Journal of Engineering and Applied Sciences 12 (Special Issue 10): 8790-8795, 2017
ISSN: 1816-949X

A Novel Cloud Based Industrial Internet of Things (IIoT) Architecture for Healthcare Applications

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Abstract: The recent decades mark the beginning of the new age of IoT (Internet of Things) which is well known by the term internet of objects. IoT is all about internetwork connection of multiple objects in realtime, containing universal intelligence and presence. The presence of IoT and its subsequent development will certainly increase this universality and versatility of the internet by connecting every entity to the internet through advanced harware systems. This forms a potpourri in entities that connects better with humans among themselves. The recent strides made in developing technologies have resulted in a plethora of opportunities that lead to a better lifestyle. Thanks to the above causes, IoT has gained immense traction in the recent times for both inventors and researchers who see its future potential. In this study, we have introduced a novel architecture for embedding IoT for industrial needs such as equipping healthcare applications via. cloud based solutions.

Key words: IoT (Internet of Things), industrial IoT (Internet of Things), healthcare, cloud based solutions, opportunities, intelligence, industrial

INTRODUCTION

Internet of things: It can be communicated as routine of internet of things learning in modern assembling ventures. Hypothetically it can be authored as "Interfacing the physical universe of sensors, gadgets and machines with the internet and by applying profound investigation through programming is transforming huge information into intense new knowledge and insight. We are entering a period of significant change as the computerized world is boosting the proficiency of our most basic physical resources". Kevin Ashtonbegan the adage "Internet of Things" in 1999. He characterized it as regular items are associated with web and taking an interest together on a framework. On a very basic level IoT can be comprehended as the mapping of physical items like gadgets to different programming which helps in return of information. IOT-GSI mirrored the IoT as "The foundation of data society". One might say that things can be controlled remotely. The outcome is productivity, precision and financial preferred standpoint. Expert's evaluate the IoT buyer base will have 50 billion gadgets by 2020. There is degree for development in consistent association of gadgets:

Constituents: Software, hardware and a connection and communication medium.

Hardware: The hand held devices that are the end-devices of connection.

Software: Handles incoming data, processes it, manipulates and stores the data.

Communication medium: Handles the information trade between equipment gadgets. Techniques and protests here suggest to the essential part which agreements with whatever is left of constituents. A case to this would be programmed sensors in vehicles.

Mix of things manages the web manages the IP (Internet Protocol) address for example, each gadget. Here, it utilizes the IPv4 deliver which is to be stretched

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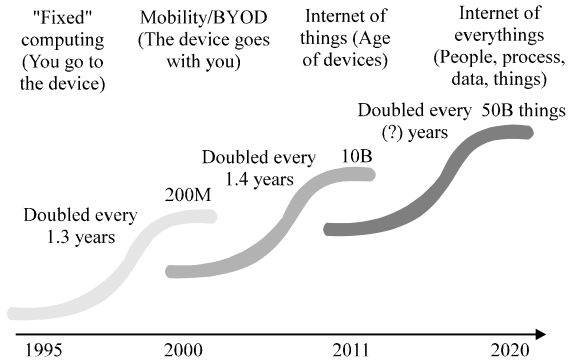

Fig. 1: Growth of web devices

out to out to Ipv6 where it has a wide range IP address though IPv4 has just 4.3 billion special locations utilized for various items. So, to get all the more no of IP deliver conceivable we need to proceed onward to IPv6 which has more IP locations. Questions in the sense can be considered as not just gadgets with sensor capacities and can have incitation abilities. To make the progress in IoT, we ought to need to utilize the Ipv6 a ddress. IoT could likewise be utilized not just as detecting things; it can likewise be utilized to perform activities.

Figure 1 demonstrates that the quantities of gadgets that are getting associated with web are expanding exponentially. So, a gauge of 50 billion gadgets before the end of 2020 is simply speculative.

Industrial internet of things: IIoT is considered as the utilization of IoT in businesses, for example for either assembling or items and so forth. For example, M2M (Mobile to Mobile) which was utilized for assembling as a part of enterprises by IoT. The principle target of IoT in ventures is brilliant machines are superior to anything, people in precision and convey information and so forth. By this information the organizations can deliver more intelligent items and can conquer the wasteful aspects and issues of the items. By the M2M availability through the web could be extremely useful to get to the information in a limited system effortlessly. Enormous Information investigation brings about the high productive IoT.

IoT can be utilized as a part of different areas of businesses for example, fabricating, deals items and so forth. By executing IoT there could be an upset in ventures for creating new items.

IoT can be utilized as a part of different segments of businesses for example, fabricating, deals items and so on. By actualizing IoT there could be an insurgency in enterprises for creating new items.

Literature review: The first study to be surveyed dealt with finding a solution to the challenge posed by data hit in most cases. Slot allocation to nodes has been refined (Wang *et al*., 2012), through the proper algorithm by designing an energy aware rule in MAC, named the DTDM access methods. This novel design evades the data hit by allocating continuous machines in the process of data aggregation which occurs in the distributed environment.

It is common knowledge that the network throughput can be considerably affected by channel assignment. This study deals with the above pressing issue by focussing on channel policies during the allocation of the nodes. In this particular study researchers have proposed new assignment algorithm for routing the channels exactly in the transmission links. Dynamic channel assignment algorithms are capable of allocating channels in a pipelined fashion that would help in allocating it in the proper resources. There are some disadvantages of this algorithm that would be the improvement of the communication throughput (Sun *et al*., 2012).

