# CLOUD-SENSOR NETWORK INTEGRATION: REVIEW

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**Abstract**

Nowadays, Wireless sensor networks have become a widespread entity in human life, it can be seen as one of the most essential technologies in 21st century in which sensors are placed in distributed manner to monitor physical and ecological environments such as temperature, pressure etc. WSNs have their own applications such as healthcare, military, environment monitoring, and manufacturing but this technology is constrained by limited resources in terms of memory, scalability, energy, computation, communication and effective management of the large number of WSNs data. Shortcomings of wireless sensors networks draws our attention to integrate them with a technology that can provide great, elastic and enormous storage infrastructure for real-time processing and storing of the WSN data. In this era, cloud computing proves itself as a inspiring technology as it provides immense computing, storage, and software facilities in a scalable and virtualized fashion at low cost. This paper presents a comprehensive survey for the various middleware available to integrate sensors with cloud. It also describes the wireless sensors network and cloud computing. The issues in existing middleware and the conclusion extracted is also discussed in this paper.

**Keywords: Cloud Computing, Wireless Sensor Network**

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## 1. Introduction

The elevation and application of wireless sensor networks become an inseparable trend into the several areas like industrial, environmental, and defense. A wireless sensor network consists of sensor motes that work cooperatively to keep track and collect data about the environment in which they are deployed. A typical wireless sensor consists of vastly distributed sensor nodes that work together and collect environmental conditions like temperature, sound, temperature, pollution, and so forth [1], [2]. Presently, wireless sensor networks have their impact in almost every area, they are effectively being utilized in healthcare, military and surveillance, natural disaster liberation, dangerous environment exploration and so forth. Each sensor node in the WSN is equipped with microcontrollers, small memory, and less than 20 kilobytes of RAM. In a WSN amount of data is large, heterogeneous and multidimensional in nature. Storage and processing of such a huge data requires high storage and computation power. However, sensor networks have to face many threats regarding their limited amount of energy, short range communication, limited bandwidth, low processing power and storage in each sensor node. Besides these WSN also have design constraints, Design constraints are application specific and dependent on monitored environment. All these limitations of WSN are the bottleneck for its performance and its quality. However, in the mean time emergence of cloud computing is seen as blessing.

Cloud computing has been evolved as the future generation's computing exemplar. The US NIST (National Institute of Standards and Technology) defines the Cloud
Computing as follows:

*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 [3].*

In current scenario, Cloud computing paradigm is associable to various domains including, scientific computation [4], e-commerce [5], online games [6] and industrial design [7]. Basic features of Cloud Computing include cost-saving, virtualization, elastic resources, self-service interface and pay per-use pricing models. The reciprocal characteristics of both the technologies gives an indication that it would be advantageous if these technologies are combined together.

The organization of our work is as follows. Section I gives introduction. Section II, III and IV gives the review of three methodologies. Finally section V concludes the paper.

## 2. CLOUD COMPUTING

Cloud Computing technology was designed by the National Institute of Standards and Technology (NIST) to increase the capacity of shared computing resources in a quick and secure way in various locations around the world. Cloud computing is the delivery of computing services over the internet. The name "Cloud" originates from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure. Cloud services allow users and businesses to use software and hardware that are operated by third parties at dispersed geographic sites. Cloud computing provides a shared pool of resources that includes huge storage space, processing power, networks, and dedicated corporate and user applications. In Cloud Computing, the users uses the web interfaces like the web browsers, however the software and data are stored at the remote servers. In a recent IBM report it was stated that the "*Cloud is a new consumption and delivery model for many IT-based services, in which the user sees only the service, and has no need to know anything about the technology or implementation*." [8]

**Features**

The fundamental features of the cloud computing are:

1. *On-demand self-service*: The requests made by the clients to use resources can be satisfied without any human involvement.
2. *Rapid elasticity*: Services can be scaled up or down; there is no official settlement or contract on the time duration for using particular resources.
3. *Abstraction*: Resources are secreted to the clients; Clients do not have any idea about the geographic location of the stored data and resource

4. *Broad network access*: Broad network access allows services to be accessible over the Internet , The client can perform with the help of mobile phones and laptop

5. *Resource pooling*: Clients avail resources as per their need from the pool of resources dynamically.

6. *Measured services*: The cloud infrastructure can quantify the usage of resources for each individual consumer

## 2.1 Service Models

The cloud provides following three services:

1. *SaaS* (*Software as a Service*): In this model, cloud providers set up and run a pre-made application in the cloud, along with essential software like operating system, hardware, and network. Cloud users can access the software through clients. Client does not need to make any investments for servers and software licenses. The most common service of SaaS is Google.

2. *PaaS* (*Platform as a Service*): In this model, development environment is offered as a service. The clients can create their personal applications, which run on the cloud provider's infrastructure. PaaS providers offer a predefined combination of OS and application servers. The most common service of PaaS is Google's app.

