. So in our project we talked to some on-campus building maintenance experts thoroughly and investigated the common structure of these buildings [12]. We found that for such small office buildings or home buildings, it is relatively simpler and easier to apply networking technologies to control or change their energy policy. In comparison, large buildings like our tested are more difficult to change and it is also one of the reasons why in this paper we primarily focus on such large office buildings. With our findings in this testbed, it is relatively easier to tailor and generalize the system to solve the issue with other buildings of the same type or different types.

ENERGY EFFICENCY ALGORITHM BASEDIOT

SystemModel

Complexity in the IoT is higher than in WSNs, as it has a large number of objects and due to this reason it has a large scale. Dynamic routing for WSN architectures is not suitable in large scale areas. Dynamic routing used in the WSN environment is difficult to use for large-scale networking such as IoT. In general, dynamic routing is difficult to use effectively because sensor transmission is highly sensitive to factors such as air, humidity, temperature, and interference. A stable topology suitable for IoT with large networks can allow static routing to participate in more energy-efficient communication than dynamic routing. Therefor we are considering the above factors we propose static and energy efficient routing for a scalable and complexIoT.

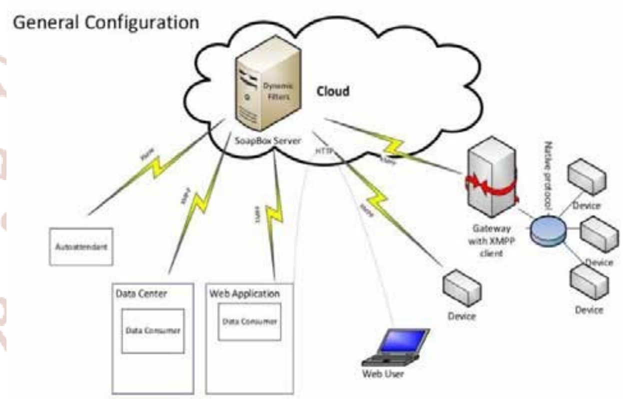

Figure 2: General configuration

We have used the same tiered framework as used except for the relay layer which is not used in our framework, as can be seen in figure 2. It presents the hierarchical network structure where all objects placed are static and follow the transmission Our proposed summarize the research on the topic into three sequential keyaspects:

1. Energy Efficiency of IoT: Through communication networks, the consumption and generation of energy are monitored and logged in different granularities including the whole building, floors, departments, labs, rooms, and even occupants.
2. Energy Modeling and Evaluation: Through off-line modeling and evaluation, identify the energy consumption patterns and factors that may influence the consumption and the extent of the irimpact.
3. IoT System to Apply Practical Changes and Strategy Adjustments: The modeling and evaluation results are used to identify the key energy components of the building, to apply adjustments, and to devise strategies to reduce energyconsumption.

The most important advantage of AODV is its ability to heal itself in case of node failures. It finds the shortest path from source to destination, based on the hop count. For resource constrained wireless sensor network, energy level of the node has to be considered. In proposed work routing residual energy considered for route discovery process. The main objective of this paper is to enhance the network lifetime to achieve an energy efficient IoT, so the optimization for IoT based on the above constraints can be modeledas:

$$T_E = \min\left[\sum_{u \in NM} E_u + \sum_{v \in RM} E_v + \sum_{x \in CH} E_x + \sum_{y \in CCO} E_y \right] \qquad (1)$$

The energy optimization problem is to reduce total energy consumption TE . There are other issues for efficient IoT-like robustness, and timely delivery of data which are covered in this paper, but the first and foremost requirement is to minimize the energy depletion of the nodes which are performing various roles.

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 drinage and node drain out its battery soon. In an IoT environment composed of WSNs, 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 intermediate nodes from source to destination. The residual energy (Er) of node is defined as Units (2).

$$E_r = {E_r}/{E_{\max}}$$

Er is remaining energy of the node and Emax is maximum energy available in the node. D. RREQ packet format AODV protocol use route request (RREQ) packet for route discovery from source node to destination node. To implement the Er in AODV, it should be added in RREQ control packet. This paper proposed figure 3 describes the RREQ packet format with Residual Energy (Er) information. By adding this information in control packet, AODV selects the path based Hop Count and Residual Energy.

Type	Flags	Reserved	Hop count
RREQ (broadcast) ID			
Destination Address			
Destination Sequence Number			
Original Address			
Original Sequence number			
Residual Energy			

Figure 3. REEQ packet format

E. Route selection by destination node based in Er value

Route selection of AODV protocol is done by destination node. When the destination node receives route request, it discards further route request and starts sending the route replay to the source. The Figure 4 shows the path selection procedure of the destination node in the IoT environment considering energy efficiency.

