SURVEY ON SCHEDULING MECHANISMS FOR WIRELESS SENSORS IN IOT SCENARIOS

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Abstract - Extending the network life time is an essential component for many types of Wireless Sensor Network (WSN) used in IoT applications. IoT networks host Wireless Sensor Networks (WSNs) in great numbers with limited computing, sensing, and energy capabilities. The data aggregation and energy constraints pose a major problem in IoT networks. To maximize the system utility, we need to adopt scheduling mechanisms. The main purpose of scheduling algorithms is to minimize resource consumption and to ensure efficient data collection as IoT hosts variety of applications. To achieve network lifetime maximization of wireless sensor network which is a major enabler of IoT networks can be done by scheduling algorithms. In this paper, we survey and discuss the existing scheduling techniques best suitable for an IoT based system.

Keywords - Internet of Things (IoT), Wireless Sensor Networks (WSN), Scheduling, Energy, Data collection

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are broadlyusedin many areas for monitoring and sensing applications in IoT [1]–[2]. Since these nodes have energy constraints,it is very imminent to adapt an efficient scheduling mechanism for WSNs to save energy and for reliable data collection. As IoT hosts numerous applications like smart grids, smart homes and delay-intolerant applications like smart healthcare, the design of scheduling mechanisms is an important task as shown in Figure 1.The main challenges in the data collection of IoT Networks are there are massive amount of sensor nodes deployed, scheduling data transmission of these massive number of IoT nodes.

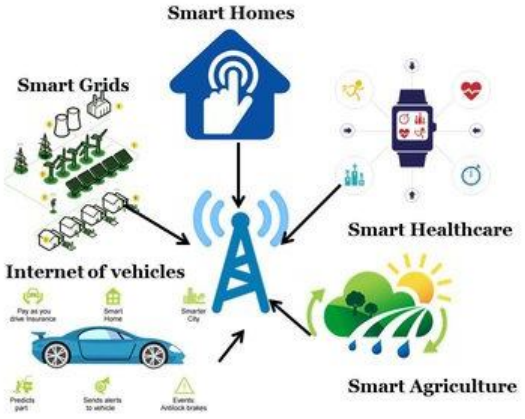


Figure 1: An example of IoT network with various applications

In IoT event-driven applications, This is very crucial to send data with low latency, so that an appropriate action can be initiated and the action can be complete. Therefore, the network design for IoT based on WSN's should aim to minimize the delay and dissipate less energy. WSN's form the major part of IoT and these sensors are very much resource-constrained, having finite processing ability, memory, and power of battery. They can be used in many applications which are deployed in remote areas like in smart agriculture. So reducing latency and conserving energy is a major aspect in the IoT environment.

In recent years, the energy problem and data aggregation in an IoT environment has been discussed a lot in the literature. This article covers a survey on existing scheduling mechanisms for data aggregation and energy reduction in a WSN enabled IoT scenario.

II. DATA AGGREGATION BASED SCHEDULING MECHANISM IN IoT

The main objections of data aggregation in an IoT scenario include data reliability, energy efficiency, latency and freshness of data collected. To schedule data aggregation is an important task as massive number of nodes is deployed, the routing scheme for each of the node should also be considered [3].The scheduling based on data aggregation are of two types, Scheduling by unslotted data aggregation and scheduling by slotted data aggregation.

First type of scheduling based on unslotted data aggregation helps to defeat the need for synchronization of network, as a massive number of IoT devices are involved [4].Further the unslotted type can be segregated to independent and dependent scheduling based on then the waiting time interval as shown in Figure 2. Mainly in unslotted schemes the clock drift among sensing nodes is allowed. The protocols that adapt this category of scheduling, grants every sensing node to make their radio on for a fixed time period. A WSN sensing node collects information then sends the consolidated decision to its parent using capillary communication to communicate. In scheduling of Unslotted data

aggregation, collisions occur when there are packets that are transmitted simultaneously. So this type of scheduling mechanisms cannot be deployed for IoT applications that are delay-intolerant.

