IOT and Cloud Based Monitoring System for Coastal Water Quality and Beach Safety

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Abstract

The coastal regions of India is both ecologically and economically rich and is home to 60% of the population. However the coastal waters are highly polluted due to industrial effluents, agriculture runoff and domestic waste and unlike the developed countries there is not much information on the health and status of the coastal waters. Internet of Things (IoT) is a concept that envisions all objects around us as part of internet and Cloud computing is a model for on-demand access to a shared pool of configurable resources (e.g. compute, networks, servers, storage, applications, services, and software) that can be easily provisioned as Infrastructure (IaaS), software and applications (SaaS) . A combination of data buoys installed along the major beaches of India along with cloud technology would make data on tides, rip currents and pollutant load accessible to beach goers. Data buoys with sensors would have to be deployed along the Indian coast to collect data on the oceanographic, physio-chemical and biological parameters of the coastal waters. The data collected by these buoys would then be transmitted to a public or hybrid cloud through satellite transmission protocols. Cloud apps and mobile cloud computing apps can be developed to disseminate information on beach water quality and safety to the public. In this paper we propose a novel IoT and cloud based monitoring system wherein the cloud acts as a front end to access Internet of Things that assimilates data from real time water quality data buoys and provides a mobile client with which the user can access data on the Coastal waters throughout the country, thereby reducing the health hazard and ensuring safety of the beach goers.

Keyword- IOT, Cloud Computing

I. INTRODUCTION

The Oil pollution along Chennai's coast that has disrupted the lives of the coastal community has brought into focus the need for effective coastal pollution monitoring. The coastline of India extends more than 8000 km and supports more than 60% of the country's population. The demographic rise in the coastal cities and towns due to existence of employment opportunities and rapid industrialization, has led to generation of increased wastes and therefore stress on the coastal environment. Untreated or partially treated domestic sewage and industrial effluents seem to be the major cause for pollution in the coastal waters. The contamination of seawater will adversely affect the survival of commercially important fishes and other marine organisms. The coastal waters receive 4.1 cubic km domestic sewage and 0.41 cu.km of industrial waste (Qasim et al, 1988). Moreover, every year many people lose their lives due to during adverse tidal condition, rip currents, strong winds etc. The deterioration of coastal water quality is a cause for concern and as it could lead to health issues among the beach goers. Lack of knowledge on the physical parameters of the coastal waters is another major cause of concern in the context of public safety. The traditional methods of water quality monitoring involves the manual collection of water sample from different locations and the testing them in the laboratory using the analytical technologies. Such approaches are time consuming and no longer efficient. Moreover, the current methodologies include analysis of various kinds of parameters of water quality such as physical and chemical. Traditional methods of the water quality detection have the disadvantages like complicated methodology, long waiting time for results, low measurement precision and high cost.

II. AN INTEGRATED IOT AND CLOUD BASED ARCHITECTURE FOR MONITORING THE COASTAL WATERS

A. Internet of Things

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The embedded technology in the objects helps them to interact with internal states or the external environment, which in turn affects the decisions taken. The IoT transforms these objects from being traditional too smart by exploiting its underlying technologies such as ubiquitous and pervasive computing, embedded devices, communication technologies, sensor networks, Internet protocols and applications. The IoT communication technologies connect heterogeneous

objects together to deliver specific smart services. Typically, the IoT nodes should operate using low power in the presence of lossy and noisy communication links. Examples of communication protocols used for the IoT are WiFi, Bluetooth, IEEE 802.15.4, Z-wave, and LTE-Advanced. Some specific communication technologies are also in use like RFID, Near Field Communication (NFC) and ultra-wide bandwidth (UWB).

