Wireless Sensor Networks In Cloud Computing

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Abstract

Cloud computing provides applications, platforms and infrastructure over the internet. It is a new era of referring to access shared computing resources. On the other hand, wireless sensor networks have been seen as one of the most essential technologies where distributed spatially connected sensor node automatically forms a network for data transmission and receive among themselves is popularly known as Sensor Network. For security and easy access of data, cloud computing is widely used in distributed/mobile computing environment. This is possible due to miniaturization of communication technology. Many researchers have cited different types of technology in this context. But the application scenario are of important consideration while designing a specific protocol for Sensor network with reference to Cloud Computing. In this paper, we surveyed some typical applications of Sensor Network using Cloud computing as backbone. Since Cloud computing provides plenty of application, platforms and infrastructure over the Internet; it may combined with Sensor network in the application areas such as environmental monitoring, weather forecasting, transportation business, healthcare, military application etc. Bringing various WSNs deployed for different applications under one roof and looking it as a single virtual WSN entity through cloud computing infrastructure is novel.
***Index Terms*—**Cloud Computing, Distributed Computing, Internet, Sensor Network, WSN

1. INTRODUCTION

The communication among sensor nodes using Internet is often a challenging issue. It makes a lot of sense to integrate sensor networks with Internet [1]. At the same time the data of sensor network should be available at any time, at any place. It is possibly a difficult issue to assign address to the sensor nodes of large numbers; so sensor node may not establish connection with internet exclusively. Cloud computing strategy can help business organizations to conduct their core business activities with less hassle and greater efficiency. Companies can maximize the use of their existing hardware to plan for and serve specific peaks in usage. Thousands of virtual machines and applications can be managed more easily using a cloud-like environment. Businesses can also save on power costs as they reduce the number of servers required.

Fig.1 consists of WSNs (i.e. WSN1, WSN2, and WSN3), cloud infrastructure and the clients. Clients seek services from the system. WSN consists of physical wireless sensor nodes to sense different applications like Transport Monitoring, Weather Forecasting, and Military Application etc. Each sensor node is programmed with the required application. Sensor node also consists of operating system components and network management components. On each sensor node, application program senses the application and sends back to gateway in the cloud directly through base station or in multi-hop through other nodes. Routing protocol plays a vital role in managing the network topology and to accommodate the network dynamics. Cloud provides on-demand service and storage resources to the clients. It provides access to these resources through internet and comes in handy when there is a sudden requirement of resources.

The organization of our work is as follows. In Section 2 & Section 3 we have presented an overview of Clouds and Sensor Network. In section 4 we have discussed various application scenarios of Sensor Network using Cloud Computing. Lastly, Section 5 concludes our work.

2. CLOUD OVERVIEW

Cloud computing is a term used to describe both a platform and type of application. A cloud computing platform dynamically provisions, configures, reconfigures servers as needed. Servers in the cloud can be physical machines or virtual machines. It is an alternative to having local servers handle applications. The end users of a cloud computing network usually have no idea where the servers are physically located—they just spin up their application and start working. Advanced clouds typically include other computing resources such as storage area networks (SANs), network equipment, firewall and other security devices. Cloud computing also describes applications that are

extended to be accessible through the Internet. These cloud applications use large data centers and powerful servers that host Web applications and Web services. Anyone with a suitable Internet connection and a standard browser can access a cloud application.
Many formal definitions have been proposed in both academia and industry, the one provided by U.S. NIST (National Institute of Standards and Technology) appears to include key common elements widely used in the Cloud Computing community:

A. characteristics

The following are the characteristics of cloud computing:

- **Elasticity and scalability:** The cloud is elastic, meaning that resource allocation can get bigger or smaller depending on demand. Elasticity enables scalability, which means that the cloud can scale upward for peak demand and downward for lighter demand. Scalability also means that an application can scale when adding users and when application requirements change.

- **Self-service provisioning:** Cloud customers can provision cloud services without going through a lengthy process. You request an amount of computing, storage, software, process, or more from the service provider. After you use these resources, they can be automatically deprovisioned.

- **Standardized interfaces:** Cloud services should have standardized APIs, which provide instructions on how two application or data sources can communicate with each other. A standardized interface lets the customer more easily link cloud services together.

- **Billing and service usage metering:** You can be billed for resources as you use them. This pay-as-you-go model means usage is metered and you pay only for what you consume

- **Resource pooling:** The resources are dynamically assigned as per clients' demand from a pool of resources .

B. Services

The cloud provides following three services:
1) SaaS(Software as a Service): This model provides services to clients on demand basis. A single instance of the service runs on the cloud can serve multiple end user. No investment is required on the client side for servers and software licenses. Google is one of the service providers of SaaS.

2) PaaS(Platform as a Service): This model provides software or development environment, which is encapsulated & offered as a service and other higher level applications can work upon it. The client has the freedom to create his own applications, which run on the provider's infrastructure. PaaS providers offer a predefined combination of OS and application servers. Google's App Engine is a popular PaaS example.

