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Integration of Body Sensor Networks and Cloud Computing in Health

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ABSTRACT

With the rise in population and increase in older people integration of Wireless Body Sensor Networks and Cloud computing can prove to be beneficial in providing medical service to people who require continuous monitoring and care. Development in technologies for Wireless Communication has led to sensor nodes which can be worn over the body, implanted and embedded over the body. These are small sized devices which can perform processing on the signals sensed from the human body and then communicate it to required destination where this data can be used for various research purposes or other diagnosis. Cloud Computing is also a versatile technology that can support a broad-spectrum of applications. The low cost of cloud computing and its dynamic scaling renders it an innovation driver for small companies, particularly in the developing world. Cloud deployed enterprise resource planning (ERP), supply chain management applications (SCM), customer relationship management (CRM) applications, medical applications and mobile applications have potential to reach millions of users. This paper gives an overview of the devices used, its architecture, protocol stack, issues, topology, WBSN and Cloud Computing standard, challenges. Some protocols and security schemes have also been discussed.

Keywords: Integration, Body Sensor Networks, Cloud Computing in Health, and Protocols

INTRODUCTION

A body area network (BAN), also referred to as a wireless body area network (WBAN) or a body sensor network (BSN) or a medical body area network (MBAN), is a wireless network of wearable computing devices [1]. BAN devices may be embedded inside the body as implants, may be surface-mounted on the body in a fixed position (wearable technology), or may be accompanied devices which humans can carry in different positions, such as in clothes pockets, by hand, or in various bags [2]. While there is a trend towards the miniaturization of devices, in particular, body area networks consist of several miniaturized body sensor units (BSUs) together with a single body central unit (BCU) [3]. Larger decimeter (tab and pad) sized smart devices, accompanied devices, still play an important role in terms of acting as a data hub or data gateway and providing a user interface to view and manage BAN applications, in-situ.

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [4]. Cloud computing has emerged as a popular solution to provide cheap and easy access to externalized IT (Information Technology) resources. An increasing number of organizations (e.g., research centres, enterprises) benefit from Cloud computing to host their applications. Through virtualization, Cloud computing is able to address with the same physical infrastructure a large client base with different computational needs. Cloud computing is not application-oriented but service-

oriented; it offers on-demand virtualized resources as measurable and billable utilities [5].

Types of wireless body area network (WBSN)

Wireless body area network can be of three types based on the decision taker of the data collected from various sensor nodes which is listed below:

Managed WBSN: A Managed Wireless Body Area Sensor Network is a network in which the decision on the data collected from one or more than one Sensor nodes is taken by a third party which can be any doctor, nurse or Medical Centre. The data is collected and sent to the third party where it is analyzed for diagnosis. Now the third party will decide as per the data that what has to be done next or what prescription has to be given to the patient. Such network is connected to other networks via WIFI or GSM [6]. The advantage of Managed WBSN lies in the fact that all vital signs can be analyzed and at the same time diagnosis can be done. But there can be problems when the third person we are trying to send information to be too busy to reply or there is some problem with the long range communication. In such cases the patient's situation can go worse.

Autonomous WBSN: The aim of Autonomous body sensor networks is same as Managed WBSNs but they do it differently. In an AWBSN there are actuators along with the sensor nodes that can cause action on the human body as per the data collected from the sensor nodes or by direct interaction with the human body without the need to wait for any third party decisions [7]. An AWBSN works best in case of emergency conditions where decision is taken in real time without any delay and proper action is then taken by the actuator hardware. Here there the Body Control Unit (BCU) is not required to be connected to the external networks. This leads to low transmissions and lower battery wastage [8]. But problems can occur in cases where BCU has not been programmed for detecting a particular disease.

Intelligent WBSN: This network is a combination of both the above networks. If situations are simple, decisions are taken on their own by actuator nodes but if they are complex then the information is sent to the third person. If he/she is busy then IWBSN waits for a specific amount of time then takes decisions on its own if there is no reply from the doctor [9].

Characteristics of Wireless Body Area Networks (WBSN)

Sensor Nodes WBSN nodes have several features that make them suitable for use in large number of emerging applications [10]. Few of them are:

Energy Efficient: The nodes are designed in way that they utilize very low energy. Power management schemes are used to handle the power resources optimally so that nodes remain alive for longer time and the network's lifetime increases.

Heterogeneous: Sensors used in WBSNs are heterogeneous in nature each having its own function, some nodes sense the temperature, and others sense blood pressure and so on [11]. Each of these sensor nodes has different storage capacity, computation capability and energy consumption.

Cost Effective: Since the nodes use power optimally and are deployed over small area so they live longer and lesser number of nodes are required in network formation and replacement, when damaged. So all this leads to a lower cost of creating a network.

