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Sensor Networks - An Insight on Market Perspective and Real Time Border Monitoring System

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Abstract: Sensor Networks are the most attractive and emerging research areas in the current market. This growth is due the advanced technology in the sensor, wireless communication and its real time applications like, military, healthcare, industries, agriculture, and retail market. The growth of wireless sensor networks is yet to be increase due the collaborative development of these networks with various emerging advance topics like Internets of Technology, Big Data, Cloud Computing and mainly due to its increasing applications in military sector. This paper aims to highlight the features and important of sensor networks by identifying its needs, current market status, analyzing some of the existing real time border monitoring system and proposes a novel real time border monitoring security system. The current business status of sensor networks will be analyzed for finding out the significance of sensor networks using some statistic data and market reports. This analysis will be cooperative for motivating the researchers to contribute more development in this area. Real time border monitoring system can play a vital role in national security for efficient border monitoring with less human intervention.

Keywords: Sensor Networks, Cloud Computing, Internet of Things, Big Data, Smart Phones, Real Time Border Monitoring System, Critical Infrastructure, Intrusion Detection

1. Introduction

Wireless Sensor Networks (WSNs) are the one where various types of sensors are deployed in remote areas which use the advance wireless technology for information transfer. These networks are monitored remotely from the central base station and are very handy in monitoring and tracking applications. According to the report from the market and markets [1], the major sectors which use WSNs are mining, food and beverages, medical and healthcare, and many industries. From the statistical report of industrial sensor networks [1] the sensor system market was valued at $401.23 Million in 2013 and is expected to grow at a Compound Annual Growth Rate (CAGR) of 12.96% in the coming future.

The global industrial WSNs market is predicted to grow from $401.23 Million in 2013 to $944.92 Million by 2020, at a CAGR of 12.96% from 2014 to 2020. This report also concentrates on systems, sensors, technologies, applications, and geographies of the industrial sensor network.

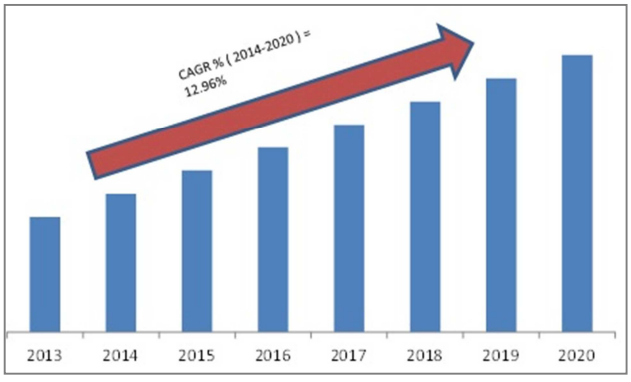

Figure 1. *Industrial WSN MARKET 2013-2020 ($MILLION) [1].*

United State of America (USA) is presently governed the most development activities and the appliance of WSNs due to the support and more funding availability. In this part WSNs are observed as a next generating of computing and it is interested to participate in many sectors and majorly interested to military sector for surveillance applications.

According to the report from Freedonia Group, U.S. sales of sensors are set to be $14.9 billion by 2016 and military is the major sector using various wireless technology with sensor for monitoring and surveillance applications

Apart from US presently Asian countries are also looking for gaining impact in WSNs market. The further section of this work focused on identifying the various emerging technology that can be integrated with WSNs with its features. Some of the recent topics which are to be discussed are Internet of Things, Big Data, Cloud Computing, Smart Phone based applications.

Next sect

2. Sensor Network and Internet of Things (IoT)

The idea of internet of things (IoT) was developed in parallel to WSNs. The term Internet of Things was given by Kevin Ashton in 1999 [2] which refer to uniquely identifiable objects and virtual representations in an internet [3]. Internet of things is the collection of tiny low powered resource constraint devices and wireless sensor networks are the major components of IoT. As almost every tiny devices are embedded with sensors and WSNs will bring the IoT to even the smallest objects installed in different kind of environment. WSNs are the network of tiny low cost devices which are having ability to sense various environmental changes and transfer the sensed data to base station from remote areas. Integration of these networks with the IoT will be a more flexible way of data transfer from one remote area to other over Internet. WSNs have wide range of applications like monitoring, tracking, smart grid, smart water, intelligent transportation systems, and many with huge amounts of data which can serve for many purposes. With these feature of WSNs and its advance technologies in wireless communication making WSNs to Integrate with IoT which can lead rapid growth of WSN and IoT in the current business market.