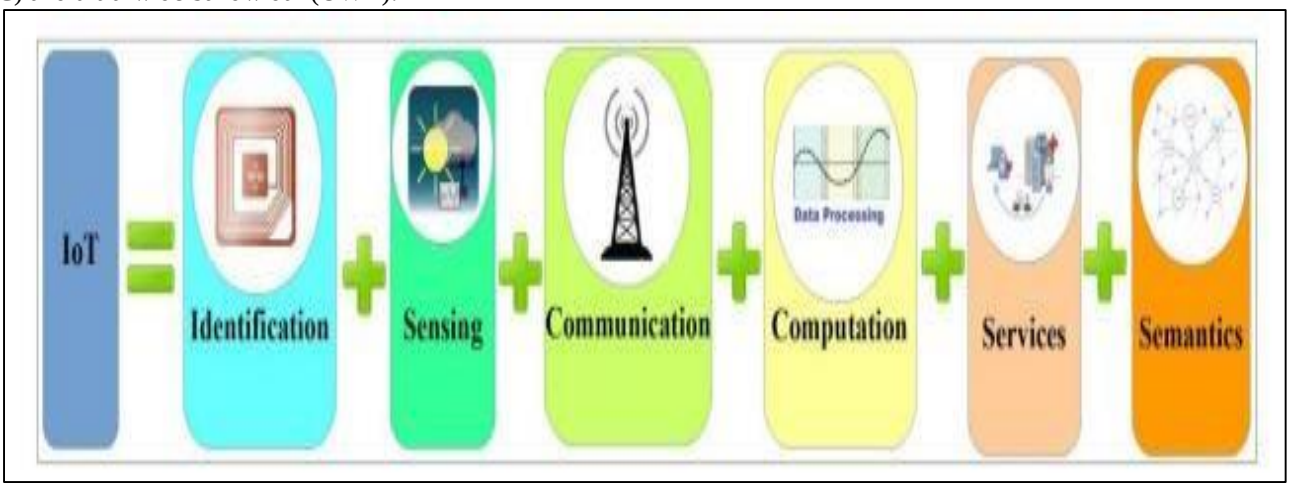

Fig. 1: IoT Architecture

B. Cloud Computing

Cloud computing, often called simply "the cloud," involves delivering data, applications, photos, videos, and more over the Internet to data centers. Cloud-based applications run on computers off site (or "in the cloud").

Cloud computing allows the systems and users to use Platform as a Service (PaaS), for example, Operating Systems (OSs), Infrastructure as a Service (IaaS), for example, storages and servers, and Software as a Service (SaaS), for example, application level programs, and so forth at a very low cost which are being provided by several cloud providers (e.g., example Amazon, Google, and Microsoft) on the basis of pay per use services. Cloud computing platform dynamically provisions, configures, and reconfigures the servers as and when needed by end users. These servers can be in the form of virtual machines or physical machines in the cloud. Cloud computing renders the two major trends in IT: (1) efficiency, which is achieved through the highly scalable hardware and software resources, and (2) agility, which is achieved through parallel batch processing, using computer-intensive business analytics and real-time mobile interactive applications that respond to user requirements [11]. The benefits of cloud computing are that the end users need not to worry about the exact location of servers.

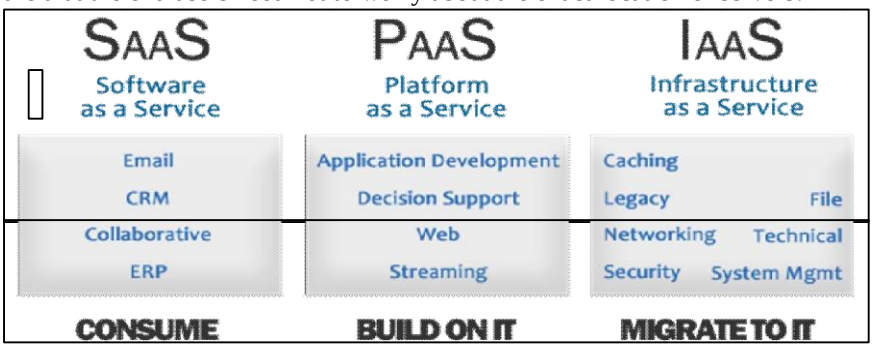

Fig. 2: Cloud based Architecture

III. AN INTEGRATED ARCHITECTURE OF IOT AND CLOUD COMPUTING

Information of water quality and physical parameters of the coastal waters is to be made available to the public on real-time basis right from data collection, processing and dissemination. The following steps are involved

- Data collection through data bouys along the coast
- Data transmission to the cloud using satellite link
- Data storage and high performance processing in a private cloud
- Data dissemination through a web and mobile application

