Energy-Efficient Cloud Integrated Sensor Network

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Abstract

Wireless sensor network applications are applicable in many significant areas like human healthcare observations, defence monitoring, environmental observations, infrastructure monitoring, etc. There are many issues & challenges like security, scalability, storage, network lifetime etc., in the wireless sensor network. To overcome the issues & challenges, Sensor Cloud (SC) becomes a significant element of the current research era. Sensor cloud is the combination of two unique technologies in one form. So, as far as fabulous data collecting capabilities of wireless sensor networks and because of the robust data storage and process capabilities of cloud computing, Sensor Cloud integration is attracting increased focus from academic and industrial purposes. Virtualization is a crucial concept of Sensor Cloud in which more than one application simultaneously executes on every sensor device. For monitoring and controlling several applications, Sensor Cloud provides us open, flexible, and adjustable platform. Here focus on the critical discussion regarding Sensor Cloud Architecture which will give us Sensor Cloud Design, Applications, Issues & Challenges. We will discuss Social Sensor Cloud in our proposed work in which we will design an algorithm for both parameter energy efficiency and security through Virtualization. Our work will help Academician as well as industry people with the design and development of sensor cloud.

Keywords: - *Wireless Sensor Network, Cloud Computing, Virtualizatoion, Sensor Cloud, Research, Virtual Sensor, Physical Sensor.*

INTRODUCTION

A. Wireless Sensor Networks

Wireless Sensor Network is a distributed group of sensors in which many sensors with limited like temperature, soil, sound, vibration, pressure, motion, etc. [8]. Wireless sensor networks are more critical in area monitoring, industry, civilian, military, and environmental or earth sensing, changing human beings' general and routine path to interact with the physical world [7]. Some of the essential characteristics of the sensor nodes are scalable, secure, programmable etc. [1].

B. Cloud Computing

Nowadays, Cloud computing become great pioneering computing innovation for suitable, on-demand network access to a collective pool of adjustable and configurable computing resources due to the great potential of data gathering capacity and data processing capacity [2][3]. The importance of cloud computing has had an incredible effect on communication and technology in the last decade [19]. An example likes Amazon, which serves better due to a cost-effective, robust and secure cloud platform [11]. There are mainly three kinds of Cloud computing functions on communication-based on the infrastructure, platform, and Software [17]. The infrastructure generally provides functionality based on storage and networks. The Platforms generally provide functionality based on Operating systems—the Software, which offers functionality typically based on application [2][3].

A. Sensor -Cloud

Sensor Cloud is the combination of two great potential technologies in the form [6]. One is Wireless Sensor Network, and the other is Cloud Computing [1]. Sensor Cloud for real time application, which provides accurate, cost-effective and efficient infrastructure. In today's researchers, Sensor clouds become popular because of data assembly and excellent storage capacity and then transmit to the user for many real time applications [1] [4]. Fig.1 shows the important elements regarding the sensor cloud system.

1) Sensor Network Provider. 2) Cloud Service Provider and 3) Cloud Service User [21]. For Client Service User, Client Service Provider works as sources for information. Similarly for Cloud Service Provider, Sensor Network Provider works as sources of data [21].

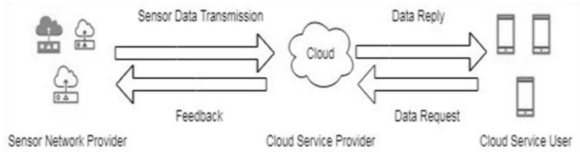

Fig. 1 Example of Sensor Cloud Scenario

B. Organization of the Paper

The flow of the rest of work is arranged as follows. Section II mentions the background of the existing work done so far. In Section III, we briefly discuss the literature review. Section IV mentions the Existing framework. We mention the proposed work in Section V. Section VI conclude our work.

BACKGROUND

A. Wireless Sensor Networks

In the last decade, Wireless Sensor Network gains the attention of researchers in both aspects, whether it is a theoretical or practical concern. Wireless Sensor Network is a network that contains sensor nodes or modes that are useful to gather physical or environmental information [13]. Sensor nodes are small in size but provide multiple functionalities.

Sensor nodes monitor environmental characteristics like sound, pressure, motion and temperature. Generally, sensor nodes have some basic functionality like sensing, processing and communicating [1]. In Sensor Network, despite having some fabulous characteristics, sensor networks face some fundamental challenges in terms of resources, communication and design aspects [10].