The report [4] a new study on WSNs market shares 2014 to 2020 has some statistical information. According to this, the semiconductor WSN is implemented with the Internet of things for variety of application like monitor pipelines, oil wells, and healthcare sectors, which shows the marketing needs of WSNs with IoT. These are also used to implement energy savings in homes and commercial buildings, which monitor many events occurring in environments with sensors and tracked same on a smart phone. The number of devices connected to Internet in 2014 was 9 billion; this growth will be likely to rises to 100 billion by 2020. This report [4] states that semiconductor Wireless Sensor Networks Markets at $2.7 billion in 2013 are forecast to reach $12 billion Worldwide by 2020. This rapid change is due to change of technology from wired sensor networks to wireless with variety real-time applications.

3. Sensor Networks and Big Data

The increase in usage of the information enabled by Facebook, Twitter, location-based services, and other social media leading the world towards the colossal term Big Data[5]. As active catalyst to the reaction, the technology and the growth of sensors has unfettered a larger warehouse of information which boost the businesses profit, safety and enable environmental benefits.

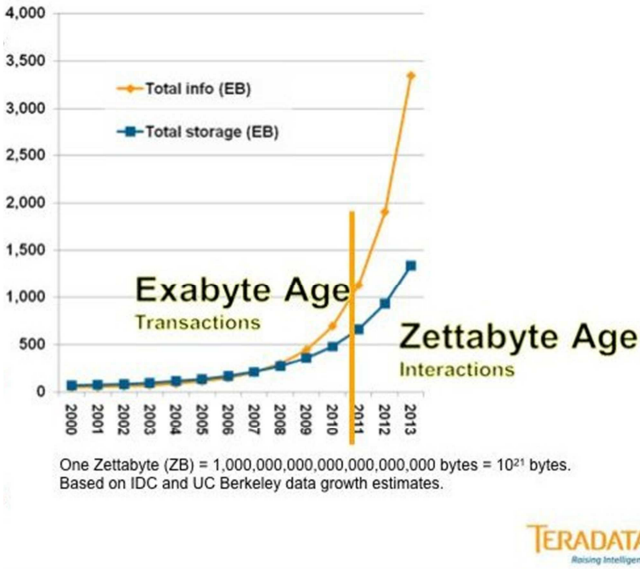

Figure 2. *Statistic of Data Generated by Social Networks [5].*

The main reason for the increase in the data is due to the increase of sensor data and mobile applications with the location aware services and high confidence application will have more data fields.

4. Sensor Networks and Cloud Computing

Cloud Computing was one of major technology in past 10 years which has gained lot of impact in the network world. Using this technology one can able to get all the computing services remotely with a nominal cost. At present cloud is somewhere behind the shadow of some most recent technology like IoT, Big Data and its slowly merging with many technology, one of the technology on integration of sensor in cloud. The WSN technology is masking the popularity of cloud by it feature and many cloud service providers are also providing service for sensor integration [6] with cloud.

Libelium [7]: the gain in sensor development, marketing, and innovating new application of sensor are providing the best Cloud software solution for integrating Internet of Things (IoT), machine-to-machine (M2M) or Smart Cities projects with various sensors. Libelium has collaborated with many cloud service provider which can push up the sensor data to the cloud platform. Some the sensor to cloud service provider are Esri [8], Azure [9] is the Microsoft Cloud Computing Platform, MQTT [10], Sentilo [11], Telefónica [12].