3. *IaaS* (*Infrastructure as a Service*): In this model, cloud providers offer infrastructure such as storage, firewalls, load balancers, and networks. Service providers supply these resources on. The most common example of IaaS is Amazon

## 2.2 Deployment Models

The following models are presented by the deployment scenario:

1. *Private Cloud*: This cloud infrastructure is operated exclusively for a particular organization, and is managed by that specific organization or a third party regardless of its location.

2. *Public Cloud*: This cloud infrastructure is maintained and operated by third parties. Examples include services designed for the general public like e-mail services, social networking sites.

3. *Community Cloud*: In this cloud infrastructure, the service is shared by some organizations and made available only to those groups. The infrastructure may be possessed and operated by the organizations or by a cloud service provider.

4. *Hybrid Cloud*: The combination of public and private cloud is identified as hybrid cloud. In this model service providers can use third party cloud providers in a full or partial manner to increase the flexibility for using the resources.

## 3. Wireless Sensor Network

A Wireless Sensor Network (WSNs) are networks comprising of spatially spread independent sensors to track physical and environmental conditions, like temperature, humidity etc. WSNs consist of small low-cost, low-power, multipurpose sensor nodes that can be used to communicate within short distances. A basic wireless sensor consists of numerous components, these are:

- A low-power CPU, a small amount of memory.
- A radio transceiver with an antenna for communicating data.
- A microcontroller for interfacing with the sensors.
- Energy sources like batteries.

WSN architecture can be of two type viz centralized or distributed. In centralized architecture the central node is the weakness of the network. If it fails, complete network downfall. Conversely, distributed architecture provides failure resistant sensor network [9]. The topology of the WSNs can vary from a simple star network to an innovative multi-hop wireless mesh network. The dissemination practice between the hops of the network can be routing or flooding. A WSNs consists of huge, heterogeneous and multidimensional data, the gathered raw data may include a large amount of irrelevant information. In order to lessen this bulk of data, this raw data needs to be refined, gathered and processed [10]. Usually these devices are small and inexpensive, so that that they can be produced and deployed in large numbers. There are various factors associated with the performance of WSN like energy, memory; computational speed and bandwidth are constrained. Sensor networks may entails many different types of sensors such as seismic, infrared visual, low sampling rate magnetic, and radar. These sensors are intelligent enough to monitor an extensive variety of atmospheric surroundings such as:

- Temperature,
- Noise heights,
- Lightening conditions,
- The existence or lack of certain kinds of objects,
- Speed, and mechanical stress of an object.

The applications of wireless sensor networks include forest fire detection [11], medical monitoring [12] and pollution monitoring [13], , battle destruction assessment, industrial process monitoring , home mechanization, traffic monitoring etc.

## 4. Literature Review

| S. No . | Paper Title | Parameter | Proposed Model | Comments | References |
|---|---|---|---|---|---|
| 1. | A Framework of Sensor - Cloud Integration Opportunities and Challenges | Data delivery | A publisher subscriber based framework is proposed to integrate sensor network with cloud. | Association with other cloud providers by VO based dynamic cooperation to make the resource available | [14] |
| 2. | Infrastructure for Data Processing in Large-Scale Interconnected Sensor Networks“ | The dynamic adaptation of the system. | GSN [15] middleware for dynamic integration and management of sensor network. | It is basically peer-to peer architecture and supports QOS aspects of system | [15] |
| 3. | Design and | Load | VFSN: Virtual Federated | The main service is | [16] |

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| | Implementation of Sensor Data Sharing Platform for Virtualized Wide Area Sensor Networks | distribution | Sensor Network is used to share sensor data among multiple users and hiding actual resources | sensor data sharing | |
| 4. | Integration of Wireless Sensor Network with Cloud | Extending the service oriented paradigm | The proposed work provides the solution to integrate the industrial sensor networks with Internet through the integration of SOA and cloud paradigm | The proposed model offers the advantages of reliability and availability. | [17] |
| 5. | Distributed Shared Memory as an approach for Integrating WSNs and Cloud Computing | Duplicate data stored on the real sensor nodes also in the virtual sensors | This paper proposes an architecture to realize distributed shared memory in WSNs using a middleware called tiny DSM | Tiny DSM is a good option to to duplicate data stored on the real sensor nodes in the virtual sensors. There are some open issues such as load balancing and energy consumption that need to be addressed | [18] |
| 6. | Integrating Sensors with the cloud using dynamic | Interoperability | This paper uses a lightweight component model and dynamic proxy-based approach to connect sensors to the | Since middleware is located in the proxy, energy consumption is less. | [19] |