C. Cloud Computing

The latest development of processing and storage technologies, better utilization of internet and resources like computing platform which provide fast and accurate computational power, Cloud Computing is trending nowadays [16]. Processing data, as well as storage data, are critical features of Cloud Computing. Accessibility, efficiency and scalability are also important aspects of Cloud Computing. Security is the main key disadvantage of Cloud Computing [5] [10].

D. Cloud Computing Service Deployment

Cloud implementation decision is a crucial task for the deployment of cloud services. In recent times, mainly three types of cloud available - Public cloud, Private Cloud and Hybrid cloud[6]:

1) Public Cloud

The general and common way to establish cloud-enable service is the public cloud—the third-party which provides us cloud service use the most common cloud resources like network, servers and storage. Consumer has to pay on pay peruse basis. As far as concerned with security aspects, Public clouds are not much advisable compared to other cloud models [6].

2) Private Cloud

Private cloud works within the limit of the data centre of any organization. Security aspects in a private cloud are more accurate than public cloud because only an authentic user who belongs to that particular organization has the right to use the private cloud. Private cloud is significantly easier to handle all kinds of resource management and upgrades and provides more security and control [6].

3) Hybrid Cloud

Another important cloud computing service is the Hybrid cloud, which combines both public and private cloud. It is more secure and protected to manage both data as well as an application over the internet. A hybrid cloud allows all end users to access data over the internet. In Hybrid Cloud, public and private clouds are associated with some external cloud services for better cloud services [6].

E. Sensor Cloud Architecture

Fig. 2 shows the formal architecture of integration of two technology wireless sensor networks and cloud computing. Wireless sensor networks provide some sensing information while cloud computing stores and processes that data according to different types of users [7].

The Sensed data provided by the sensor network is collected and sent through the sink node to the cloud environment. There are many limitations like limited battery life, storage issues etc., of wireless sensor networks [28]. This integration gives us a cost-effective, efficient and scalable mechanism for some real applications. Virtualization is the critical factor of sensor cloud combination, which creates different virtual sensors [6].

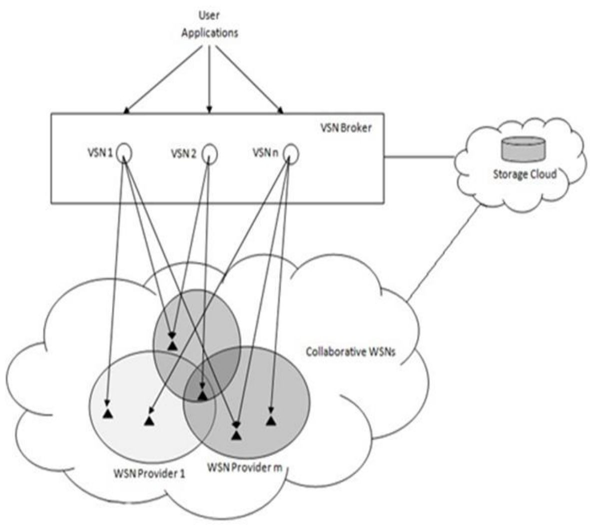

Fig. 2 Sensor Cloud Architecture

F. Integration of Cloud with Wireless Sensor Network

Fig. 3 shows cloud-integrated sensor network combination, which describes the overall scenario regarding the sensor cloud mechanism. Wireless Sensor Network has a different number of real time applications which is generally integrated with numerous mechanisms.

With the help of a cloud-integrated sensor network that gathers important information from various sensors and transmits it to the cloud computing platform. In a cloud computing platform, first data will be processed and then store in the cloud. Users can use this important and processed data at any time any place as per requirement.

The cloud-integrated sensor network paradigm is faster, cost-effective, and scalable, serving people better than traditional wireless sensor networks. This sensor cloud mechanism is very helpful in storage, security, and data transmission [8]. In terms of security, Processed Data may best be stored in the cloud at some secure place, and storage is also better.