Simple: Lightweight, small sized nodes are used which can be easily carried from one place to the other by wearing them or keeping them in a bag.

Advantages of Wireless Body Area Networks (WBSN)

Body Area Networks have proved to be better than the previous approaches so far being used for patient monitoring and in general too [13].

No wires: The traditional approaches of health monitoring used lots of wires thus making the entire system clumsy. Wireless Body Sensor Networks use small devices which communicate wirelessly with each other.

Energy Efficient and User Friendly: Previous approaches were not efficient in terms of power, mobility etc. but this new approach of using sensors has led to user friendly techniques of tracking the motion, body temperature and other human body signals [14]. We can get the readings on a PDA, laptop anytime we want and can store them for later use too.

Support user mobility: Traditionally the person who used to be monitored had to stay at hospital till they were monitored because of the wires attached to the human body which were in turn connected to the monitor [15]. The patient couldn't move from his bed. But the new technology made patients roam freely, even when they are at home, office and at places far from the hospital, doctors don't have to know their location and can easily access their data on their PC and diagnose them.

Applications of Wireless Body Area Networks (WBSN)

WBSNs serve variety of applications in consumer electronics, healthcare, games and lifestyle [16]. Below is description of some WBSN applications:

Sports and Fitness: In Sports WBSN can be used to examine the health of the athletes. Readings can be taken from the athletes without requiring them to exercise on a treadmill. Coaches can take a closer look at the strong and weak points of an athlete by measuring various body conditions like change in heartbeat, oxygen level etc. during a race and other real life scenarios. This can help in improving their shortcomings and in improving their skills [17].

Military: Uses of WBSN in defense are many. Examining the health condition of soldiers, checking level of hydration, tracking their location and body temperature monitoring are few of them. All the readings can be used for providing help to the soldiers when they get injured, to get an idea of when strength, precision, attention have to be enhanced and can also be used for reducing incidents of friendly fire due to misunderstanding in identity by telling them their exact location and identity time to time.

Emergency Services: WBSN can be used in providing emergency services to fire fighters. The readings of changes in body conditions of fire fighters like oxygen level, pulse etc. is taken and along with it the toxin level in the air are monitored and the fire fighters are warned in case of the emergency conditions or asked to leave the location or use some preventive measures like using gas mask [18].

Emotion Detection: Human emotions can also be monitored by WBSN. A chemical called serotonin is created in the human body by the brain and the intestine. Decrease in level of serotonin causes sadness and increased level causes happiness or anxiety [19]. Thus we can keep track of this chemical and know the mood of the person.

Personal Health Monitoring: Non-stop monitoring of critical parameters of the patients who suffer from chronic diseases such as heart attacks, asthma and diabetes can be done by WBSN. Readings of ECG, EMG can be taken by patients on their own at home and can be checked by doctors.

Posture Detection: The posture of a person can be detected by using sensor nodes. Games can be played on computer by wearing sensors over body that gives a feel as if a person is playing on a real field [19]. The motion of the player changes as per player's motion. Dance lessons can also be given by gesture detection and body movement.

Medical: BANs can prove to very helpful in monitoring the health of the patients from faraway places. The patient and doctor do not necessarily have to be at the hospital. Even when patients are at home they can be administered medicines and their body's vital signs like blood glucose level, heartbeat, blood pressure etc. can be checked. In the near future the patient would be monitored independent of their location and required drugs can be prescribed to them. There will not be a need for patients to remain connected to big machines for getting monitored [19].

Consumer Electronics: Devices like microphone, MP3 players and head

mounted displays can form a part of BAN and play their respective roles. Like as per the mood of the person songs can be played etc.

Essential Characteristics of Cloud Computing

In this section we describe the essential characteristics that a cloud must possess. Any cloud is expected to have these five characteristics that are being described below:

A. On-demand self-service

A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider [20].

B. Broad network access

Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and personal digital assistants (PDAs).

C. Resource pooling

The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand [21]. There is a sense of location independence in that the subscriber generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or data centre). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

D. Rapid elasticity

Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

E. Measured Service

Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts) [21]. Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

Challenges and Issues of Cloud Computing

Here we'll explain the challenges and issues cloud computing has to face. As a lot of economics is tied to this field it will be better that these issues are resolved as early as possible [22]. The following are the issues that a cloud computing environment has to still resolve:

A. Security

When using cloud-based services, one is entrusting their data to a third-party for storage and security. Can one assume that a cloud-based company will protect and secure ones data (Cloud computing presents specific challenges to privacy and security [23]. Back it up, check for data errors, defend against security breaches) if one is using their services at a very low cost? Or often for free? Once data is entrusted to a cloud based service, which third-parties do they share the information with? Cloud-sourcing involves the use of many services, and many cloud based services provide services to each other, and thus cloud-based products may have to share your information with third parties if they are involved in processing or transferring of your information. They may share your information with advertisers as well. Security presents a real threat to the cloud.