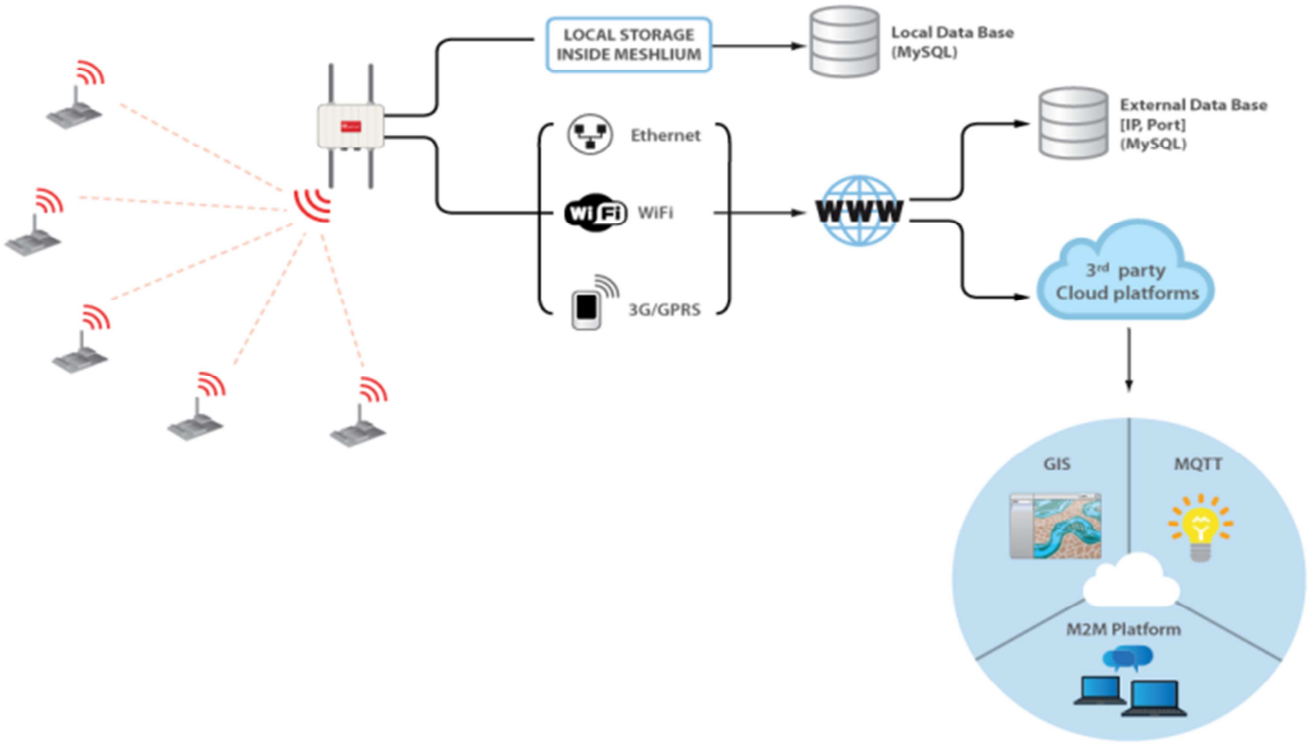

Figure 3. *Connecting Sensors to Cloud [7].*

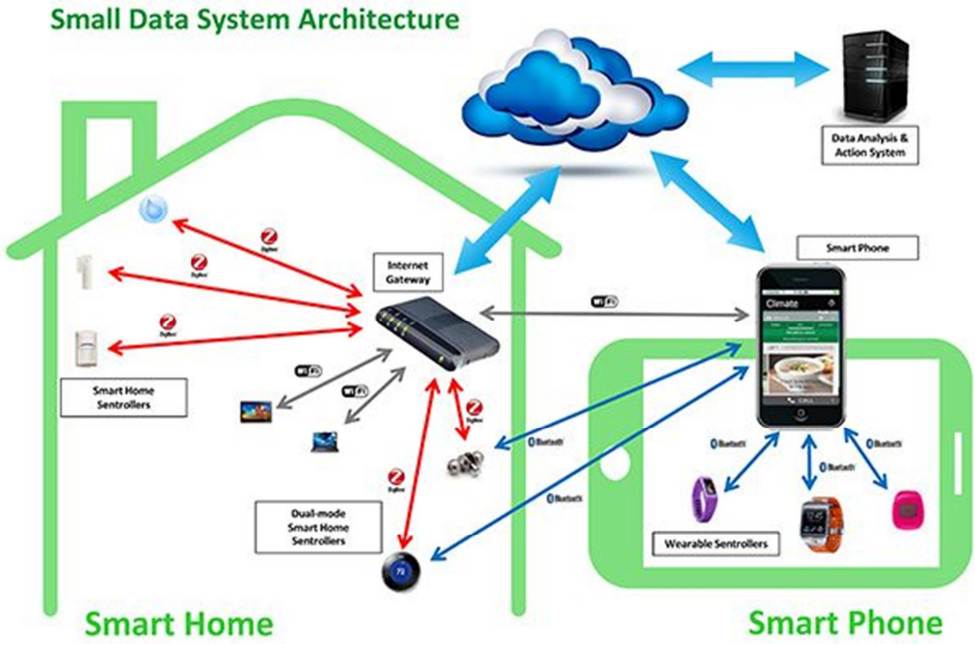

Figure 4. *Smart Home Application based with Smart Phone [13].*

5. Sensor and Smart Phones

This section focused on integrating the above discussed technology with Smart Phones for many day to day real-time applications. From the report of Sensor Cloud and Homeland Security has reported the process of sensor data can be done by integrating sensors with cloud. This in further required a secure connection between the WSNs and the central monitoring systems, for this purpose smart phone are used as bridging devices. Using smart phone one can easily monitor the remote area on a cloud platform. In many routing real-time application like building monitoring, surveillance, smart home, critical equipment monitoring in industries and many these integration will be very helpful.

