Wireless Sensor Communication using Mobile Cloud Computation

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Abstract— **Cloud environments are mainly used for storage and processing of data, but lately many organizations have desired to operate their businesses, works and services from a mobile phone through cloud. Together with an explosive growth of mobile applications and emerging cloud computation concept, mobile cloud computation has been introduced to be a potential technology for mobile services. Activities like e-learning, environmental learning, remote inspection, health-care, home security and safety mechanisms etc. requires a special infrastructure that might provide continuous, secured, reliable and mobile data with proper information/ knowledge management system in context to their confined environment and its users. Wireless Sensor Network is a very important technology in which sensor are placed in distributed manner to monitor physical and environment changes such as temperature, pressure etc. Combining these two technology helps in easy management of remotely connected sensor nodes and the data generated by these sensor nodes. This paper discusses the integration of Wireless Sensor Communication using Mobile Cloud Computation, with their applications, the issues with the current system, and their possible solutions.**

I. INTRODUCTION

Cloud computing is becoming popular day by day in a distributed computing environment. Cloud environments are used for storage and processing of data. Cloud computing provides applications, platforms and infrastructure over the internet. Cloud computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. The following models are presented by considering the deployment scenario: 1) Private Cloud: This cloud infrastructure is operated within a single organization and managed by the organization or a third party irrespective of its location. 2) Public Cloud: Public clouds are owned and operated by third parties. 3) Community Cloud: This cloud infrastructure is constructed by number of organization jointly by making a common policy for sharing resources. 4) Hybrid Cloud: The combination of public and private cloud is known as hybrid cloud.

Mobile devices (e.g., smartphone and tablet PC) are increasingly becoming an essential part of human life as the most effective and convenient communication tools not bounded by time and place. Mobile users accumulate rich experience of various services from mobile applications (e.g., iPhone apps and Google apps), which run on the devices and/or on remote servers via wireless networks. The rapid progress of mobile computing (MC) becomes a powerful trend in the development of IT technology as well as commerce and industry fields. However, the mobile devices are facing many challenges in their resources (e.g., battery life, storage, and bandwidth) and communications (e.g., mobility and security). The limited resources significantly impede the improvement of service qualities.

Cloud Computing has emerged as a phenomenon that represents the way by which IT services and functionality are charged for and delivered. NIST (National Institute of Standards and Technology, USA) definition from September, 2011 released in its "Special Publication 800-145" of Cloud Computing is: "Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable resources (e.g. networks, servers, storage, applications and services) that can rapidly be provisioned and released with minimal management effort or service provider interaction.

"It is an information technology service model where computing services (both hardware and software) are delivered on demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks.

II. OVERVIEW OF CLOUD COMPUTING

The main idea behind cloud computing is not a new one, it was first defined by John McCarthy in 1960 and he had envisioned that cloud computing facilities will be provided to the general public.

The term "cloud" has also been used in various contexts such as describing large ATM networks in the 1990s. However, it was after Google's CEO Eric Schmidt used the word to describe the business model of providing services across the Internet in 2006, that the term really started to gain popularity. Since then, the term cloud computing has been used mainly as a marketing term in a variety of contexts to represent many different ideas. Certainly, the lack of a standard definition of cloud computing has generated not only market hypes, but also a fair amount of skepticism and confusion. For this reason, recently there has been work on standardizing the definition of cloud computing. As an example, the work in [1] compared over 20 different definitions from a variety of sources to confirm a standard definition. In this paper, we adopt the definition of cloud computing provided by The National Institute of Standards and Technology (NIST) [2], as it covers, in our opinion, all the essential aspects of cloud computing:

NIST Definition of Cloud Computing: g Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

The main reason for the existence of different perceptions of cloud computing is that cloud computing, unlike other technical terms, is not a new technology, but rather a new operations model that brings together a set of existing technologies to run business in a different way. Indeed, most of the technologies used by cloud computing, such as virtualization and utility-based pricing, are not new. Instead, cloud computing leverages these existing technologies to meet the technological and economic requirements of today's demand for information technology.

III. Sensor - Cloud computing Architecture

This section describes the architectural, business and various operation models of cloud computing.

Sensor-Cloud is a new paradigm for cloud computing that uses the physical sensors to accumulate its data and transmit all sensor data into a cloud computing infrastructure. SensorCloud handles sensor data efficiently, which is used for many monitoring applications.