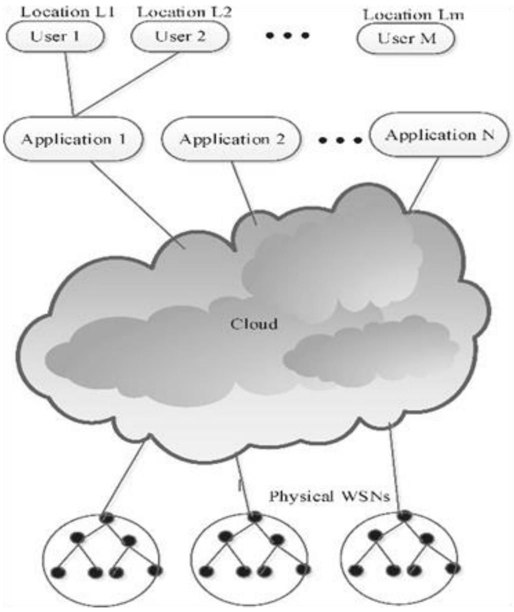

Fig. 3 Sensor Cloud Integration

Following are the important elements of a cloud-integrated sensor network [6] [9].

- **End User**: End users may use this processed data over the internet using cloud environment.
- **Provision Server:** Provisional Server gives important services to the sensor node.
- Portal: This is the bridge between the design of sensor cloud and sensor.
- **Virtual Sensor:** Virtual sensor is a virtual or logical device that uses processed data collected by sensors.
- **Physical sensor:** this is the real time entity from the wireless sensor network.

G. Advantages of Sensor-Cloud

Here we describe some significant advantages of sensor cloud [2] [21].

1. Analysis. Different types of observations and analysis become necessary for the sensor data and cloud computing model by users because providing scalable, secure and important processing power.
2. Scalability. Sensor-Cloud capable of changing the size or scale of a sensor network as well as a cloud model. As far as resources management in a sensor cloud is concerned, it is very easy for the system to expand itself.
3. Collaboration. Sensor-Cloud capable of sharing important and efficient sensor data through the combination of different types of sensor networks. Also, it is capable of data distribution among the clouds.
4. Visualization. Visualization API provides by sensor cloud combination. It is used for establishing and representing data as well as diagrams. With the help of visualization

techniques and tools, users can potentially calculate recent trends.

5. Unlimited Storage and Processing. Sensor Cloud provides unlimited processing and storage capacities to handle different resources to handle large-scale data and applications.
6. Automation. Automation Service of sensor cloud provides a significant time consuming, low-cost data processing capacity.
7. Flexibility. Sensor-Cloud provides time and sharing resources additional flexibility to its users.
8. Resource Management: Cloud integrated Sensor Platform capable of efficient resource utilization by allowing them to share their sources for numerous Real time applications.

H. Sensor-Cloud Applications

There are some existing sensor cloud-based applications for data as well as infrastructure. Here we discuss some applications below [18].

1) Nimbits

Nimbits is a kind of sensor cloud service based on recording data and sharing information on the cloud. Nimbits is also helpful for data calculation, data and information alert mechanism and data compression techniques using some simple mathematical analysis [18].

2) Pachube Platform

Pachube platform is one kind of service provider-related database that allows users to directly or indirectly connect to the web. Pachube platform is one short of cloud-oriented IoT platform. This platform provides services and products to discover and share real time sensed data which is very useful for users [18].

3) IDigi

iDigi is an important service related to PaaS that cuts down different hurdles to develop cost-effective and secure solutions that may bring together data, applications, and device assets. iDigiDia is user connector software that simplifies the integration and connectivity of data [18].

RELATED WORK

Parameter based on sensor cloud-like Energy Efficiency, Security, Authorization and Quality of Services is a major concern related to research. Table 1 indicates some glimpse regarding literature review based on a survey of cloud-integrated sensor framework for parameter and resource management [6].

TABLE 1. RELATED WORK

Author	Summary of Contribution	Features of Research
Jayesh M. Patel et al. 2018	VM allocation and migration policy of mobile cloud	Mobile Cloud Computing, SVM, Virtual Machine
Chunsheng Zhu Et al. 2015	CLSS for WSNs integrated with MCC	integration, location, network lifetime, sleep scheduling
Pawan Kumar Thakur et al. 2015	Using Offloading Technique	Energy Saving, Offloading
Rubbing Liang et al. 2018	cloudlet based energy-saved data transfer model (EDTM)	date transfer model, cloudlet
RajalakshmiKrishnamurthi et al. 2019	computation offloading Into the Cloud	Reduce Energy Consumption
Buddesab et al. 2018	SCLSS for MCC integrated With WSN	Security. Packet delivery ratio