3) IaaS(Infrastructure as a Service): This model provides basic storage and computing capabilities as standardized services over the network. Servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads. The customer would typically deploy his own software on the infrastructure. The common example of IaaS is Amazon.

C. Cloud Computing Deployment Models

The following models are presented by considering the deployment scenario:

- **Private cloud:** The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

- **Community cloud:** The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

- **Public cloud:** The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

- **Hybrid cloud:** The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

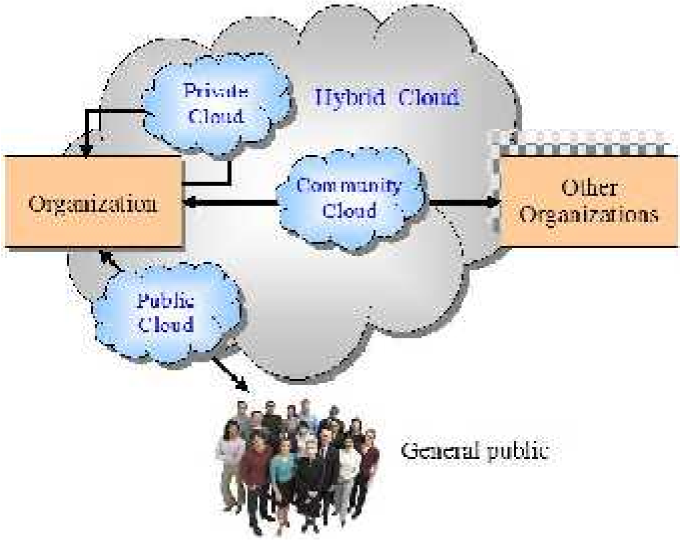

Fig: Cloud deployment diagram.

3. Sensor Network: overview

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. They are now used in many industrial and civilian application areas, including industrial process monitoring and control, machine health monitoring, environment and habitat monitoring,

healthcare applications, home automation, and traffic control .Each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. The size of sensor node may vary from shoebox down to a grain of dust. The cost of sensor nodes is also varies from hundreds of dollars to a few pennies, depending on the size of the sensor network and the complexity required of individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth .

A sensor network is a computer network Composed of a large number of sensor nodes. The sensor nodes are densely deployed inside the phenomenon, they deploy random and have cooperative capabilities. Usually these devices are small and inexpensive, so that they can be produced and deployed in large numbers, and so their resources in terms of energy, memory, computational speed and bandwidth are severely constrained. There are different Sensors such as pressure, accelerometer, camera, thermal, microphone, etc. They monitor conditions at different locations, such as temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, the current characteristics such as speed, direction and size of an object. Normally these Sensor nodes consist there components: sensing, processing and communicating [9]. The development of sensor networks requires technologies from three different research areas: sensing, communication, and computing (including hardware, software, and algorithms). Thus, combined and separate advancements in each of these areas have driven research in sensor networks. Examples of early sensor networks include the radar networks used in air traffic control. The national power grid, with its many sensors, can be viewed as one large sensor network. These systems were developed with specialized computers and communication capabilities, and before the term ―sensor networks‖ came into vogue.

A. Terminology

Following are the important terms which are used widely in sensor network:

- ***Sensor:*** A transducer that converts a physical phenomenon such as heat, light, sound or motion into electrical or other signal that may be further manipulated by other apparatus.
- ***Sensor node:*** A basic unit in a sensor network, with processor, memory, wireless modem and power supply.
- ***Network Topology:*** A connectivity graph where nodes are sensor nodes and edges are communication links.
- ***Routing****:* The process of determining a network path from a source node to its destination.
- ***Resource****:* Resource includes sensors, communication links, processors and memory and node energy.
- ***Data Storage****:* The run-time system support for sensor network application. Storage may be local to the node where the data is generated, load balanced across a network, or anchored at a few points.

4. APPLICATION SCENARIOS

Combining WSNs with cloud makes it easy to share and analyze real time sensor data on-the-fly. It also gives an advantage of providing sensor data or sensor event as a service over the internet. The terms *Sensing as a Service* (SaaS) and *Sensor Event as a Service* (SEaaS) are coined to describe the process of making the sensor data and event of interests available to the clients respectively over the cloud infrastructure.

Merging of two technologies makes sense for large number of application. Some applications of sensor network using cloud computing are explained below:

A. Military Use

Sensor networks are used in the military for Monitoring friendly forces, equipment and ammunition, Battlefield supervision, inspection of opposing forces target, Battle damage assessment and Nuclear, biological and chemical attack detection reconnaissance etc .

The data collected from these applications are of greatest importance and needs top level security which may not be provided using normal internet connectivity for security reason. Cloud computing may be one of the solution for this problem by providing a secure infrastructure exclusively for military application which will be used by only Defense Purpose.