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| | proxies | | Cloud | | |
| 7 | Cloud Computing System Based on Wireless Sensor Network | Faster access of information | The sensor data will be uploaded to the cloud database permitting the client to use Cloud Service as long as the user's display facility has internet connectivity. | The issue of quick access of information at the client end has been addressed by our system. | [20] |
| 8 | Integrating Wireless Sensor Network into Cloud Services for Real-time Data Collection | Data collection | Data collection | Web service based on REST is used to monitor patient's health | [21] |
| 9. | Proposed framework for underwater sensor Cloud for environmental Monitoring | Meta modeling | A Hadoop framework is used as a middleware for underwater sensor cloud. | Historical data is used to predict future actions. | [22] |
| 10. | Generic Integrated Secured WSN-Cloud Computing For U-Life | Informatio n Sharing | A Secured Wireless Sensor and Cloud Computing based Life Care system is proposed | Tracks Patient's health and distributes this information between doctors, care-givers so that users can have better care with low | [23] |

| | | | | | |
|---|---|---|---|---|---|
| | Care | | | cost | |
| 11. | A Cloud Computing Solution for Patient's Data Collection in Health Care Institutions | Latency | Sensors are attached to the medical equipments that are inter-connected to interchange services for efficient medical data management | The information becomes available in the cloud from where it can be accessed and analyzed by expert systems and circulated to medical staff. | [24] |
| 12. | Distributed processing from large scale sensor network using Hadoop | Handle big data | Present the main features of a model to test Hadoop framework applied to process climate. | Proposed model help in the decision making process in agricultural production | [25] |

## 5. Research Objective

A thorough literature survey projects that private and public cloud have their own constraints. As an instance private cloud suffers from the drawback of lack of elasticity, on the other hand public cloud suffers from the problem of high latency for interactive applications. Our main research objective:

- To study the use of hybrid cloud for the integration purpose and
- To focus on load distribution & data sharing to overcome the limitation of public clouds.

## 6. Methodology:

### 1.1 Simulation Tool

The use of real infrastructures as metric for the application performance (throughput, response time) under inconstant environments is often constrained by the severity of the infrastructure. Hence, this makes the duplication of results an extremely difficult task. Hence Instead of the real environment, cloud simulator could simplify the experiments.

Simulators allows users to measure the performance bottlenecks or evaluates different kinds of features under varying load distributions. Execution analysis of load balancing algorithms will be presented through CloudSim. Different kinds of functionalities of CloudSim are presented in the following.

(i) support for modeling and simulation of large scale Cloud computing environments, containing data centers; (ii) a self-sufficient platform for modeling Clouds, service brokers, provisioning policies, and allocation policies; (iii) support for simulation of network connections among the simulated system and (iv) facility for simulation of federated Cloud environment that inter-networks resources from both private and public domains

Apart from these above-mentioned functionalities, developers or researchers need not to think about the lower level details of cloud based infrastructure and service.

### 1.2 Existing load balancing algorithms

Any algorithm regarding load balancing is designed, based on the state or behavior of the system, which may be static or dynamic

*Static Algorithms*: These algorithm requires a prior knowledge of system resources, so that the choice of shifting of the load does not depend on the live state of system. They have a major shortcoming, in case of an unexpected catastrophe of system resource and tasks.

*Dynamic Algorithms*: These algorithms take decisions concerning load balancing based upon the present state of the system and don't need any prior knowledge about the system. The algorithms in this category are comparatively complex, but have better fault tolerance and overall performance.

*Round Robin (RR)*: This algorithm passes each new request to the next server in queue, eventually distributing requests evenly across the machines. Round Robin works well in most configurations, but could be more effective if the resources that we are load balancing are equal in processing speed, memory and other important parameters.

*Equally spread current execution load*: This algorithm involves a load balancer that continually monitors the jobs submitted for execution. The task of load balancer is to queue up the jobs and to deliver them to different virtual machines.

*Throttled*: In this algorithm the user first requests the load balancer to find a suitable Virtual Machine (VM) which can accept that load easily and perform the required operation. The weakness of this algorithm, it does not consider the processing time for each individual requests.

## 7. Conclusion & Discussions

The integration of WSN with Cloud Computing is a very important research topic. Both Wireless Sensor Network and Cloud Computing technologies accompanied by their applications are discussed here. Integration of cloud computing with WSN can solve the resource constraint problems of WSN. In future we will consider load distribution in Cloud Computing. In this paper, we conducted deep study about the use of Sensor-Cloud architecture in the perspective of several applications

## 8. Future Research

Our future endeavor will propose a dynamic load balancing scheme that will manage the load on the cloud using task migration technique in sensor-cloud framework. There are several static and dynamic type of load balancing algorithms on which various research have been made. Static scheduling algorithm like ISH [26], MCP [27] and ETF [28], and dynamic algorithms like weighted least connection (WLC) are generally being used .Proper load balancing, increase both resource utilization and job response time, also evading a situation where some of the nodes are heavily loaded while other nodes are sit idle or doing very little work.

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