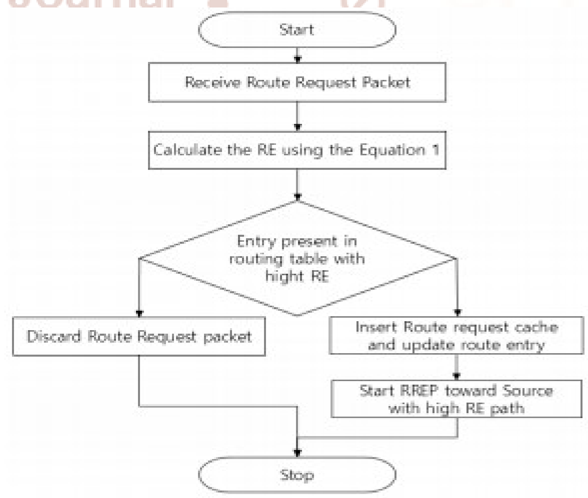

Figure 4. Minimum Er path selecting by destination node

The proposed method considers the residual energy of the IoT device to improve energy efficiency. figure 4 show the path selection step of the destination node considering the residual energy(Er) of the IoT device. It selects the node, which has good Er. After starting RREP timer, destination node sends reply RREP to each RREQ packet stored in cache. After data transmission it removes all the entries in the cache.

SIMULATION RESULTS

This paper, Performance evaluation of hierarchical relay node placement with Energy efficient routing mechanism *RE* (AODV) is done. The comparison between random node deployment and proposed architecture is evaluated by the used of NS2 (NetworkSimulator-2).

Simulation setup

Simulations of the proposed scheme have been performed by the Network Simulator version 2.35 on the Linux Ubuntu version 14.04. The experimental environment is shown in Table 1. 50 joules is used as initial energy for sensor nodes and 60 joules as initial energy for Relay nodes. Relay nodes transmit the data to sinknode.

Simulation Results:

Description	Default
Routing Protocol	AODV, AODV(RE)
MAC /Physical Layer	802.11
Channel Type	Wireless
Radion Propagation Model	Two Ray Ground
Traffic Type	Constant Bit rate
Antenna Model	Omni Directional
Initial node energy	50J
Initial relays energy	60J
Total number of nodes	68

PerformanceEvaluation

Network lifetime: The network is said to be energy efficient network based on its network lifetime. Balancing the energy consumption will prolong the network lifetime and prevent the network from energy whole problem. The lifetime of the network is estimated based on first death node, because when first node starts drain out its energy, within a short span of time all other nodes will drain out its energy. The reason for quick node death after first node death is, after first node death the second node will carry the data load of fist node, hence it will be overloaded and leads to battery drain out. After second node death, the data overload of first and second will be given to thirdnode.

Similar all the nodes in network drain out its battery. In simulation result, the first node death in random placement of relay occur at 140thsecond, in proposed network architecture first node death occur at 200thsecond. In random placement of relay nodes, all the nodes losses its energy in 400thseconds. Also In proposed architecture, only 15 nodes losses its energy after entire simulation period. This shows, the proposed network architecture performs uniform energy consumption and gives better network lifetime.

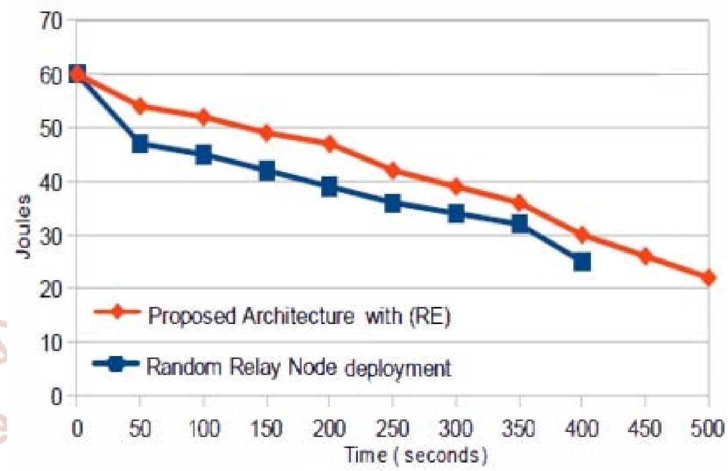

Figure 5.Average energy consumption of node

Average Energy consumption of nodes: Energy efficiency of the network is directly related to average energy consumption of nodes. The performance and lifetime of the network depends on balanced energy consumption of nodes. In Fig. 4 the average energy consumption of relay nodes are in balanced way (uniform). This says the proposed network architecture, gives balanced energy consumption of nodes. From above results it is understood that, the effective combination of node placement and routing mechanism gives energy efficient network.

CONCULSION

In this section, we suggest a few research directions for energy conservation in wireless networking-based IoT. IoT is referred as low power smart device network. Implementing required smart device for particular application and maintaining the network for long time are the two important considerations of loT network. Utilizing the energy in efficient way is the main goal of loT network.

In this paper, hierarchical network architecture is proposed to solve the energy whole problem and suitable routing mechanism is implemented to handle low power devices (battery operated). Common problem affects the network lifetime is uneven energy consumption, this problems are taken care in proposed work. Our simulation result shows, the proposed architecture gives balanced energy consumption, better network lifetime. Hence it is concluded that, proposed network architecture is more suitable for WSN and loT applications.

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