IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 6, June 2016

A Study on Sensory Data processing Framework in integration of WSN and Cloud Computing

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Abstract: Wireless sensor network (WSN) are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to pass cooperatively their data through the network to a main location. Although WSNs have many advantages such as small size, low cost, low power and can communicate with each other over a short range, they have many limitations in terms of their processing power, storage resources, and battery life. Cloud computing (CC) is a distributed computing paradigm that provides access of the resources such as storage, network, servers and applications on demand. The integration of wireless sensor network and cloud computing which consists of taking advantages of data gathering capability of WSN as well as the data storage and processing ability of CC is done to overcome limitations of WSN. This integration provides a flexible, an open and reconfigurable platform for different monitoring and controlling applications. In this work we show the importance of integrating wireless sensor network with cloud to achieve these objectives. Then we present some issues and methodologies used by some authors in integration of wireless sensor network with cloud computing along with future directions.

Keywords: Wireless Sensor Network (WSN), Cloud Computing (CC), Data Processing, Integration.

I. INTRODUCTION

A. Wireless Sensor Network (WSN)

Wireless sensor networks (WSNs) consist of a large number of tiny battery-powered sensors that are densely deployed to collect data from their environment and report their findings to a central processor (base station) over wireless links. Recent approaches in Micro-Electro-Mechanical systems (MEMS) technology, wireless communications and digital electronics have accredited the advancement of low cost, low power, multi functioning sensor node that are small in size and can communicate with each other over short ranges. WSNs have great potential to enable many important applications such as battlefield surveillance, battle damage assessment, industrial process monitoring and control, health monitoring, home automation, and traffic monitoring, which could change the way that people interact with the physical world. For example in battlefield surveillance, instead of sending physical scouts to monitor the condition of critical terrain, approach routes, paths, and straits, sensor nodes can be deployed and the activities of the opposing forces can be closely viewed on the surveillance centre. Thus, these tiny nodes have the capability to sense the environment, process the captured data, aggregate the data and then to transmit those data wirelessly to the destination which is known as Base Station (BS).

B. Cloud Computing

Today Cloud Computing is one of the most impacting technology innovations; it is defined as a distributed computing paradigm that is driven by economies of scale, in which a pool of virtualized, abstracted, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet. Cloud provide preconfigured infrastructure at lower cost, can manage increased peak load capacity and moreover uses the latest technology, provide consistent performance that is monitored by the service provider and then a dynamic allocation of the resources such as processors, storage, networks, applications, and other services when are needed. Cloud computing has now embarked on information systems research arena as a prevalent topic for integrated information and systems. With the use of cloud environment, the problem of definite storage, limited battery life and limited processing capability have been solved but there are open research challenges in cloud computing that require attention. Services and resources like bandwidth, storage, network, application, and server are provided in pay on demand manner. Private Cloud is used and managed by one organization but Public Cloud provides resources to its users as services on demand to a general public because all users have same infrastructures. Hybrid Cloud is a combination of both private and public cloud. A group of organization having same goals can set up a Community Cloud. Cloud computing provides services like Platform as a Service (PaaS), Infrastructure as a Service (IaaS), and Software as a Service (SaaS). IaaS is a service model which associates two parties Client and service provider. The client has control over using the services and do not have to go through the hassles of managing and controlling the resources. The service provider extends services on lease to the clients like storage space, processing, networks as per user demand. Other models like PaaS and SaaS, the abstraction level

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increases and the control of users over computing resources diminishes. In Paas consumer is only responsible for writing the application code. The vendors give a sandboxed environment to write and deploy the codes of the user. The same application platform is shared by many users. In Paas, the programming language APIs, tools and other components for building application is allowed only that which are supported by the provider. In Paas, user has no control of the underlying architecture like network, servers, storage. In SaaS user has no control on network, servers, operating systems, storage and individual application. The applications are provided to the user in an on demand fashion.

C. Integration of WSN and CC

Integrate wireless sensor networks with cloud computing consists of combining advantages of the ubiquitous data gathering capability of WSN and the powerful data storage and processing power of CC.

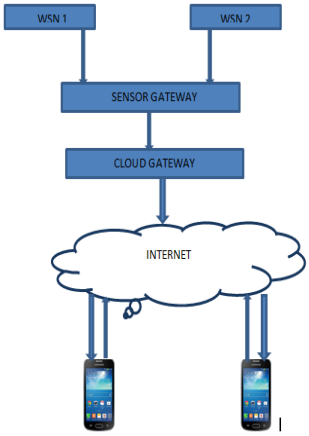

Fig. 1. Architecture of WSN integrated with CC

This means the use of sensor network for collecting data in an environment and a powerful platform of cloud computing to store and process the sensory data such as sound, traffic, temperature, humidity, pressure etc. Sensor node in a WSN has limitation in hardware design, lower communications, limited computing power, limited storage capacity, and limited battery energy. This critical issues cause problems of WSN lifetime, traffic and bandwidth demand and the delay for the applications or users to eventually obtain the desired data. So if the advantages of both the technologies are considered, then the WSN-CC integration can figure out many problems. As the need of wireless sensor networks continue to grow, sensor node became small, and the use of non-rechargeable battery for energy, to provide an effective method for collecting data, transmitting data, processing data, storing the data and secure the data from the transmitting process to the user is a big problem. Thus come the need of using cloud as a solution to overcome these challenges of WSN, but steel this integration has also its own challenges like security, privacy issue, Integration process, scalability, end to end delay constraint, routing, heterogeneity and other energy constraints and need to be focused. We will discuss some issues related to the integration of WSN and cloud and the current work that have been done in this area.

II. LITERATURE REVIEW

A. Introduction

Due to their prospects, WSNs has direct application in various fields like in battlefield surveillance, health monitoring, smart home etc. On the other hand due to their hardware limitations, and in pursuit of a better performance and enhancing greater computing capability, people turn to find other techniques to achieve their goals. The term “Cloud” mainly refers to a cost efficient way to provide resources and services in an on demand fashion. Cloud computing has emerged as a new computing model because of its low cost, more powerful and ubiquitous computing resources. If we were to take advantage of both technologies, the WSN and cloud, this will resolve the corresponding challenges in the individual areas and also integration of both these forces will open up numerous opportunities. Combining Wireless sensor networks and cloud make sense for large number of applications like in transport monitoring system, sensor nodes are used to detect vehicles and traffic control lights. Weather forecasting is the application of WSN to predict the future state of the environment for any given location at a given time. Disaster surveillance is another area where the sensor nodes are used to detect the disaster providing accurate surveillance to reduce the loss of lives and property. Several approaches have been done so far for collecting and processing data by WSN, then the integration of both WSN and CC.

B. WSN and CC Integration Frameworks

B. Tang and Y. Wang propose a large scale sensory data processing system based on cloud computing. They show that there is an urgent demand of high performance sensory data processing due to limited computing power and storage capacity of sensor nodes. Then they studied the interconnection of wireless sensor networks and cloud-based storage and computing infrastructure by proposing the idea of distributed databases to store sensory data and MapReduce programming model for large-scale sensory data parallel processing. This system is just built upon scalable, fault-tolerant distributed systems-Hadoop and HBase, to facilitate data analysis. HDFS and HBase-based sensory data storage model and a flexible data processing framework based on Hadoop MapReduce can fit for a variety of applications.

• Data storage model-HDFS and HBase: The Apache Hadoop project develops open-source software for reliable, scalable, distributed computing. The Hadoop software offers Hadoop Distributed File System (HDFS), a distributed file system that provides high-throughput access to application data. HBase is an open-source; scalable, distributed database that supports structured data storage for column-oriented large tables.

• Data processing framework-Hadoop MapReduce: MapReduce is a parallel programming paradigm successfully used by large Internet service providers to

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perform computations on massive amounts of data. After being strongly promoted by Google, it has also been implemented by the open source community through the Hadoop project.

• Interconnection of cloud and WSN: Authors do not address any problems of energy-efficiency communication protocol for data aggregation, sensor data fusion, data pre-processing, data filtering, and so on. We only focus on the back-end system. The interconnection is implemented by data gateway. Gateway is a client which accesses remote cloud service through Java API interface for data writes. The gateway receives data from the Sink node and then writes data into local storage as a backup, and a daemon thread is in charge of periodically writing data to Cloud Data Centre. I/O Controller module is designed for interaction between gateway and cloud. So as to the Web Server module, it is used for providing friendly web interface for users to access sensory data, and submit query and processing request job.

L.P.Dinesh Kumar et.al proposes data filtering in WSN using neural networks. They have used neural networks to find anomalies in the data which is sensed by the sensors at the gateway. The input to the neural network was the data which was gathered by the sensors. The neural network checks whether the data falls within an acceptable range or not. The authors argue that if the data deviates means if there is too much or too less data, then accordingly the input data is sensed by the neural network and stores it in the gateway and all the other data is discarded because this method only find anomalies. Hence the traffic congestion and the bandwidth requirement for data transmission is less because this method stores and transmits only the anomalies. Also the data in the cloud is periodically updated. The data which is gathered is compressed using deflate algorithm and it is transmitted to the cloud gateway. Thus the data which was collected by the sensors first filtered by using trained neural network at the sensor gateway for finding the anomalies in the data. The data was sent to cloud gateway after compression where the data firstly decompressed and then it was stored on the cloud for future references.

Sajjad Hussain Shah et.al Proposed a framework to integrate sensor network and cloud which has the major components like data processing unit, publisher/subscriber broker, request subscriber, data repository, and identity and access management unit. The data is first gathered by WSN and then it is sent to DPU and after processing the data it is added to the data repository (DR).The user can access the data which is stored on the cloud by using secured IAMU. Thus a framework has been proposed to integrate the WSN and cloud for solving problems like storage as well as the recovery mechanism to the sensed data. The data can be accessed from any location of the world by user.