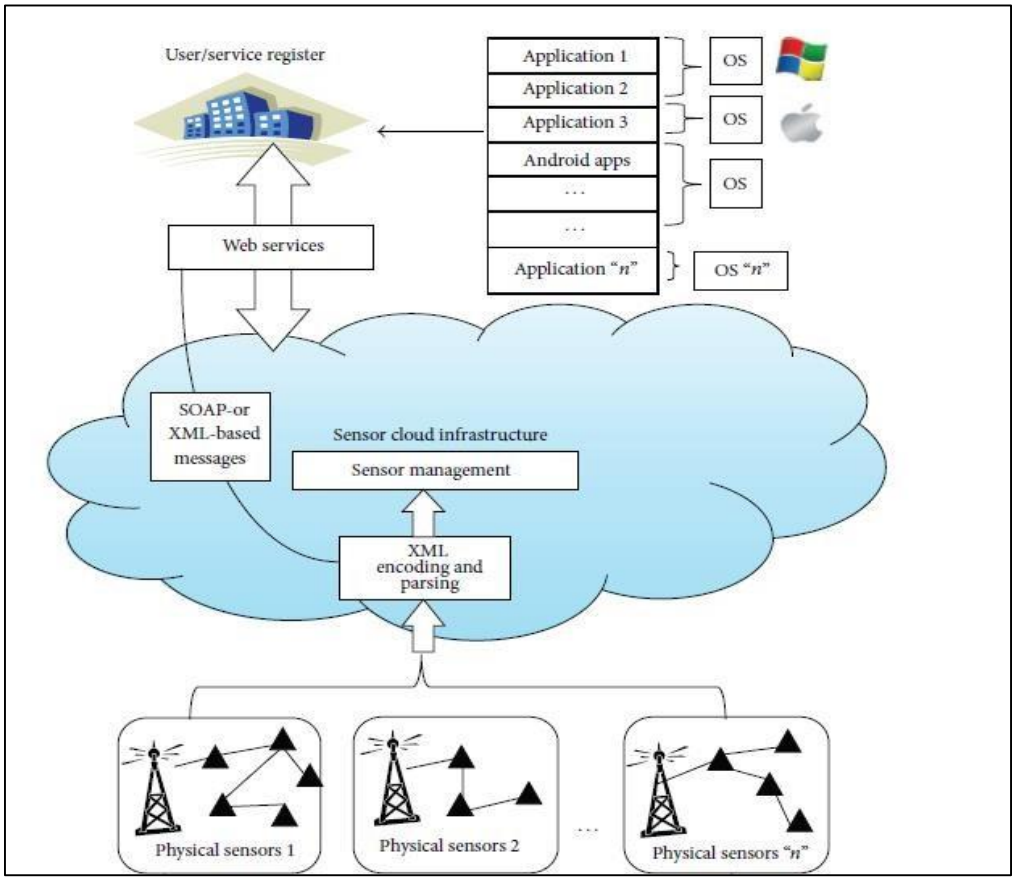

Fig. 3: Integrated IoT and Cloud based system for water quality monitoring

A. IoT for Data Collection Using Data Buoys

The proposed architecture consists of a network of data bouys which are placed at specific locations along the Indian coast. The data buoys have sensors which measure the physical parameters such as tides, waves, wind, current, temperature, Dissolved oxygen, pH, bacterial count etc.

Fig. 4: Data buoy as a part of IoT

B. Data Transmission through GPRS, Irirdium Satellite Link

The data collected by the data buos have to be transmitted to a private cloud using the GPRS/Irirdium satellite link.

C. Data Processing in Cloud Computing

Data collected by the data buoys are transferred to a public or private cloud for data processing. Cloud based platforms help to connect to the things (IaaS) around us so that we can access anything at any time and any place in a user friendly manner using customized portals and in built applications (SaaS). Hence, cloud acts as a front end to access Internet of Things. The data have to be stored and used intelligently for smart monitoring and actuation. Hadoop is an open-source platform developed by the Apache Software Foundation utilising the NoSQL paradigm. It is based on a distributed file system by Google using the MapReduce model. The Hadoop platform is an environment designed for building reliable and scalable parallel systems. They can perform operations on very large files that are stored in a distributed file system.

