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Network Blueprint for Maximizing the Lifetime of Smart Devices in Low Power IoT Networks

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ABSTRACT

In the modern communication and computation era, internet of things (IoT) is developing as the key technology that satisfies the requirements of various applications. Prolonging device lifetime and maintaining network reliability is the evident objective for IoT network. Therefore, the authors come up with the network architecture that integrates node placement technique and routing technique. In the architecture, node placement is implemented by varying the density of nodes, by varying battery level of nodes, and by varying transmission range of nodes. Energy efficient and reliable path computation is addressed by routing technique. Therefore, enhancing the features of routing and node placement technique and integrating them together in network architecture can efficiently prolong the network lifetime. From the results, the authors observed that the proposed network architecture prolongs the network lifetime two times better than the standard model and also outperforms EQSR protocol and maintains the reliable data transfer.

KEYWORDS

Energy Efficiency, Internet of Things, Network Architecture, Node Placement, Routing

1. INTRODUCTION

IoT is famed as a unified technology that organize the Internet-enabled devices and attains global information sharing. The main aspiration of IoT is to accomplish efficient resource utilization. Therefore IoT technology is implemented and practiced in many private organizations (Smart retail and e-health) and public organizations (smart city and smart grid). In future, IoT will be indispensable for several applications. In the Internet of Things, the word "Things" includes the objects that includes RFID tag to aircraft, and with the help of networking technology, these "Things" are connected to the global network infrastructure. Therefore, by utilizing IoT technology, any object from anywhere at any time can be connected globally (Al-Fuqaha et al., 2015; Atzori et al., 2010; ITU & Unit, 2005) IoT can be referred as "Expanded Internet", since it converges the internet enabled smart devices (sensor/actuator, RFID, Bio-chip, drones, multimedia device, etc.) with existing Internet architecture. In IoT applications, Internet featured IoT devices work more smartly with their basic capabilities such as

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identifying, sensing, tracking, deciding, actuating, etc. (Botta et al., 2016; Gubbi et al., 2013; Lee et al., 2011; Vasseur & Dunkels, 2010).

In Figure 1 the overview of IoT architecture is represented. IoT architecture is elaborated based on IoT reference model which is developed by the CISCO. It is an integration of query oriented data processing layers, event oriented data processing layers and data accumulation layer. In an IoT network, IoT devices process the data, and they transmit the data globally. The IoT reference model is comprised of seven layers, which is required to maintain complete IoT system. In Figure 1, lower layers are referred to event oriented data processing layers. In IoT-WF, lower layers (edge computing layer, connectivity layer and edge device layer) aggregates and computes real time data. Where higher layers (collaboration and processes layer, application layer, data abstraction layer) aggregates and computes non-real-time data.

Data storage is organized by data accumulation layer (middle layer). Energy efficiency and reliability need to addressed in lower layers of IoT, since they are not sourced by power grid. Achieving efficient energy utilization among smart objects and maintaining reliable data delivery in IoT network is the major challenge. Designing efficient storage devices and temperature dissipation maintenance is the prime need in Data accumulation layer, since they store huge amount of data or bulk data. Data processing is the major concern in higher layers (collaboration and process layer, application layer, data abstraction layer). In IoT applications, various types of data from various applications will be generated. Processing the data from multiple resources, maintaining and responding them for user query is the challenging task in IoT. Security, Interoperability and scalability are other major challenges in IoT since IoT applications handle multiple devices in common network platform. In this paper, we are concentrating on challenges (energy efficiency and reliability) faced by lower layers of IoT-WF. To improve the energy efficiency and reliability the communication unit need to be concentrated.

1.1. Communication Unit Optimization

The Smart device is designed by various components such as transmitter and receiver antenna, transducer, processor, actuator. Among these components, the considerable measure of device power

Figure 1. IoT World Forum Reference Model