What is Sensor – Cloud?

An infrastructure that allows truly pervasive computation using sensors as an interface between physical and cyber worlds, the data-compute clusters as the cyber backbone and the internet as the communication medium.

A Sensor-Cloud collects and processes information from several sensor networks, enables information sharing on big scale, and collaborates with the applications on cloud among users. It integrates several networks with a number of sensing applications and cloud computing platform by allowing applications to be cross-disciplinary that may span over multiple organizations [3]. Sensor-Cloud enables users to easily gather, access, process, visualize, analyze, store, share, and search for a large number of sensor data from several types of applications and by using the computational IT and storage resources of the cloud.

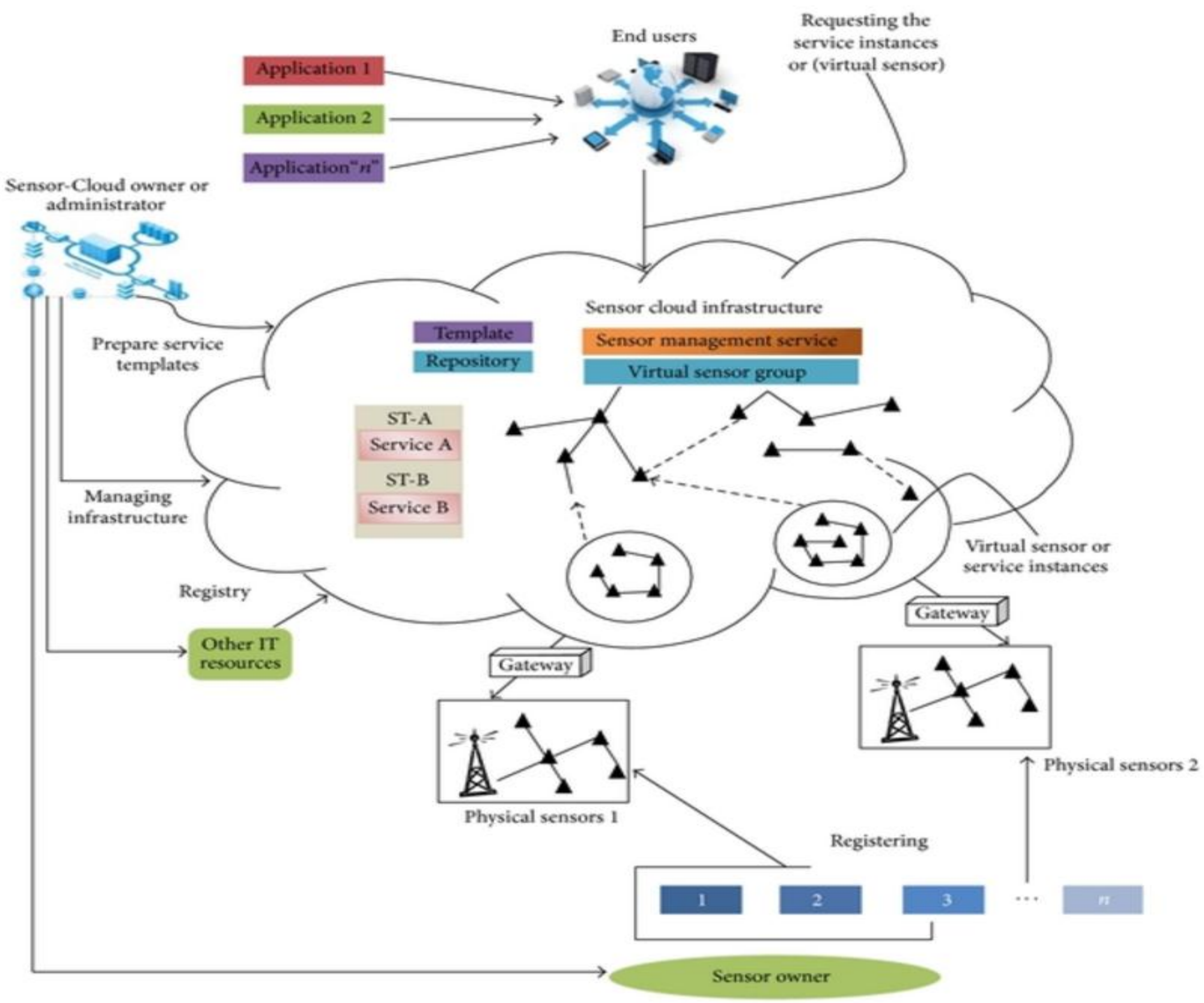
In a sensor network, the sensors are utilized by their specific application for a special purpose, and this application handles both the sensor data and the sensor itself such that other applications cannot use this. This makes wastage of valuable sensor resources that may be effectively utilized when integrating with other application's infrastructure. To realize this scenario, Sensor-Cloud infrastructure is used that enables the sensors to be utilized on an IT infrastructure by virtualizing the physical sensor on a cloud computing platform. These virtualized sensors on a cloud computing platform are dynamic in nature and hence facilitate automatic provisioning of its services as and when required by users [4]. Furthermore, users need not to worry about the physical locations of multiple physical sensors and the gapping between physical sensors; instead, they can supervise these virtual sensors using some standard functions [5].