MohammadFarhan Khan etal. 2019	Energy-efficient data transmission in sensor cloud	Data transmission
N. Mahendran et al. 2016	Sleep Scheduling Schemes Based on Location of Sensor-Cloud	Energy efficiency
Xuefeng ding and jiangwu et al. 2019	Optimization Scheduling for Internet of Things	Reduce energy consumption
ShreyasPatole et al. 2019	MCC	MCC Related Parameters
HalahMohammed Al-Kadhim et al.2019	IoT	Energy-Efficient and Reliable Transport of Data
Qun Jin et al. 2019	Fog computing	Algorithm for workload balance
Tian Wang et al. 2015	Industrial sensor cloud	Big data cleaning
Tian Wang et al. 2019	Sensor cloud	Sensor cloud characteristics
VennilaSanthanam et al.2018	Sensor Cloud Platform	Middleware Service Utilization
Martin Pandurski et al. 2018	Cloud Integrated Sensor Platform	Resource Management
Nahla F. Omran et al. 2018	IoT Health Care Projects	IoT Related Parameters
Falguni Jindal et al. 2018	IoT	IoT Characteristics
Hyun-Jong Cha et al. 2018	Fog Computing Architecture	Combination of Fog and Sensor Network
NGOC-THANH DINH et al. 2018	Energy-Efficient Model	Energy Reduction in Sensor Cloud
Thanh Dinh et al. 2017	Information-Centric Sensor Cloud	Improve Network Lifetime
Hany F. Atlam et al. 2017	IoT with Cloud	Research and Challenges of Cloud and IoT
Sudip Misra et al. 2017	Sensor Cloud Paradigm	Issue and Challenges of Sensor Cloud

EXISTINGFRAMEWORK

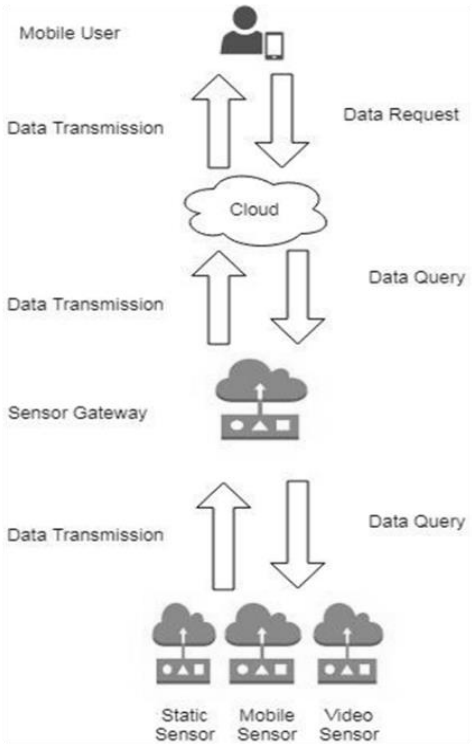

Fig. 4 Sensor cloud Framework Overview

Fig. 4 shows the existing cloud-integrated sensor framework for resource management which describe the overall scenario [6]. In Sensor Cloud Combination, the first sensor senses environmental or physical characteristics like temperature, sound, moisture, pollution, vibration, etc. It then sends it to the cloud environment for storage and process purposes. Cloud processed the entire data according to the user's requirement and sent it on pay per basis [21].

Some parameters are generally considered in a sensor cloud network, like Energy, Security, Storage, Data Transmission and QoS[13]. Energy Consumption, Network Lifetime, and QoS parameters (accuracy, throughput and availability) generally ignore in many algorithms of the cloud-integrated sensor network. So in our proposed work, we will focus on these parameters [13]. Fig. 5 shows the issues and challenges of Sensor-Cloud combination Authorization Issue, Energy Issue, Storage Issue and Security Issue[15].

1) Authorization Issue-The Biggest challenge in sensor cloud integration is Authorization Issue. This issue generated when somebody wants to access the network without prior permission of the admin, then a problem arises.
2) Energy Issue-Energy Consumption is a big challenge as far as concerned with sensor cloud as sensor nodes require a large amount of power to perform proper functioning for data collection and data transmission.
3) Security Issue- Security issue is a main concern in any data transmission and network for managing and maintaining integrity in a cloud-integrated sensor network for daily routine.
4) Storage Issue- Data storage is an important issue in Cloud integrated sensor network because the large scale of a data store at some securer place is a big challenge.

