Clustering Internet of Things: A Review

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Abstract—Internet of Things is a paradigm shift in networking that seeks to connect virtually all things on the planet. Given the constrained nature of smart devices, energy efficient routing would play a key role in successful deployment of such networks. Clustering algorithms organize nodes of a network into groups or clusters and a specific designated node, cluster head is responsible for its cluster. Clustering algorithms have been particularly suggested in the context of Wireless Sensor Networks (WSN) but their application may also address similar challenges in Internet of Things (IoT). Clustering would facilitate energy efficient routing and topology management by delegating large chunk of communication overhead to cluster head. This paper presents a review of various clustering algorithms, analyses routing characteristics of various IoT domains and suggests appropriate clustering algorithms for each domain.

Index Terms—Internet of Things, Clustering, Wireless Sensor Networks, Pervasive Computing.

1. Introduction

INTERNET of things (IoT) is an emerging field of research which incorporates plethora of areas of study. The main idea of IoT is to connect all things like home appliances, smart phones, cars, buildings, robots, machines etc. to the Internet.The idea is to have a virtual counterpart for all devices in the physical world that sense information of interest from the surroundings so that advanced end user services can be provided [1]. One of the main concern while using such devices is energy efficiency as communication and computations at the constrained device might quickly exhaust its limited battery resources. In the context of WSN, nodes rely on self-organizing multi-hoping networking methodology which can work in the absence of a base station and similar approaches can be adopted for IoT. The development of dynamic routing protocols that can efficiently find routes between mobile nodes is a crucial research issue. Dynamic networks cannot use conventional protocols because of the increase in the computational burden on mobile nodes. The quality of link and the topology of the network may vary while a message packet is being routed [2]. Hence, maintaining a good quality link incurs frequent calculation and updating of routing paths [3].Clustering is considered to be the most successful method for dealing with the maintenance problem of ad hoc networks and their use in the context of IoT naturally follows because of similar challenges [4].

The process of finding natural association among some specific nodes or grouping of similar objects is termed as Clustering [5]. Clustering network comprises of three main types of nodes namely 1) Cluster Heads, 2) normal nodes and 3) gateway nodes. Each cluster consists of one cluster head acting as a local controller. Transmission range of the nodes determines the size of the cluster in a single hop cluster and in the multi-hop cluster it is determined by the number of hops. The cluster head receives the data from a normal node, which is forwarded to the next hop. The gateway nodes acts are a bridge between two clusters of different cluster heads. They together form the backbone of the network, although the presence of gateway node is not compulsory [6]. Moreover, base station (BS) serves as a communicational channel between the sensor network and user. Thus, the amount of transmitted data is reduced by electing a cluster head and grouping nearby nodes. Data aggregation is performed to avoid redundancy and communication load caused by multiple transmissions.

In IoT paradigm, devices with better processing capabilities like smart phones could serve a similar relationship with various ubiquitous sensors like temperature sensor, surveillance cameras, home appliances etc. In IoT network the change in any node in the network induces change in the topology which results in overhead messages for topology maintenance. The clustering algorithms represent good solutions to address such scenarios [6]. Scientific work that considers the possibility of using clustering in IoT is quite sparse. Though authors in [7-9] suggest some clustering solutions for IoT networks, our work conducts a comprehensive analysis of various clustering algorithms typically used in the context of WSN and discusses their suitability for different IoT application scenarios.

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