IV. Architecture of Sensor Cloud

. Cloud computing service framework delivers the services of shared network through which the users are benefited by the services, and they are not concerned with the implementation details of the services provided to them. When a user requests, the service instances (e.g., virtual sensors) generated by cloud computing services are automatically provisioned to them [5, 4]. Some previous studies on physical sensors focused on routing, clock synchronization, data processing, power management, OS, localization, and programming. However, few studies concentrate on physical sensor management because these physical sensors are bound closely to their specific application as well as to its tangible users directly. However, users, other than their relevant sensor services, cannot use these physical sensors directly when needed. Therefore, these physical sensors should be supervised by some special sensor-management schemes. The Sensor-Cloud infrastructure would subsidize the sensor system management, which ensures that the data management usability of sensor resources would be fairly improved.

Sensor-Cloud infrastructure provides service instances (virtual sensors) automatically to the end users as and when requested, in such a way that these virtual sensors are part of their IT resources (like disk storage, CPU, memory, etc.) [6]. These service instances and their associated appropriate sensor data can be used by the end users via a user interface through the web crawlers as described in Figure 1. However, for the service instance generation, the IT resources (like CPU, storage devices, etc.), sensor capable devices, and service templates (which is used to create virtual sensors) should be prepared first in Sensor-Cloud infrastructure. Users make the request for service instances according to their needs by selecting an appropriate service template of Sensor-Cloud, which will then provide the needed service instances freely and automatically because of cloud computing services integration. Once service instances become useless, they can then be deleted quickly by users to avoid the utilization charges for these resources. Sensor service provider will manage the service templates (ST) and it can add or delete the new service template when the required template is no longer needed by applications and services [5]. Automation of services played a vital role in provisioning of cloud computing services, and automation can cause the delivery time of services to be better [4]. Before the emergence of cloud computing, services were provided by human influence and the performance metrics like efficiency, flexibility, delivery times, and so forth would have experienced an adverse effect on the system. However, the cloud computing service model has reduced the cost expenses and delivery time and has also improved the efficiency and flexibility.

Since the cloud computing enables the physical sensors to be virtualized, the users of the Sensor-Cloud infrastructure need not to worry about the status of their connected physical sensors (i.e., whether a fault free or not). However, they should concern only with the status of their virtual sensors provided only when the users are not concerned with the accurate results. To achieve accurate results, users must be concerned about the status of physical sensors too. In a Sensor-Cloud infrastructure, sensors owners are free to register or unregister their physical sensors and can join this infrastructure. These IT resources (physical sensors, database servers, processors, etc.) and sensor devices are then prepared to become operational. After that, templates are created for generating the service instances (virtual sensors) and its groups (virtual sensors). Once templates are prepared, the virtual sensors are able to share the related and contiguous physical sensors to receive quality sensor data. Users then request these virtual sensors by choosing the appropriate service templates, use their service instances (virtual sensors) after being provisioned, and discharge them when became useless [5].



V. MOBILE CLOUD COMPUTING

This section describes why we use mobile cloud computing so efficiently, it's architecture, advantages, applications, and issues regarding mobile cloud computing(MCC).

1. What is Mobile Cloud Computation?

'Mobile cloud computing at its simplest, refers to an infrastructure where both the data storage and data processing happen outside of the mobile device. Mobile cloud applications move the computing power and data storage away from mobile phones and into the cloud, bringing applications and MC to not just smartphone users but a much broader range of mobile subscribers'.