6. Real Time Border Monitoring System

Currently national security systems emphasize more on security against terrorism attacks, border crossing and infiltration from the neighboring countries. Current monitoring system use fence and walls to protect from the neighboring countries with human intervention, but is difficult in adverse climatic condition. This problem can be solved by using the Real time border monitoring system (RTBMS) using wireless communication and sensor technology. Security in battle field surveillance in very crucial as the attacker can malfunction the internal node and can also deploy the malicious nodes. These operations may lead to loss of critical information by Intercepting, Modifying and fabricating the message sent by original nodes.

6.1. Current Border Monitoring System

As a preventive measure, currently many countries have developed their own real-time border monitoring system on wireless sensor platform for military applications. The research works carried on the existing Real Time Border Monitoring System (RTBMS) reports that the data generated in the monitoring system is 4% authenticated, 34% distorted and 62% is due to false information generated by intrusion. This distorted and false information leads to the concealment of the original events taking place at the borders and leading to loss of ingenious information.

A report from Defendec[14] Smart Sensors Guarding System says, borders are not protected by humans every 10 meters and armed guards near critical infrastructure sites. And human monitoring is difficult in adverse climatic condition, but with help from RTBMS border integrity is possible 24/7 round the clock.

But the RTBMS systems can be hacked by any intruder nodes to raise false alarms which to conceal the course of the events along the border areas. During the past year, there have been 200 attacks on core critical infrastructures in the military surveillance applications. [15]

Another report by National Science Foundation[16] says, there are many attacks on RTBMS which prevents in detecting the events along the borders. Hello Flood attack is the one of the attacks they have identified in which the intruder jams the channel of all sensors. And Packet Sniffing is the second attack identified in which the rate of false information is very high. As a result of the above attacks, RTBMS is failing to receive the authenticated information of the original events. Because of this lack, it has been reported that many events are going undetected

To overcome these monitoring problems there is a need of RTBMS with sensor platform. A report by National Border Patrol Strategy [17] shows that RTBMS are very efficient than the satellite monitoring system due to real time information transmission. Wireless Sensor Networks (WSNs) is very effective in RTBMS, which is able to detect the various events happening at the borders like trespassing, creating tunnel, chemical attacks by the enemy nations

Border Sense [18]: This work focused on monitoring the border in real-time, with high accuracy and minimize the need of humans by utilizing the most advanced WSNs. These WSNs uses different onboard sensors for detecting various parameters like image, pressure, vibration. The system architecture of border Sense is show in fig-5

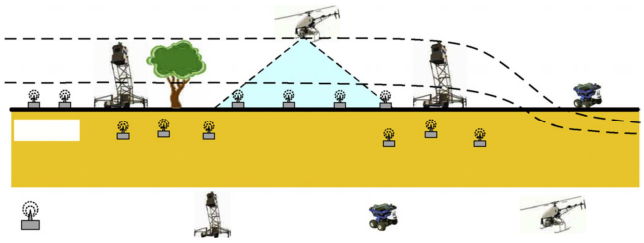

Fig. 5. *System Architecture of Border Sense [18].*

The Border Sense concentrated on reducing the false alarm by distinguishes a human intruder from large animals by fusing the heterogeneous set of information. But there is no security issues considered as the networks may be hacked by the same heterogeneous malicious nodes deployed by the enemies. These malicious nodes can be a threat to the network and responsible for raising the false alarms, signal jamming, packet sniffing with different types of attacks like Sink Hole, Energy Draining, Denial of Service and many more.

Flgense [19]: Their main objective is the detection and signaling of trespassers within a predefined area. Accessibility entails the presence of both malicious and non-malicious interference, thus imposing high demands regarding security and robustness in protocol design. The project FleGSens realizes WSN architecture for secure trespasser detection on green line borders. This prototype has been extensively tested in an outdoor prototype consisting of 152 sensor nodes for monitoring a 300 m long and 20 m wide land strip. It demonstrates the feasibility of border monitoring system in a real world environment.