B. Performance

Cloud computing suffers from severe performance issues [24]. The cloud provider must ensure that the performance of the service being provided remains the same all through. There may be peak time break downs, internal flaws, and technical snags arising. Load balancer, data replicators, high end servers must be installed when needed.

C. Availability

Even though cloud promises to be a 24X7X365 service, cloud outages occur

frequently. Outages can be scheduled or unscheduled [24].

D. Cost

Cloud computing can have high costs due to its requirements for both an "always on" connection, as well as using large amounts of data back in-house.

E. Regulatory requirements:

What legislative, judicial, regulatory and policy environments are cloud-based information subject to? This question is hard to ascertain due to the decentralized and global structure of the internet, as well as of cloud computing. The information stored by cloud services is subject to the legal, regulatory and policy environments of the country of domicile of the cloud service, as well as the country in which the server infrastructure is based. This is complicated by the fact that some data in transit may also be regulated [25].

F. Bandwidth, quality of service and data limits

Cloud computing requires "broadband of considerable speed" Whilst many websites are usable on non-broadband connections or slow broadband connections; cloud-based applications are often not usable [12]. Connection speed in Kilobyte per second (or MB/s and GB/s) is important for use of cloud computing services. Also important are Quality of Service (QoS); indicators for which include the amount of time the connections are dropped, response time (ping), and the extent of the delays in the processing of network data (latency) and loss of data (packet loss).

G. Major suppliers

Only handful providers are available in the market which is still holding back many SME's to join a cloud [18].

still holding back many SME's to join a cloud.

CONCLUSION

Body Sensor Networks and Cloud Computing provide useful applications in healthcare, entertainment and fitness. It can prove to be a revolutionizing technology in the next few years whose applications will not be limited to the areas mentioned in the above but will come up with more new possible applications and will provide more market opportunities to developers. Though works are being done in solving the various issues like latency, interference, dynamic topology, works should also be done to make this technology more user friendly and convenient to users thus enhancing their general comfort. On the other hand, the world is poised to explode with a billion new devices that will be desperate for the very technology that clouds almost offer today. It is possible that the wave of users, applications and demand will just wash over the cloud landscape, regardless of how robust they are. Sports and entertainment are taking new directions and new opportunities will be available for people working in this direction. At present the amount of information that can be transferred over the WBSN is limited and the resources to supplement power to the nodes' battery are not much, but in near future WBSN will show a tremendous improvement.

REFERENCES

1. Bag and M. Bassiouni, `Hotspot Preventing Routing algorithm for delay-sensitive applications of in vivo biomedical sensor networks', Information Fusion (2008), Vol. 9, No.3, pp. 389-398.
2. Bag, M.A. Bassiouni, `Routing Algorithm for Network of Homogeneous and ID-Less Biomedical Sensor Nodes (RAIN)', Proceedings of IEEE Sensors Applications Symposium (2008) February 12-14; Altanta, GA, USA, pp. 68–73.
3. Culpepper, L. Dung and M. Moh, `Design and analysis of Hybrid Indirect Transmissions (HIT) for data gathering in wireless micro sensor networks', ACM SIGMOBILE Mobile Computing and Communications Review (2004), Vol. 8, No.1, pp. 61-83.
4. J. Bangash, A. Abdullah, M. Anisi, and A. Khan, `A Survey of

Routing Protocols in Wireless Body Sensor Networks', Sensors (2014), Vol. 14, No. 1, pp. 1322-1357.