Aepona [7] describes MCC as a new paradigm for mobile applications whereby the data processing and storage are moved from the mobile device to powerful and centralized computing platforms located in clouds. These centralized applications are then accessed over the wireless connection based on a thin native client or web browser on the mobile devices. Alternatively, MCC can be defined as a combination of mobile web and CC [8,9], which is the most popular tool for mobile users to access applications and services on the Internet. Briefly, MCC provides mobile users with the data processing and storage services in clouds. The mobile devices do not need a powerful configuration (e.g., CPU speed and memory capacity) because all the complicated computing modules can be processed in the clouds.

2. Architecture of Mobile Cloud Computing

From the concept of MCC, the general architecture of MCC can be shown in Figure 1. In Figure 1, mobile devices are connected to the mobile networks via base stations (e.g., base transceiver station, access point, or satellite) that establish and control the connections (air links) and functional interfaces between the networks and mobile devices. Mobile users' requests and information (e.g., ID and location) are transmitted to the central processors that are connected to servers providing mobile network services. Here, mobile network operators can provide services to mobile users as authentication, authorization, and accounting based on the home agent and subscribers' data stored in databases. After that, the subscribers' requests are delivered to a cloud through the Internet. In the cloud, cloud controllers process the requests to provide mobile users with the corresponding cloud services. These services are developed with the concepts of utility computing, virtualization, and service-oriented architecture (e.g., web, application, and database servers).

The Details of cloud architecture could be different for different contexts, for example a four-layer architecture will be quite different from a three-layered architecture. The four-layered architecture is very well explained [10] to compare cloud computing and grid computing. Alternatively, a service-oriented architecture, called Aneka, is introduced to enable developers to build. Microsoft .NET applications with the supports of application programming interfaces (APIs) and multiple programming models [11]. [12] presents an architecture for creating market-oriented clouds and [13] proposes an architecture for web-delivered business services. In this paper, we focus on a layered architecture of CC (Figure 2). This architecture is commonly used to demonstrate the effectiveness of the CC model in terms of meeting the user's requirements [14]. Generally, a CC is a large-scale distributed network system implemented based on a number of servers in data centers. The cloud services are generally classified based on a layer concept (Figure 2). In the upper layers of this paradigm, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) are stacked.