Trespasser Detection Protocol [20]: A trespasser that moves within the range of a passive infrared (PIR) sensor creates a PIR event. The basic idea of the trespass detection protocol used in the FleGSens system is to collect PIR event messages locally before flooding an aggregate of local events into the network. During the demonstration, this shows the trespasser's path on a border map at runtime, based upon the flooded aggregated information received at gateways. *This Protocol effectively reduces the percentage of false information, but may be vulnerable to many threats caused malicious nodes.*

Although the existing system discussed here are detecting and preventing the intrusion in the network but are failing to eliminate false information. The main problem identified by these survey are, even though there is monitoring system, the intruder and intrusion detection system are not up to the extent which can decide the events occurred by intrusion or original node. There are many hindrance and constraints involved when designing a security protocol for Wireless Sensor Networks (WSNs). The limited memory, storage, processor capabilities and harsh environmental conditions may restrict the researchers for providing security protocols.

6.2. Proposed RTBMS with Intrusion Collaboration

The proposed method aims to develop a novel monitoring system which not only reduces the false information but also increase the accuracy of detecting the original events. The proposed mechanism discussed here is a just a part of our work which is being implemented for RTBMS.

This work is accomplished by developing a secure system for intrusion and intruder detection, prevention module. Using these modules any efficient decision will be generated to identify the intrusion and intruder. Currently there is intrusion detection, prevention module but they may be computational overhead for resource constrained devices. This work mainly aims to concentrate on contributing the novel work resource constrained nodes like sensor which are the magnificence of wireless communications.

This work mainly aims to analyze the vulnerabilities and security requirements necessary for secure information transfer in Wireless Sensor Networks. Based on this a suitable model will be proposed for the identified vulnerabilities and threats to mitigate the attacks. At the major an OSI layer wise analysis will be done for the associated threats and vulnerabilities. Once the analysis is done a cluster based protocols with efficient resource utilization for secure communication will be developed.

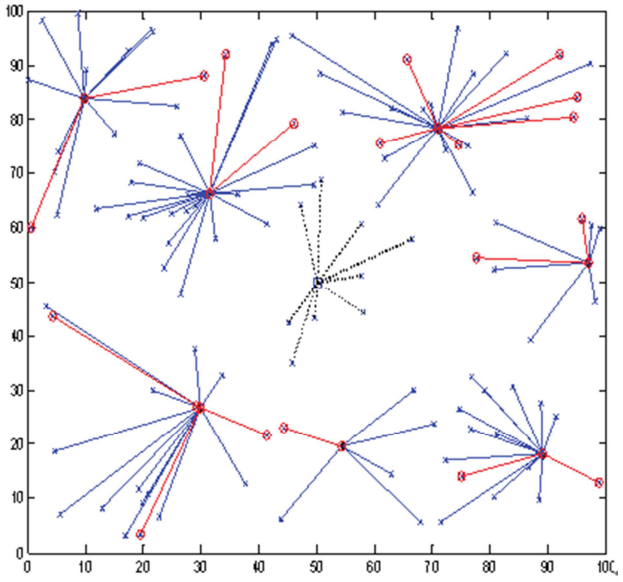

Fig. 6. *Proposed System.*

Fig-6 shows the blocking of sending and receiving information from malicious nodes, identified by red color. The proposed algorithm is evaluated by deploying some percentage of malicious nodes into the network.

This RTBMS can eliminate upon 50% of the false information by eliminating the intrusion in the network. This leads to the increases in the percentage of authenticated information, which are the original events caused due to terrorism, trespassing, infiltration. This robust system will reduce the percentage of false alarm, delay and amount of data modified during various attacks such as Sinkhole, Hello flood, Denial of Service and Packet Sniffing attacks.

7. Conclusions

This work focused on analyzing the needs of wireless sensor networks with current market perspective. The statistic result and survey shows that the wireless sensor networks can still gain a lot of impact by integrating to recent advance technology. This may leads to easy use of day to day real time application with the low cost with some devices like smart phone. Then an intrusion collaboration system is proposed for RTBMS as it is a major problem facing by all the nations. The main aspire of this review is to motivate the researchers to contribute more in this filed with collaboration with the emerging technology. The application of sensor networks in military sector plays a important role in border surveillance. The proposed method for RTBMS will be efficient and can reduce 50% of the false information.

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