B. Weather Forecasting

Weather forecasting is the application to predict the state of the atmosphere for a future time and a given location. Weather monitoring and forecasting system typically includes- Data collection, Data assimilation, Numerical weather prediction and Forecast presentation .

Each weather station is equipped with sensors to sense the following parameters—wind speed/direction, relative humidity, temperature (air, water and soil),barometric pressure, precipitation, soil moisture, ambient light (visibility), sky cover and solar radiation. The data collected from these sensors is huge in size and is difficult to maintain using the traditional database approaches. After collecting the data, assimilation process is done. The complicated equations that govern how the state of the atmosphere changes (weather forecast) with time require supercomputers to solve them.

C. Transport Monitoring

Transport monitoring system includes basic management systems like traffic signal control, navigation, automatic number plate recognition, toll collection, emergency vehicle notification, dynamic traffic light etc.

In transport monitoring system, sensors are used to detect vehicles and control traffic lights. Video cameras are also used to monitor road segments with heavy traffic and the videos are sent to human operators at central locations. Sensors with embedded networking capability can be deployed at every road intersection to detect and count vehicle traffic and estimate its speed. The sensors will communicate with neighboring nodes to eventually develop a ―global traffic picture‖ which can be queried by users to generate control signals. Data available from sensors is acquired and transmitted for central fusion and processing. This data can be used in a wide variety of applications. Some of the applications are - vehicle classification, parking guidance and information system, collision avoidance systems, electronic toll gates and automatic road enforcement.

In the above scenarios, both the applications require storage of data and huge computational cycles. They also require analysis and prediction of data to generate events. Access to this data is limited in both the cases. Integrating these WSN applications with the cloud computing infrastructure will ease the management of storage and computational resources. It also provides an improvement on the application data over the internet through web.

5. CONCLUSION

The communication among sensor nodes using Internet is a challenging task since sensor nodes contain limited band width, memory and small size batteries. The issues of storage capacity may be overcome by widely used cloud computing technique. In this paper, we have discussed some issues of cloud computing & sensor network. To develop a new protocol in sensor network, the specific application oriented scenarios are of important consideration. Keeping this in mind we have discussed some application of Sensor Network using Cloud Computing.

REFERENCES

[1] C. Ulmer, L. Alkalai and S. Yalamanchili, Wireless distributed sensor networks for in-situ exploration of mars, Work in progress for NASA Technical Report. Available in: http://users.ece.gatech.edu/

[2] P. Mell and T. Grance, "Draft nist working definition of cloud computing - v15," *21. Aug 2005,* 2009.

[3] M. Armbrust, A. Fox, R. Griffith, A. Joseph, R. Katz, A. Konwinski, G. Lee, D. Patterson, A. Rabkin, and I. Stoica, "Above the clouds: A Berkeley view of cloud computing," *EECS Department, University of California, Berkeley, Tech. Rep. UCB/EECS-2009-28,* 2009.

[4] Römer, Kay; Friedemann Mattern (December 2004), "The Design Space of Wireless Sensor Networks", *IEEE Wireless Communications* 11 (6): 54–61, doi:10.1109/MWC.2004.1368897, http://www.vs.inf.ethz.ch/publ/papers/wsn-designspace.pdf

[5] Thomas Haenselmann (2006-04-05). *Sensornetworks*. GFDL Wireless Sensor Network textbook. http://pi4.informatik.uni-mannheim.de/~haensel/sn_book. Retrieved 2006-08-29.

[6] Tiwari, Ankit et. al, *Energy-efficient wireless sensor network design and implementation for condition-based maintenance*, ACM Transactions on Sensor Networks (TOSN), http:// portal.acm.org/citation.cfm?id=1210670

[7] Hadim, Salem; Nader Mohamed (2006), "Middleware Challenges and Approaches for Wireless Sensor Networks", *IEEE Distributed Systems Online* **7** (3): 1, doi:10.1109/MDSO.2006.19, http://doi.ieeecomputersociety.org/10.1109/MDSO.2006.19 art. no. 0603-o3001.

[8] http://en.wikipedia.org/wiki/Sensor_Networks

[9] Akyildiz, I.F., W. Su, Y. Sankarasubramaniam, E. Cayirci, "A Survey on Sensor Networks", IEEE Communications Magazine, August, 102-114(2002).

[10] W. Heinzelman, J. Kulik, and H. Balakrishnan, "Adaptive Protocols for Information Dissemination in Wireless Sensor Networks," Proc. 5th ACM/IEEE Mobicom Conference (MobiCom '99), Seattle, WA, August, 1999. pp. 174-85.

[11] J. Kulik, W. R. Heinzelman, and H. Balakrishnan, "Negotiation-based protocols for disseminating information in wireless sensor networks," Wireless Networks, Volume: 8, pp. 169-185, 2002.

[12] C. Intanagonwiwat, R. Govindan, and D. Estrin, "Directed diffusion: a scalable and robust communication paradigm for sensor networks," Proceedings of ACM MobiCom '00, Boston, MA, 2000, pp. 56-67.