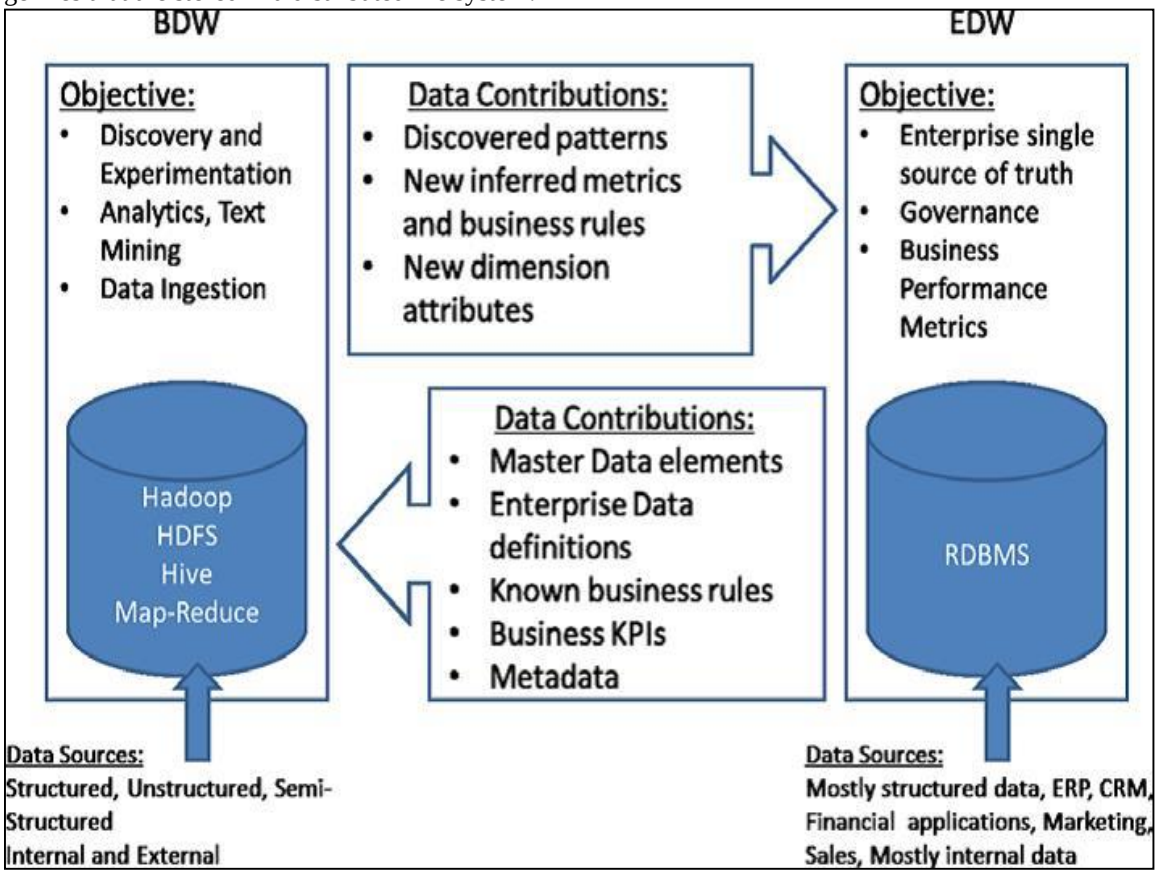

Fig. 5: Hadoop framework for big data processing

One of the main benefits of HADOOP, is its ability to work in a distributed environment. Due to the nature of the gathering process, which combines data from multiple locations, the geographical distribution of the databases can be an advantage. In addition, given HADOOPs ability to automatically replicate data as well as its security, reliability and overall effectiveness can make it vastly beneficial as well structured ones.

D. Data Dissemination Using Mobile and Web Applications

Applications are developed to disseminate the data to users wanting to access the sensor data from different OS platforms, such as mobile phones OS, Windows OS, or Mac OS for a variety of applications. This structure allows users of different platforms to access and utilize the sensor data without facing any problem because of the high availability of cloud infrastructure and storage.

E. Conclusion

This paper proposes a integrated architecture comprising of IoT and cloud computing to monitor the beaches and coastal waters ans regularly issue information on the status of the coastal waters to protect humans from health issues associated with sewage contamination and also adverse sea state condition. Based on the real time data warning can be issued stating that the waters are safe or unsafe for the public.

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