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A Flexible Non-Orthogonal Software Defined Data Aggregator for IoT Applications

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Abstract

A flexible rate non-orthogonal data aggregator is proposed and discussed for internet of things (IoT) applications. The proposed scheme aggregates the data of several IoT devices before transmission to the cloud for visualization and monitoring. The aggregation scheme is based on non-orthogonal multiplexing and similar to data multiplexing in quadrature amplitude modulation (QAM). Complexity reduced software-defined aggregator and de-aggregator operations are discussed.

Keywords: Data aggregation, Quadrature amplitude modulation (QAM), Internet of things (IoT), non- orthogonal multiplexing.

1. Introduction

Internet of things (IoT) is becoming more prevalent all over the world, wherever internet is within the range of access [1]. Sensors are getting the data from the environment [2], the human being's body [3] and the equipment [4] and send these data usually via wireless access technologies to the remote website, for monitoring and possibly control. Several wireless access technologies such as local WiFi, cellular generations, specifically 5G, LPWAN technologies may provide the required connectivity [5]. Due to the sharp increase in the number of IoT devices in recent years, where it is expected to rise, the role of data aggregators becomes important. Data aggregators combine the collected data from the local IoT devices and send them over internet, and work as an access point, as well.

Data aggregation for IoT has been addressed in several reported researches among them [6], [7]. Importance of data aggregation in IoT is to save the spectral efficiency, to increase the network lifetime by decreasing the number of transmissions, and to add some levels of physical layer security. The reported types of data aggregation for IoT are tree- based, cluster-based and centralized [7].

In this paper, a non-orthogonal data aggregation scheme is proposed and discussed for IoT applications. The proposed approach compresses the data of multiple sensors to one ready symbol to transmit, where it helps in improving the spectral efficiency at the verge of spectrum scarcity. The proposed approach combines the digital information of several sensors based on their importance into one symbol and transmits the symbol over the channel for presentation over the cloud, as it is illustrated in Fig. 1. In development of the proposed aggregator and de-aggregator, we used the efficient structure that was proposed for implementation of hierarchical quadrature amplitude modulation (QAM) [8-11]. The aggregation approach that is proposed for software defined applications, needs small amount of memory and has small computationalcost.

The rest of this paper is organized as follows. In section II, the structure of the proposed data aggregator and deaggregators are given. The implementation cost of the proposed approach is presented in section III. The flexibility of the proposed approach and its performance is discussed in section IV.

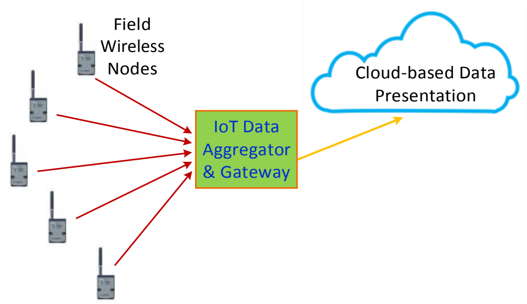

Fig. 1: System model for the proposed data aggregation scheme

2. Implementation of the proposed Aggregation Scheme

In this section, an implementation routine is discussed for the proposed compressive data aggregator. The proposed data aggregator is based on hierarchical QAM modulation and based on the approach that was discussed in [8,9]. Similar to the scenario that is presented in Fig. 1, each IoT sensor sends its data to the data aggregator that also roles as the gateway of access to the cloud-based data presentation site. These data are stored in the data distributer buffer and sampled to be aggregated as it is illustrated in Fig. 2. The data aggregator module combines the data of different sensors at a constant rate, which is higher than the data rate of each input branch.

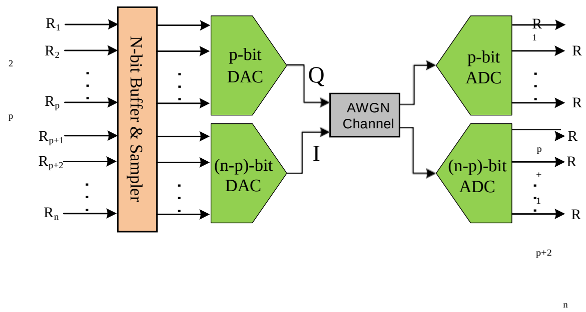

Fig.2: The general structure of the proposed data aggregator and de-aggregator

The sampler's binary output data d_k, k = 1, …, n at transmitter side are combined together with different weights to form the I and the Q components, similar to the formation steps for one symbol of 2^n-QAM [9]. For this purpose, each sub- channel that forms the I and the Q branches are formed by weighted summation of the bipolar binary data d_k that are ±1. Each symbol S is formed as follows: