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A report on Integration of Wireless Sensor Network with Cloud Computing

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Abstract

Nowadays, wireless sensor community (WSN) commitments were used in a number of fundamental areas, comparable to healthcare, military,major infrastructure monitoring, atmosphere monitoring, and manufacturing. However, as a result of the limitations of WSNs interms of memory, energy, computation, conversation, and scalability, efficient management of the huge number of WSNs informationin these areas is a predominant dilemma to handle. There is a need for a powerful and scalable high-efficiency computing andbig storage infrastructure for actual-time processing and storing of the WSN information as good as analysis (on-line and offline) ofthe processed understanding under context making use of inherently intricate models to extract events of interest. In this situation, cloudcomputing is becoming a promising technological data to provide a flexible stack of massive computing, storage, and software services ina scalable and virtualized method at low cost. Therefore, in present years, Sensor-Cloud infrastructure is fitting preferred that canfurnish an open, flexible, and reconfigurable platform for a couple of monitoring and controlling purposes. In this paper, we presenta comprehensive studyon Sensor-Cloud infrastructure, so one can furnish general readers and summary ofthe Sensor-Cloud platform togetherwith its definition, structure, and applications.

Keywords: Cloud Computing, Sensor Network, WSN

I. INTRODUCTION

The expansion and application of wireless sensor networks grow to be an unbeatable trend into the more than a few industrial, environmental, and business fields. A typical sensor network could encompass a number of sensor nodes appearing upon collectively to monitor a area and fetch data in regards to the surroundings. A WSN comprises spatially distributed self-regulated sensors that may cooperatively display the environmental conditions, like sound, temperature, stress, motion, vibration, pollution, and so on [1, 2]. Every node in a sensor network is loaded with a radio transceiver or every other wireless communication device, a small microcontroller, and an energy source most often cells/battery. The nodes of sensor network have cooperative capabilities, which might be mainly deployed in a random manner. These sensor nodes basically encompass three ingredients: sensing, processing, and communicating [3]. One of the most common sensor gadgets deployed in sensor networkOne of the most common sensor devices deployed in sensor network as sensor nodes are digital camera sensor, accelerometer sensor, thermal sensor, microphone sensor, and so on. Presently, WSNs are being utilized in a number of areas like healthcare, defense similar to army target tracking and surveillance [4, 5], govt and environmental services like typical disaster remedy [6], hazardous atmosphere exploration, and seismic sensing [7], and many others. These sensors may just furnish various valuable data when they are intently hooked up to every of their respective functions and services immediately [8]. Nevertheless, sensor networks need to face many disorders and challenges concerning their communications (like short communication range, security and privacy, reliability, mobility, and so forth.) and resources (like power issues, storage potential, processing capabilities, bandwidth availability, and many others.). Apart from, WSN has its own useful resource and design constraints. Design constraints are software exact and based on monitored environment. Founded on the monitored environment, network dimension in WSN varies. For monitoring a small area, fewer nodes are required to form a network whereas the coverage of a very tremendous discipline requires a significant quantity of sensor nodes. For monitoring huge atmosphere, there may be restricted communication between nodes due to obstructions into the environment, which in turn affects the overall network topology (or connectivity) [9]. All these obstacles on sensor networks would most likely obstruct the provider performance and fine. In the course of these issues, the emergence of cloud computing is noticeable as a relief.

II. RELATED WORK

When a user requests, the service circumstances (e.g., virtual sensors) generated by cloud computingservices are routinely provisioned to them [11, 12]. Some prior reviews on physical sensors interested by routing, clock synchronization, data processing, power management, OS,localization, and programming [10]. There are very much less work had been carried out which listenon physical sensor management for the reason that these physical sensors are sure intently to theirexact application as well as to its tangible users directly. However, users, rather than theirrelevant sensor services, cannot use these physical sensors directly when needed. As a result,these physical sensors should be supervised by using some distinctive sensor-management schemes. TheSensor-Cloud infrastructure would subsidize the sensor process administration, which ensuresthat the data-administration usability of sensor assets can be particularly accelerated.

There exists no application that can make use of every variety of physical sensors in any respectoccasions; as a substitute, each and every utility required pertinent physical sensors for its fulfilment. To realisethe notion, publish/subscription mechanism is being employed for selecting the appropriatephysical sensor [10]. Server-Cloud infrastructure supplies the power to user to create thetemplate/virtual specific group of sensor nodes whose data will likely be collaborated for the designatedapplications. These service templates/virtual agencies are reconfigurable consistent with the userwants. Once provider situations end up unsuccessful, they are able to then be deleted speedily by way of users toavert the utilization costs for these assets. Each sensor node, software sensesthe application and sends the sensor data again to the gateway within the cloud instantly via ofthe base station. Sensor-Cloud infrastructure supplies service situations (virtual sensors)routinely to the top clients as and when requested, in this kind of approach that these digital sensorsare part of their IT resources (like disk storage, CPU, memory, and so forth.) [13]. These templateservices/digital agencies' situations and their associated right sensor data can be used by way ofthe top users via a user interface through the web crawlers as described in Fig.1.

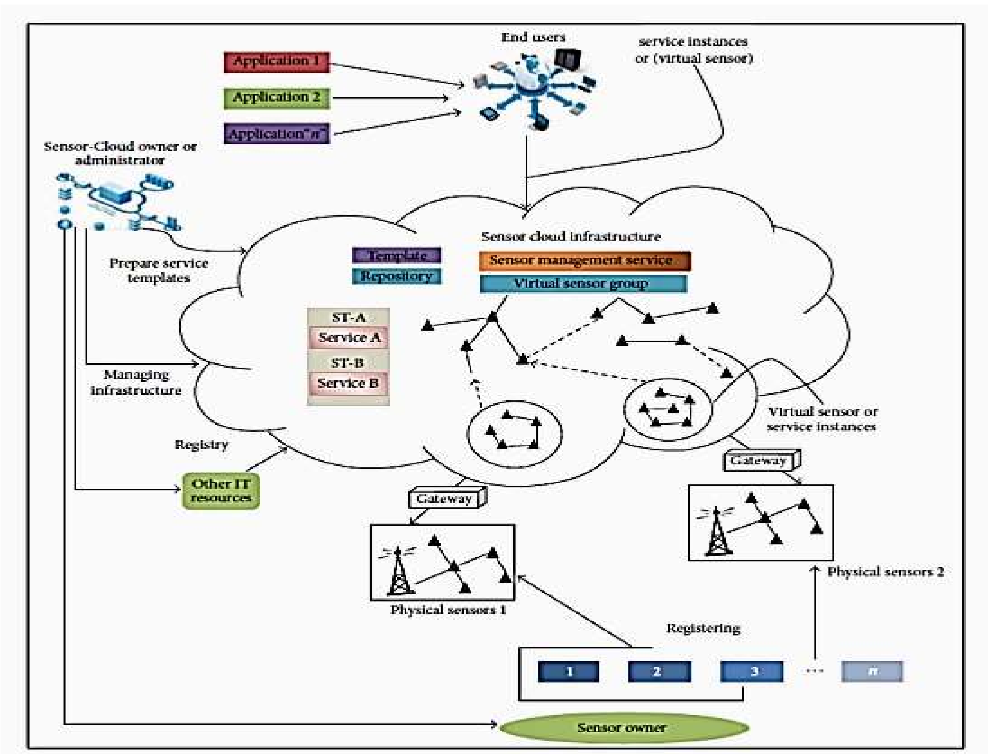

Fig.1 Sensor-Cloud Architecture [10]

The physical sensors are ranked on a basis of their sensor readings as well as on theiractual distance from an event. The authors of [14] proposed a technique (FIND) to locatephysical sensors having data faults by assuming a mismatch between the distance rank andsensor data rank. However, the study led by FIND aims at the assessment of physical sensorsfaults, and there is a close relation between the virtual and physical sensors and hence a virtualsensor will provide incorrect results if their relevant physical sensors are faulty.Since the cloud computing enables the physical sensors to be virtualized by creatingtemplates or virtual grouping, the users of the Sensor-Cloud Infrastructure need not to worryabout the status of their connected physical sensors.

The basic disadvantages of aWSN and cloud computing are almost the same and energy efficiency of sensor nodes is lost due to the limited storageand processing capacity of nodes. The authors of [18] haveproposed a system for health monitoring using the textilesensors, which work much better and give more accurateresults. These textile sensors can be easily sewed and are evenwashable. Although the proposed system of textile sensorsis performing well in the majority of aspects, the batterycan last only 24 hours after continuous monitoring anddata transmitting regarding user's heartbeat rate, movement,respiratory conditions, and so forth. The gathered accumulated data can then be visualized in charts using some webapplications and the results are received at user end throughan alert message remotely on user's smartphone. But inorder to extend system independency, energy efficiency ofsuch systems (textile sensors and microcontroller based) isa primary issue that has to be handled.

Datacachingmechanism [15] canbeusedtoreusebygonesensor data for applications that are tolerant to time, forexample, an application related to variant room temperature.If this bygone sensor data is used to satisfy the variousrequests for a common sensor data, the energy consumptionwill be reduced [16]. Still more work is needed to overcomethe energy consumption.

To improve the energy efficiency and memory usage ina Sensor-Cloud infrastructure, there should be a middlewarewhich can tackle the adverse situation in case of continuousand long-duration monitoring of data. This can be donethrough the gateway that is acting as a middleware andcollects the huge sensor data from sensor nodes [17]. Thismiddleware should be able to compress the sensor data toavoid the transmission load and then transmits it back tothe gateway acting as a middleware on cloud side which inturndecompressesandstoresit there. When thetransmissionoverload reduces, the energy consumption of sensor nodesimproves automatically due to less processing.

III. COMPARISON OF DIFFERENT APPROACHES IN SENSOR-CLOUD INFRASTRUCTURE

In this section, we first present the advantages and disadvantages of Sensor-Cloud infrastructure in terms of agility, reliability, portability, real-time, and flexibility. Next, we provide atechnical comparison of different messaging approaches andalgorithmsusedinseveralexistingresearchonSensor-Cloud.

Pros of Sensor-Cloud Infrastructure:

(i) Service requesters or end users can control the serviceinstances freely.

(ii) End users can examine the eminence of their relevantvirtual sensors.

(iii) Service requesters can use the virtual sensors withoutworrying about the implementations detail.

(iv) The client/users need not to anxiety about the exactlocations and comprehensive description of their sensors.

(v) The service instances are automatically provisionedwhenever a request is made.

(vi) The Three sourcesandsensorsarereleasedasandwhenthe required job is over, which means that users candelete them when they become nonuseful.

(vii) Usage of physical sensors can be tracked by the sensorowner.
(viii) Sensor data are available all the time for a number ofvarious applications until the connection is provided.

(ix) The Sensor-Cloud architecture provides an extensible, open, interoperable, and intelligent sensor network for service provisioning in health care.

(x) The cost of IT resources and WSN infrastructure isreduced when integrating with Internet/Cloud.

(xi) End users can also create the sensors group dynamically in the form of virtual-sensor groups to innovatethe new services.

Besides these advantages, the Sensor-Cloud infrastructure also has some drawbacks and these are as follow.

Cons of Sensor-Cloud Infrastructure:

(i) The IT resources and physical sensors should beprepared prior to operation of the Sensor-Cloudinfrastructure.

(ii) The Sensor-Cloud infrastructure will not providemuch accurate data as in the case of direct sharing ofphysical sensors data.

IV. APPLICATION SCENARIOS

Combining WSNs with cloud makes it easy to share andanalyze real time sensor data on-the-fly. It also gives anadvantage of providing sensor data or sensor event as a serviceover the internet. The terms Sensing as a Service (SaaS) andSensor Event as a Service (SEaaS) are coined to describe theprocess of making the sensor data and event of interestsavailable to the clients respectively over the cloudinfrastructure.Merging of two technologies makes sense for large numberof application. Some applications of sensor network usingcloud computing are explained below:

A. Transport Monitoring

Transport monitoring system includes basic managementsystems like traffic signal control, navigation, automaticnumber plate recognition, toll collection, emergency vehiclenotification, dynamic traffic light etc. [19].In transport monitoring system, sensors are used to detectvehicles and control traffic lights. Video cameras are also usedto monitor road segments with heavy traffic and the videos aresent to human operators at central locations. Sensors withembedded networking capability can be deployed at every roadintersection to detect and count vehicle traffic and estimate itsspeed. The sensors will communicate with neighbouring nodesto eventually develop a global traffic picture which can bequeried by users to generate control signals. Data availablefrom sensors is acquired and transmitted for central fusion andprocessing.

This data can be used in a wide variety ofapplications. Some of the applications are – vehicleclassification, parking guidance and information system,collision avoidance systems, electronic toll gates and automaticroad enforcement.

In the above scenarios, both the applications require storageof data and huge computational cycles. They also requireanalysis and prediction of data to generate events. Access tothis data is limited in both the cases. Integrating these WSNapplications with the cloud computing infrastructure will easethe management of storage and computational resources. It alsoprovides an improvement on the application data over the

B. Military Use

Sensor networks are used in the military for Monitoringfriendly forces, equipment and ammunition, Battlefieldsurveillance, Reconnaissance of opposing forces, Targeting,Battle damage assessment and Nuclear, biological and chemicalattack detection reconnaissance etc [20].The data collected from these applications are of greatestimportance and needs top level security which may not beprovided using normal internet connectivity for security reason.

Cloud computing may be one of the solution for this problemby providing a secure infrastructure exclusively for militaryapplication which will be used by only Defense Purpose.

C. Weather Forecasting

Weather forecasting is the application to predict the state ofthe atmosphere for a future time and a given location. Weathermonitoring and forecasting system typically includes- Datacollection, Data assimilation, Numerical weather prediction andForecast presentation.

Each weather station is equipped with sensors to sense thefollowing parameters—wind speed/direction, relative humidity,temperature (air, water and soil),barometric pressure,precipitation, soil moisture, ambient light (visibility), sky coverand solar radiation. The data collected from these sensors ishuge in size and is difficult to maintain using the traditionaldatabase approaches. After collecting the data, assimilationprocess is done. The complicated equations that govern how thestate of the atmosphere changes (weather forecast) with timerequire supercomputers to solve them.

D. Health Care

Sensor networks are also widely used in health care area. Insome modern hospital sensor networks are constructed tomonitor patient physiological data, to control the drugadministration track and monitor patients and doctors andinside a hospital.In the above scenario, the data collected from the patients arevery sensitive and should be maintained properly as collecteddata are required by the doctors for their future diagnosis. Intraditional approach the patient's history database is maintainedin the local nursing home. So reputed doctors who are speciallyinvited from abroad to handle critical cases cannot analyze thepatient's disease frequently. They will only make diagnosiswhen they will visit the particular nursing home. This problemmay be solved by forming a cloud where the critical data of thepatients can be maintained and authorized doctors sitting inabroad can analyze the data and give proper treatment.

V. CONCLUSION

In this paper, we surveyed the use of Sensor-Cloud architecture in the context of several functions. The Sensor-Cloudstructure allows the sensor data to be classified, stored,and processed in such a manner that it turns into cost-effective,well timed available, and quite simply accessible. Previous, most WSN systems that have been incorporated to a couple of controlling/monitoringschemes were closed in nature, zero, or less interoperability, specific utility oriented, and non-extensible. However,integrating the prevailing sensors with cloud will permit anopen, extensible, scalable, interoperable, and convenient to make use of, reconstructible network of sensors for numerous functions.In this paper, we've mentioned the opportunities of imposing the technology to manage more elaborate situationsof a real world through the provider innovation capability ofSensor-Cloud infrastructure.

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