Cognitive Agent Based Data Synchronization in Ubiquitous Networks: A Survey

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ABSTRACT

In the recent past, some research works are focused on the design and management of ubiquitous networks (UNs) in terms of performance metrics like routing, computation overhead, latency, and security. Nowadays, data synchronization is one of the most challenging tasks in UNs to ensure the data consistency between the nodes or devices and servers. In this work, the authors present an overview of the UNs, including issues and challenges, cognitive agents, synchronization algorithms, and proposed data synchronization model using cognitive agents. This review article classifies some of the data synchronization algorithms into four categories named: synchronization based on the message digest; timestamp based synchronization; synchronization based on scalability performance; and delta synchronization with their relative performance. This article also compares synchronization algorithms against data synchronization in terms of accuracy, efficiency, scalability, consistency, and control overheads. The authors provide the model of cognitive agent-based data synchronization in UNs, which ensures the network performance in terms of reliability, energy efficient, accuracy, scalable, fault tolerant, and QoS based data synchronization algorithms using cognitive agents.

KEYWORDS

Cognitive Agents, Delta Synchronization, Message Digest, Scalar Performance, Time Stamp Based Synchronization, Ubiquitous Networks

INTRODUCTION

The development of Internet associated with the problem of communication between users or devices and environment. The users can access the consistency of data in his/her devices from different environments. The network with computing devices connected at any place, anytime, anywhere with any object is Ubiquitous Networks (UNs). This allows user to access and exchange information or data at anytime, anyplace, and anywhere in different environments through the use of broadband and mobile devices (Pallapa, 2010). The management of ubiquitous network includes core network, access network, ubiquitous appliances, and sensors. The prime focus of ubiquitous computing is used to create intelligent products that are connected, making communication and the exchange of data easier and less obtrusive (Kevin & Jairo, 2010).

Due to the above requirements of UNs, so need of data synchronization, which is one of the important issues of ubiquitous computing environment which provides assurance of data consistency

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among devices, i.e., allows users to access application on any device without any conflicts in the data stored. The purpose of data synchronization is to provide services to the users with convenience and continuous updating of data available at various devices without any conflicts. Data synchronization allows user device independent for accessing ubiquitous services over UNs. Various applications are running on user mobile devices/nodes, such devices are needed for data synchronization mechanisms for accessing the services through its servers (Aaqif & Mureed, 2012).

Figure 1 illustrates the layout of proposed UN, which has four layers like physical layer, network layer, ubiquitous computational layer, and application layer. The physical layer of the UN is associated with heterogeneous wireless sensor networks, mobile adhoc networks, and vehicular adhoc sensor networks, etc., the network layer or Internet layer is comprised with ubiquitous network nodes for computing ubiquitous services. The access points such as base stations, sensors, controllers and gateways are used as network administrators to access ubiquitous services continuously without any interrupt. The ubiquitous nodes hold the information from the network for computing and processing of ubiquitous services. The ubiquitous computing layer consists of a set of the following functions for services to users such as resource management, fault tolerance, data synchronization, context aware, and ubiquitous service. An application layer has ubiquitous applications which are accessed by users at different application sectors like agriculture, health monitoring, transportation, disaster management, landmine detection, robotic landmine detection, water catchment, eco-system monitoring and so on. Finally end user can access the ubiquitous services using a mobile device. The objective of the UN is used to provide distribution of communication infrastructure and wireless technologies throughout the environment to enable continuous service to users at any time, and anywhere through the use of broadband and mobile devices.

The following sections describe the issues and challenges in UNs, the cognitive agent approach, the classifications of data synchronization algorithms are used in UNs, the proposed data synchronization model in UNs using cognitive agent approach, and finally concluding remarks of the paper.

**ISSUES AND CHALLENGES IN UBQUITOUS NETWORKS**

The major issues and challenges that affect the design and performance of ubiquitous network are as follows (Franklin, 2001; Jaydip, 2010; Stajano, 2009; Upkar, 2010):

1. **Context Aware Resource Management:** This is one of an issue of UNs. Based on the context, to provide the resources to requesting users in a ubiquitous environment.
2. **Seamless Connectivity:** The network should be always connected to the user nodes in all environments.
3. **Data Processing/Routing:** A users can access the efficient data in ubiquitous computing environment is a crucial task due to limitation of network configurations. Therefore, transmit the data from source to destination over UNs efficiently.
4. **Data Synchronization:** The data synchronization is used to rapidly recognize the changes in UNs, find a solution to network complexities, and propagate updates to the variety of synchronizing devices.
5. **Device Management:** The devices in the network should have the ability to recognize different available networks. For example, there will be different networks like Wi-Fi, GPRS, WiMax, 3G, and 4G, etc. The devices should select the appropriate network among these available networks.
6. **QoS Management and Monitoring:** QoS in the network is a problem because of different technologies and services. Hence it is necessary to design and develop better algorithms for QoS management.
7. **Network Routing and Control:** Includes providing various network services flexibly, comfortably and seamlessly. Network Routing includes the different handover techniques like low latency handover and lossless handover. This also includes End-to-End QoS routing.
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