PROPOSED WORK

There are two schemes: CLSS1 and CLSS2. CLSS1isusedto more energy consumption, and CLSS2 is used to make the device more scalable and robust, but it saves less energy consumption. So we are adding these two schemes to increase efficiency, remove all CLSS schemes' limitations, and create a new scheme, CLSS3. If the restriction is not removed, we will use another technique like NOSS(novel optimal sleep scheduling). Fig. 6 shows the proposed algorithm for cloud sensor networks, also known as Sensor Cloud, for different parameters [14]. MCC and WSNs integration schemes ignore the following two observations: 1) the specific data cloud clients request usually depends on the current location of cloud clients 2) most sensors are usually equipped with non-rechargeable batteries with limited energy. In this paper, motivated by the above two issues, we present a combination of two novel collaborative location-based sleep scheduling (CLSS) schemes for WSNs to integrate with MCC. This new CLSS scheme will cover the limitations of the first two schemes, and it will be more energy-efficient. In the below image for the CLSS1 scheme, the current location lu of mobile users is obtained by clouds first(Step1ofCLSS1). Then a flag AorZissent to the base station s by the cloud c according to whether lu is in the location list L or not (Step 2 of CLSS1). The flag is further broadcasted by base station s, and each sensor node I determines its awake or asleep status according to the flag it receives during the epoch T (Step 3 to Step 5 of CLSS1). Concerning CLSS2, the first four steps of CLSS2 are the same as that of CLSS1.The different ceiling step 5 of CLSS2 and CLSS1. When sensor node i receives flag Z in step 5 of CLSS2, i will be sleep scheduled based on the energy-consumption based connected k-neighbourhood (ECCKN scheme). For the EC-CKN sleep scheduling scheme, the current residual energy rank (e.g., Eranki) of each node i is got (Step 6 of CLSS2) and the subset Ci of i's currently awake neighbour shaving Erank>Eranki is computed(Step10 of CLSS2). Before a node i can go to sleep in the epoch T, it needs to ensure that (1) all nodes in Ciare connected by nodes with Erank>Eranki (2) each of its neighbours has at least k neighbours from Ci(Step 11 ofCLSS2).

Pseudocode of CLSS1 scheme

Step 1: Cloud c obtains mobile user u's current location l_u.
Step 2: If $l_u \in L$, c sends flag A to base station s. Otherwise, c sends s flag Z.
Step 3: s broadcasts flag to sensor nodes.
Step 4: Run Step 5 at each node i.
Step 5: If node i receives flag A, remain awake. Otherwise, go to sleep.

Pseudocode of CLSS2 scheme

Step 1: Cloud c obtains mobile user u's current location l_u.
Step 2: If $l_u \in L$, c sends flag A to base station s. Otherwise, c sends s flag Z.
Step 3: s broadcasts flag to sensor nodes.
Step 4: Run Step 5 at each node i.
Step 5: If node i receives flag A, remain awake. Otherwise, run Step 6 to Step 12.

Step 6 to Step 12 are the pseudocodes of EC-CKN scheme

Step 6: Get the current residual energy $Erank_i$.
Step 7: Broadcast $Erank_i$ and receive the ranks of its currently awake neighbors N_i. Let R_i be the set of these ranks.
Step 8: Broadcast R_i and receive R_j from each $j \in N_i$.
Step 9: If $|N_i| < k$ or $|N_j| < k$ for any $j \in N_i$, remain awake. Go to Step 12.
Step 10: Compute $C_i = \{j | j \in N_i \text{ and } Erank_j > Erank_i\}$.
Step 11: Go to sleep if both the following conditions hold. Remain awake otherwise.

- Any two nodes in C_i are connected either directly themselves or indirectly through nodes within i's 2-hop neighborhood that have $Erank$ more than $Erank_i$.
- Any node in N_i has at least k neighbors from C_i.

Step 12: Return.

Fig. 6 algorithms used to combine in a new algorithm

CONCLUSIONS AND FUTURE DIRECTIONS

This report is working with two CLSS schemes (i.e., CLSS1 and CLSS2) for WSNs integrated with MCC. CLSS schemes involve both the WSN and the cloud and then dynamically change the awake or asleep status of the sensor node in the integrated WSN, based on the locations of mobile users. CLSS1 focuses on saving the most energy consumption of the integrated WSN, and CLSS2 further pays attention to the scalability and robustness of the integrated WSN. For the integration of MCC and WSNs, both theoretical and simulation results are shown. They demonstrate that CLSS1 and CLSS2 could prolong the integrated WSN while still satisfying the data requests of mobile users. With the help of these two schemes, we are developing a new scheme that is more efficient than these schemes. We will propose algorithms and prototypes in MCC to reduce power consumption and increase resources efficiency and utilization. We will further implement CLSS schemes. We will show the results of the simulator in the future using our implemented new algorithm.

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