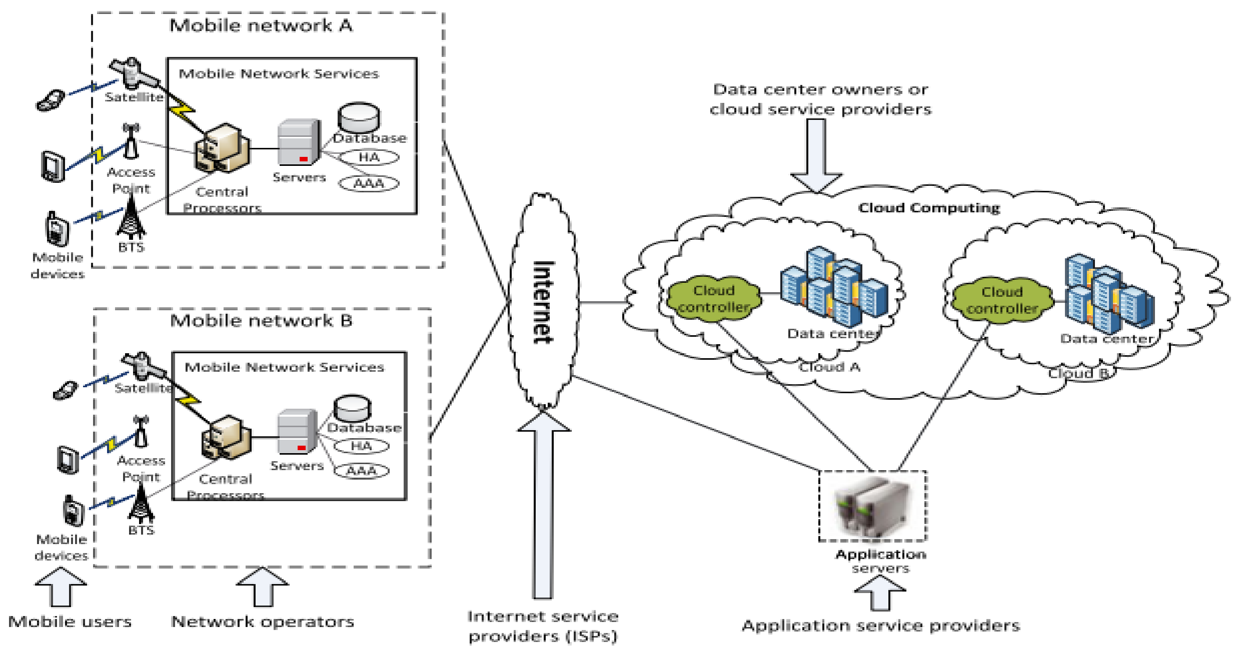


Figure 1. Mobile cloud computing architecture.

3. Advantages of Mobile Cloud Computing

(1) Extending battery lifetime. Battery is one of the main concerns for mobile devices. Several solutions have been proposed to enhance the CPU performance [15,16] and to manage the disk and screen in an intelligent manner [17,18] to reduce power consumption. However, these solutions require changes in the structure of mobile devices, or they require a new hardware that results in an increase of cost and may not be feasible for all mobile devices. Computation offloading technique is proposed with the objective to migrate the large computations and complex processing from resource-limited devices (i.e., mobile devices) to resourceful machines (i.e., servers in clouds). This avoids taking a long application execution time on mobile devices which results in large amount of power consumption. Rudenko et al. [19] and Smailagic and Ettus [20] evaluate the effectiveness of offloading techniques through several experiments. The results demonstrate that the remote application execution can save energy significantly. Especially, Rudenko et al. [19] evaluates large-scale numerical computations and shows that up to 45% of energy consumption can be reduced for large matrix calculation. In addition, many mobile applications take advantages from task migration and remote processing. For example, offloading a compiler optimization for image processing [21] can reduce 41% for energy consumption of a mobile device. Also, using memory arithmetic unit and interface (MAUI) to migrate mobile game components [22] to servers in the cloud can save 27% of energy consumption for computer games and 45% for the chess game.

(2) Improving data storage capacity and processing power. Storage capacity is also a constraint for mobile devices. MCC is developed to enable mobile users to store/access the large data on the cloud through wireless networks. First example is the Amazon Simple Storage Service [23] which supports file storage service. Another example is Image Exchange which utilizes the large storage space in clouds for mobile users [24]. This mobile photo sharing service enables mobile users to upload images to the clouds immediately after capturing. Users may access all images from any devices. With the cloud, the users can save considerable amount of energy and storage space on their mobile devices because all images are sent and processed on the clouds. Flicker [25] and ShoZu [26] are also the successful mobile photo sharing applications based on MCC. Facebook [27] is the most successful social network application today, and it is also a typical example of using cloud in sharing images.

(3) Dynamic provisioning. Dynamic on-demand provisioning of resources on a fine-grained, self-service basis is a flexible way for service providers and mobile users to run their applications without advanced reservation of resources.

(4) Scalability. The deployment of mobile applications can be performed and scaled to meet the unpredictable user demands due to flexible resource provisioning. Service providers can easily add and expand an application and service without or with little constraint on the resource usage.

(5) Ease of integration. Multiple services from different service providers can be integrated easily through the cloud and Internet to meet the user demand.

4. Applications of Mobile Cloud Computation.

Mobile applications have gained a lot of share in the global mobile market. Various Mobile Applications have already taken advantage of MCC. In this section we discuss the numerous applications of MCC in the global market.

(1) Mobile commerce: Mobile commerce (m-commerce) is a business model for commerce using mobile devices. The m-commerce applications generally fulfill some tasks that require mobility (e.g., mobile transactions and payments, mobile messaging, and mobile ticketing). The m-commerce applications can be classified into few classes including finance, advertising, and shopping (Table II). The m-commerce applications have to face various challenges (e.g., low network bandwidth, high complexity of mobile device configurations, and security). Therefore, m-commerce applications are integrated into CC environment to address these issues. Yang et al.[28] proposes a 3G E-commerce platform based on CC. This paradigm combines the advantages of both third generation (3G) network and CC to increase data processing speed and security level [29] based on public key infrastructure (PKI). The PKI mechanism uses an encryption-based access control and an over-encryption to ensure privacy of user's access to the outsourced data. In [30], a 4PL-AVE trading platform utilizes CC technology to enhance the security for users and improve the customer satisfaction, customer intimacy, and cost competitiveness.