Zhang Peng et.al propose an architecture of integration of WSN and cloud where sink is used to improve performance of WSN and this sink is responsible of collecting the various sensory data and each sink point is responsible for collecting the data from various zones. Then the gathered sensory data is finally stored in the cloud and processed in the cloud. The resultant system is proved to be reliable, available and extensible. This framework mainly focused on the utilization of the sensory data after the data is transmitted to the cloud but they did not consider the situation that the mobile user may have a preference about the sensory data and they did not consider the context awareness between the mobile users and WSN.

Chunsheng Zhu et.al proposed a novel sensory data processing framework to integrate WSN and mobile cloud. In this work authors present the framework from how sensory data are gathering, the processing of those data up to the transmission to the mobile user. For each wireless sensor network gathering specific sensory data, there is a sensor gateway for each cluster. Each sensor gathers the sensory data and then sends it to its sensory gateway. The sensory gateway makes the processing of the sensory data collected. After the sensory data is received by sensor gateway, it process these data with five components which are data traffic monitoring unit for monitoring the data traffic, data filtering unit to filter the data traffic according to a set of rules which are predefined, data prediction unit for predicting the future sensory, data compression unit, and then data encryption unit. Then the sensory data are sent to the cloud for storage and further processing so that they are suit to be presented to the mobile user on demand.

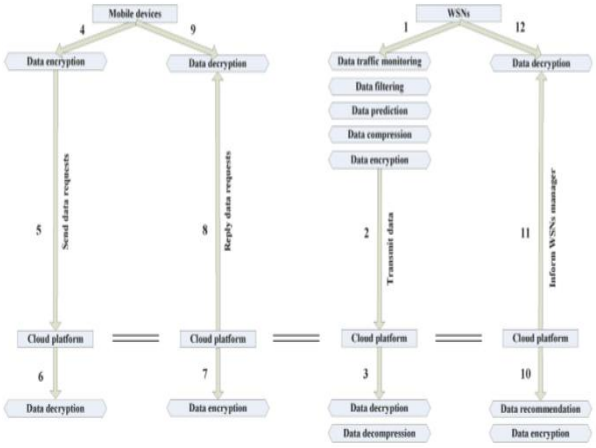

Fig.2. Flowchart of the proposed framework

Due to the descriptions of data processing tasks that are used in the proposed system, we can see that the proposed system can:

• Prolong lifetime of the sensor network: By processing the sensory data to the cloud, consumption of energy due to extensive data processing at the sensors will be reduced significantly, then prolong lifetime of sensor network.

• Reduce transmission bandwidth requirement and traffic of sensory data: Transmission bandwidth requirement and traffic load of sensory data are reduced because data are filtered before transmitting to the cloud.

• Storage requirement of the sensor is decreased: Because complex processing functions are offloaded on the cloud in the proposed system, there is no need to sensor to store a lot of data for processing then the storage requirement of the sensor and sensor gateway is reduced.

DOI 10.17148/IJARCCE.2016.5679

• Future trend of sensory data is predicted: By using SESM, future trend of the sensory data can be predicted and this can prevent the occurrence of dangerous events by taking measures in advance.
• Sensory data traffic is monitored: Network manager get alert to check the status of the sensors when the sensory data traffic is too high or too law to ensure that sensors work properly.

Zhu, C., Leung, V. C., Yang, L. T., & Shu, L. focuses mainly on these two observations and they proposed two location based sleep scheduling (CLSS) schemes. CLSS1 focused on maximizing the energy consumption saving of the integrated WSN while CLSS2 also considered the scalability and robustness of the integrated WSN. For this they used two mobile user location lists i.e. mobile user location history list and mobile user prediction location list. In mobile user location history list to achieve the location history of user they used StarTrack service which is a mobile client application and it periodically captures the current location of the user (e.g with GPS) and relays the location information to the StarTrack server which runs as the service in the cloud. To achieve the prediction location list of the user, the future location of the mobile user would be associated with the frequently visited locations of the mobile user.

III. GAP AND FUTURE WORK

As we have briefly introduced some techniques which have been recommended by different researchers in the area of integration of WSN and cloud, we can emphasize on gaps which can be addressed.

• One such issue was considered in data filtering in WSN using neural networks was homogeneous whereas the heterogeneous networks can also be considered for monitoring different type of applications.
• The encryption details presented in this paper was limited to only some sensitive data thus makes it an open area for exploration.
• In resource scheduling of Cloud for WSN and for these authors have used the multiple Ant Colony algorithms and compared it with the traditional ant colony algorithm but it can further be studied that there are various other algorithms like genetic algorithm, Particle swarm optimization which can also be applied in this area.
• The performance parameters selected for optimization were only average delay, packet reception rate and the network throughput however there are many other parameters like Hop count, network load, latency which can be considered for future work and may yield better results.

IV. CONCLUSION

We have presented the survey on integration of wireless sensor network with cloud computing. The integration of WSNs and CC is a very important research topic as it is a new emerging area which provides a robust and scalable infrastructure for several applications. Cloud Computing is an innovative technological paradigm that provides convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. WSN consists of a large number of low cost, low power multi functioning nodes deployed in the environment to collect data. In this work we present challenges and solutions provided by current research in integration of WSN and cloud and expect that these solutions can be improved. There are other new challenges that need critical focus like security, privacy issue, routing, and heterogeneity.

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