Some protocols related to unslotted data aggregation include Delay sensitive feedback Control(DSFC) [5], Adaptive data aggregation for clustered WSN (ADAC) [6] propose to increase the data accuracy while collecting data from massive IoT nodes. While protocols like Directed Diffusion [7] decrease data latency. Aggregation Time Control Algorithm (ATCA), controlling timing at the time of aggregation of data operations of distributed sensor networks (TCDA) increase upstream data accuracy [8]-[9].

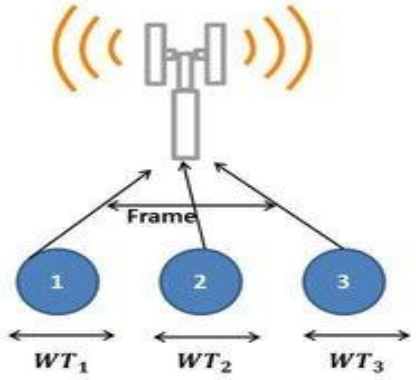


Figure 2: Waiting time interval in an IoT based network

Aggregation protocols using slotted data, integrate routing and MAC protocols together. Usually, the scheduling based on slotted data aggregation strives to minimize the data latency. So slotted scheduling mechanisms can be used for delay-intolerant applications. Some of the slotted scheduling mechanisms include, TDMA-based techniques, scheduling based on Distributed data Aggregation in WSN, Aggregation Converge cast Scheduling in WSN with some hybrid scheduling algorithms [4].

So based on the latency of the IoT applications we can deploy a particular scheduling mechanisms either slotted or unslotted mechanisms. The data aggregation principle should focus on the data aggregation scheduling protocols for efficient data retrieval.

III. ENERGY EFFICIENCY BASED SCHEDULING MECHANISM IN IoT

Since energy efficiency is a challenging task in energy constraint IoT nodes, there exists work in the literature to address this problem. Two main places for consuming power in an embedded system are the energy consumed because of switching activities and static energy consumed is because of leakage current. Scheduling based on energy-efficiency need to be exploited in IoT based applications for minimizing the energy consumption along with meeting the latency requirement of event based applications.

Few works proposes a model where the WSN nodes and IoT GW are in sleepmode considering the applications quality of service (QoS) requirements required for the particular application. But the event arrivals might be periodic or non-periodic in an IoT scenario involving a variety of applications. To model irregular event arrivals in IoT based systems, Real-Time Calculus (RTC)[11] can be adopted. But the arrival time of IoT data streams are non-deterministic. By considering this there are proposals to prevent buffer overflow on the system and the possibility to schedule the data streams [11].

Existing works on energy efficient scheduling algorithms depends on dynamic programming to control by which time to activate and deactivate the system for bursty traffic is useful in IoT applications. Further a framework for system at idle time helps the periodic traffic in IoT [12]. Many works exist on the basis of lowering power of devices and schedule based on their reporting times. This can be achieved by scheduling the sleeping and wake up time of IoT devices. Also many works on DRX is carried out in cellular IoT to control power consumption during the idle mode. Scheduling protocol can also be studied with focus on energy aware and QoS considering multipath cluster based scheme is used [12].K. Wongthavarawat et al. elaborated a scheduling scheme which supports QoS along with energy efficiency by considering various traffic classes [13].

Finally while choosing a scheduling algorithm for the IoT based applications, the algorithm should adapt dynamic requirements of IoT applications. Moreover it should schedule practical tasks having top priority confirming a minimum point-to-point data transmission delay suitable for delay-intolerant applications, energy efficiency and QoS in the system.

CONCLUSION

Sensor nodes are resource constrained and they are used in large numbers in IoT networks. Hence, scheduling and routing protocols are required to improve the energy conservation and lifetime of the IoT network. This paper describes various scheduling schemes based on data aggregation and energy efficiency in an IoT network. The impact of both data collection and the energy consumption inIoT communications increases transmission reliability, network throughput, reduce expected packet delivery delay, energy conservation in IoT.

ACKNOWLEDGMENT

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF−2016R1D1A1B03935633).

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