(2). Mobile healthcare: The purpose of applying MCC in medical applications is to minimize the limitations of traditional medical treatment (e.g., small physical storage, security and privacy, and medical errors [31,32]). Mobile healthcare (m-healthcare) provides mobile users with convenient helps to access resources (e.g., patient health records) easily and efficiently. Besides, m-healthcare offers hospitals and healthcare organizations a variety of on-demand services on clouds rather than owning standalone applications on local servers. There are a few schemes of MCC applications in healthcare. For example, [33] presents five main mobile healthcare applications in the pervasive environment.

- Comprehensive health monitoring services enable patients to be monitored at anytime and anywhere through broadband wireless communications.
- Intelligent emergency management system can manage and coordinate the fleet of emergency vehicles effectively and in time when receiving calls from accidents or incidents.

- Intelligent emergency management system can manage and coordinate the fleet of emergency vehicles effectively and in time when receiving calls from accidents or incidents.
- Pervasive access to healthcare information allows patients or healthcare providers to access the current and past medical information.
- Pervasive lifestyle incentive management can be used to pay healthcare expenses and manage other related charges automatically.

(3). Mobile gaming: Mobile game (m-game) is a potential market generating revenues for service providers. M-game can completely offload game engine requiring large computing resource (e.g., graphic rendering) to the server in the cloud, and gamers only interact with the screen interface on their devices. Li et al.[34] demonstrates that offloading (multimedia code) can save energy for mobile devices, thereby increasing game playing time on mobile devices. Cuervo et al.[22] proposes MAUI, a system that enables fine-grained energy aware offloading of mobile codes to a cloud. Also, a number of experiments are conducted to evaluate the energy used for game applications with 3G network and WiFi network. It is found that instead of offloading all codes to the cloud for processing, MAUI partitions the application codes at a runtime based on the costs of network communication and CPU on the mobile device to maximize energy savings given network connectivity. The results demonstrate that MAUI not only helps energy reduction significantly for mobile devices (i.e., MAUI saves 27% of energy usage for the video game and 45% for chess), but also improves the performance of mobile applications (i.e., the game's refresh rate increases from 6 to 13 frames per second).

5. Issues Regarding Mobile Cloud Computing.

Cloud is extremely powerful to perform computations while computing ability of mobile devices has a limit so many issues occur to show how to balance the differences between these two. So, there are some issues in implementing cloud computing for mobile. These issues can be related to limited resources, related to network, related to security of mobile users and clouds [4]. Some issues are explained as follows:

- Limited Resources: Having limited resources in mobile device make use of cloud computing in mobile devices difficult. Basic limitations related to limited resources are limited computing power, limited battery and low-quality display.
- Network related issues: All processing in MCC is performed on the network. So, there are some issues related to the network like Bandwidth, latency, availability and heterogeneity.
- Security: Most of mobile devices have almost same functionalities like a desktop computer. So mobile devices also have to face a number of problems related to security and privacy. To overcome this problem threat detection services are now performed at clouds but this also has to face a lot of challenges. Some security issues are like device security, privacy of mobile user and securing data on cloud etc. There are so many security threats like viruses, hacking, Trojan horses in mobile devices also. The use of global positioning system (GPS) in mobile devices gives birth to the privacy issues.
- Low Bandwidth: Bandwidth is one of the big issues in MCC since the radio resource for wireless networks is much scarce as compared with the traditional wired networks. A solution to share the limited bandwidth among mobile users who are located in the same area (e.g., a workplace, a station, and a stadium) and involved in the same content (e.g., a video file). The authors model the interaction among the users as a coalitional game. For example, the users form a coalition where each member is responsible for a part of video files (e.g., sounds, images, and captions) and transmits/exchanges it to other coalition members. This results in the improvement of the video quality. However, the proposed solution is only applied in the case when the users in a certain area are interested in the same contents. Also, it does not consider a distribution policy (e.g., who receives how much and which part of contents) which leads to a lack of fairness about each user's contribution to a coalition. Consider the data distribution policy which determines when and how much portions of available bandwidth are shared among users from which networks (e.g., WiFi and WiMAX). It collects user profiles (e.g., calling profile, signal strength profile, and power profile) periodically and creates decision tables by using Markov Decision Process (MDP) algorithm. Based on the tables, the users decide whether or not to help other users download some contents that they cannot receive by themselves due to the bandwidth limitation, and how much it should help (e.g., 10% of contents). The authors build a framework, named RACE (Resource-Aware Collaborative Execution), on the cloud to take advantages of the computing resources for maintaining the user profiles. This approach is suitable for users who share the limited bandwidth, to balance the trade-off between benefits of the assistance and energy costs.
- Availability: Service availability becomes more important issue in MCC than that in the cloud computing with wired networks. Mobile users may not be able to connect to the cloud to obtain service due to traffic congestion, network failures, and the out-of-signal.