5. K. Sayrafian-Pour, Yang Wen-Bin, J. Hagedorn, J. Terrill and K.Y. Yazdandoost, `A Statistical Path Loss Model for Medical Implant Communication Channels', Proceedings of IEEE 20th International Symposium on Personal, Indoor and Mobile Radio Communications (2009) September 13-16; Tokyo, pp. 2995–2999.
6. Kwak Kyung Sup, S. Ullah and N. Ullah, `An Overview of IEEE 802.15.6 Standard', Proceedings 3rd International Symposium on Applied Sciences in Biomedical and Communication Technologies (ISABEL) (2010) November; Rome, Italy.
7. Latr , B. Braem, I. Moerman , C. Blondia, E. Reusens, W. Joseph and P. Demeester, `A lowdelay protocol for multihop wireless body area networks', Proceedings of Mobiquitous (2007) August; Philadelphia, pp. 1-8.
8. Li Huaming and Tan Jindong, `An ultra-low-power medium access control protocol for body sensor network', Proceedings of IEEE 62nd Vehicular Technology Conference, (2005), pp. 2342-2346.
9. Li Huaming and Tan Jindong, `Heartbeat driven medium access control for body sensor networks', The IEEE Transactions on Information Technology in Biomedicine (2009), Vol. 14, No.1, pp. 44-51.
10. M. Patel, and W. Jainfeng, `Applications, challenges, and prospective in emerging body area networking technologies', IEEE Wireless Communications (2010), Vol.17, No. 1, pp. 80-88.
11. M. Quwaider and S. Biswas, `Probabilistic Routing in On-Body Sensor Networks with Postural Disconnections', Proceedings of the 7th ACM International Symposium on Mobility Management and Wireless Access (2009) October 27-30; Tenerife, Canary Islands, Spain, pp. 149–158.
12. M. Quwaider, and S. Biswas, `DTN routing in body sensor networks with dynamic postural partitioning. Ad Hoc Networks', (2010), Vol. 8, No. 8, pp. 824-841.
13. M. Tabandeh, M. Jahed, F. Ahourai and S. Moradi, `A Thermal-Aware Shortest Hop Routing Algorithm for in vivo Biomedical Sensor Networks', Proceedings of 6th International Conference on Information Technology (2009) April 27-29; Las Vegas, NV, USA, pp. 1612–1613.
14. M. Chen, S. Gonzalez, A. Vasilakos, H. Cao and V. C. Leung, `Body Area Networks: A Survey', Mobile Network Applications (2011), Vol. 16, No.2, pp.171-193.
15. Maskooki , C.B. Soh , E. Gunawan and K.S. Low, `Opportunistic Routing for Body Area Network', Proceedings of IEEE Consumer Communications and Networking Conference (CCNC) (2011) January 9-12; Las Vegas, NV, USA, pp. 237–241.
16. Q. Tang, N. Tummala, S.K.S. Gupta and L. Schwiebert, `TARA: Thermal-Aware Routing Algorithm for Implanted Sensor Networks', Proceedings of First IEEE International Conference Distributed Computing in Sensor Systems, (2005) June 30-July 1; Marina del Rey, CA, USA, pp. 206–217.
17. R. Aoun, E. A. Doumith, and M. Gagnaire, "Resource provisioning for enriched services in Cloud environment," in Proc. IEEE CloudCom Conf., 2010, pp. 296 – 303.
18. S. Movassaghi, M. Abolhasan and J. Lipman, `Energy Efficient Thermal and Power Aware (ETPA) Routing in Body Area Networks', Proceedings of IEEE 23rd

International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC) (2012) September 9-12; Sydney, NSW, Australia, pp. 1108–1113.

19. S. Movassaghi, M. Abolhasan, and J. Lipman, `A Review of Routing Protocols in Wireless Body Area Networks', Journal of Networks (2013), Vol. 8, No.3, pp. 559-575.
20. S. Ullah, H. Higgins, B. Braem, B. Latre, C. Blondia, I. Moerman,S. Saleem, Z. Rahman and K. S. Kwak, `A Comprehensive Survey of Wireless Body Area Networks', Journal of Medical Systems (2012), Vol. 36, No. 3, pp. 1065-1094.
21. Shyam Patidar Dheeraj Rane "A Survey Paper on Cloud Computing" 2012 Second International Conference on Advanced Computing & Communication Technologies.
22. T. Watteyne, I. Augé-Blum, M. Dohler and D. Barthel, `Anybody: A Self-Organization Protocol for Body Area Networks', Proceedings of the ICST 2nd International Conference on Body Area Networks (2007) June 11-3; Brussels, Belgium.
23. V.S. Abhayawardhana, I.J. Wassell, D. Crosby, M.P. Sellars and M.G. Brown, `Comparison of Empirical Propagation Path Loss Models for Fixed Wireless Access Systems', Proceedings of IEEE the 61st Vehicular Technology Conference (2005) May 30-June 1; Stockholm, Sweden, pp. 73–77.
24. Z. Khan, S. Sivakumar, W. Phillips and B. Robertson, `QPRD: QoS-Aware Peering Routing Protocol for Delay Sensitive Data in Hospital Body Area Network Communication', Proceedings of 7th International IEEE Conference on Broadband, Wireless Computing, Communication and Applications (BWCCA) (2012) November 12-14; Victoria, BC, Canada, pp. 178–185.
25. Z. Khan, S. Sivakumar, W. Phillips, and B. Robertson, `A QoS-aware Routing Protocol for Reliability Sensitive Data in Hospital Body Area Networks', Procedia Computer Science (2013), Vol. 19, pp. 171-179. M. Quwaider and S. Biswas, `On-Body Packet Routing Algorithms for Body Sensor Networks', Proceedings of 1st International Conference on Networks and Communications (2009) December 27-29; Chennai, India, pp. 171–177.