VI. IOT BASED MONITORING SYSTEM

The IOT monitoring system is an advanced solution for monitoring parameters of a particular place and making this information visible anywhere in the world. The technology behind this is the internet of things(IOT) which is an advanced an effective solution for connecting the things to the internet. We are monitoring air in a certain region, but this concept can be used as a base for any effective monitoring system.

The need for an IOT based monitoring system.

The main objective of the AIR and WATER pollution is due to the growing issues these days. It is necessary for us to monitor the air quality and keep it under control for a better future and healthy living for all. Due to low cost and flexibility, Internet of Things(IoT) is become very popular in the recent days. With increasing urbanization and with the increase of vehicles on the road and also the increase of factories and industries, the atmospheric conditions have been considerably affected. Harmful effects of air pollution mild allergic reactions such as irritation of throat, eyes, nose and also some serious problems such as bronchitis, heart diseases, pneumonia, asthma etc.

Monitoring gives measurement of air pollutant concentrations which then can be analysed and then interpreted. This information can be appreciable in various ways. Analysis of monitoring data allows us to assess how bad the air pollution is in that particular place from day to day.

The concept: Here we are making an IoT based Air Pollution system in which we will monitor the air quality over the cloud, the data can be seen on the PC as well as on one's phone through an app. We also have a 16x4 LCD that will display the data in ppm, data will be displayed on the LCD as well on the phone through cloud. There are 3 sensors, Carbon Monoxide (Mq 7), Ammonia(Nh3), and dust sensor. With this IoT based Air Pollution system we can monitor the data from anywhere in the world with the help of cloud, and due to its flexibility and low cost and portable nature we can install the system anywhere in the world.

Through the internet of things(IOT) we are using sensor cloud combination to display this data and now with the evolution of mobile cloud computing we are making this data accessible anywhere in the world. We are using Thing Speak as a module or as a cloud to display this info. How to setup and then create channels, and in the end how to collect, analyse and then send this data to anyone who has access to the channel codes is given in [35].

VII. Conclusion

In this paper, we surveyed the use of Sensor-Cloud architecture in the context of several applications. The Sensor-Cloud architecture enables the sensor data to be categorized, stored, and processed in such a way that it becomes cost-effective, timely available, and easily accessible. Moreover, we have highlighted possible advancement and researches regarding this field. The above all aspects have been studied and advocated by various researchers and their work done have also been taken under deliberation. Mobile cloud computing is one of mobile technology trends in the future since it combines the advantages of both mobile computing and cloud computing, thereby providing optimal services for mobile users this paper has provided an overview of mobile cloud computing in which its definitions, security, issues and advantages have been presented. Mainly it discussed about security of data stored in cloud and importance of data security. This paper has explored a number of mechanisms for providing data security so that Mobile Cloud Computing can be widely accepted by a number of users in future. It also proposed a mechanism to provide confidentiality, access control as well as integrity to mobile users. The Automatic Air management system is a step forward to contribute a solution to the biggest threat. The air monitoring system overcomes the problem of the highly-polluted areas which is a major issue. It supports the new technology and effectively supports the healthy life concept. This system has features for the people to monitor the amount of pollution on their mobile phones using the application.

So, it becomes very reliable and efficient for the Municipal officials along with the Civilians to monitor environment. Letting civilians also involved in this process adds an extra value to it. As civilians are now equally aware and curious about their environment, this concept of IOT is beneficial for the welfare of the society. And it is implemented using the latest technology.

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