The next surveyed study develops the infrastructural policies that have been adapted for wireless sensor networks (Ju *et al*., 2012). Here, the concept is quite obvious that finds widespread adoption and regular use from Asia and USA researchers on a daily basis. There are some intrusion detection framework was seen to outperform all the existing standards (Le *et al*., 2012). Many cryptographic concepts have been evolved to solve the IDS in QoS related model of designing a strong network infrastructure.

Keeping in line with the topic from the previous study, this study investigates the susceptibility of sensor networks (Hai *et al*., 2010) and some fewer concepts of wireless sensor that will show a lesser energy consumption in the detection of intrusion than most state of the art schemes.

It is believed that the identification of radio frequencies is a dispensable technology for the internet of things. The next study, proposes the modulation frequency and code division variations that are seen as a must for IoT. This network must be optimized for throughput and this is achieved through the design of an effective medium access control and a dynamic frame size adjustment algorithm (Zhang *et al*., 2012).

MATERIALS AND METHODS

Proposed cloud based IIoT architecture in healthcare applications

Cloud based IIoT in healthcare applications: Cloud based IIoT architectures could be the optimal solution for

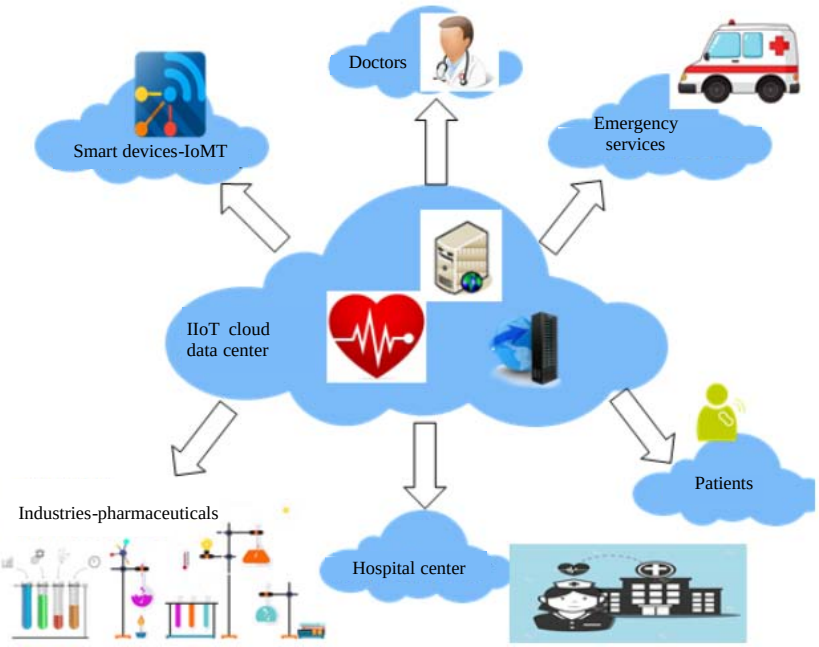

Fig. 2: Depiction of cloud based IIoT in healthcare applications

addressing healthcare issues in an effective manner. As the number of users (patients) recordkeeping is a mandatory procedures in any hospital based systems. Also, it's an essential component for a doctor to check the patient's history every time. For this complexity, we have designed a novel cloud based IIoT in healthcare applications to optimize and to deliver better results for patients ECG (Electrocardiogram) records analysis.

The cloud based IIoT in healthcare applications is depicted in Fig. 2. The internal components in Fig. 2 have been described as follows:

- IIoT cloud data center
- Smart devices-IoMT (Internet of Medical Things)
- Doctors
- Emergency services
- Industries-pharmaceuticals
- Hospital center
- Patients

Firstly, for any cloud based IIoT design, the necessary component is cloud data center where all the data have been stored and retrieved by any user (patient or doctor and so on). In our design, we are focussing keenly on storage and retrieval of medical ECG data through cloud data center (Sekaran and Krishna 2016). Smart devices such as wearable ECG shirts (Chen *et al*., 2017; Ghosh *et al*., 2016) would keep on sensing the ECG pulses from patient's body and sends the data towards a communicating medium. Then, it is being stored in cloud data center for the further doctors report analysis. The doctor can login anytime into the system through their credentials. By connecting, it to the industries-pharmaceuticals, it's easy for the patient to know about the drugs and other hospital centre details. There is an emergency service also connecting the system to provide utmost care or an emergency cases such as sever heart block patients.

ECG monitoring system in the IIoT cloud systems: For cloud based IIoT in healthcare applications such as patients ECG (Electrocardiogram) records analysisan ECG (Electrocardiography) sensors have been deployed that sense the bio-potential and generates the electrical signals that control the expansion and contraction of heart chambers. The unit for electrical signals is microwatt. In our proposed ECG monitoring system in the IIoT cloud systems, we have analysed the four core components to rectify the normal ECG error methods. The important components and their systematic procedures in Fig. 3 and 4 have been described.

Smart sensors/actuators and ECG monitoring devices such as wearable IoMT shirts sensing and sending the medical data from the patient's body.

Online monitoring tool would be used for collecting and analysing the data for further data analytics and

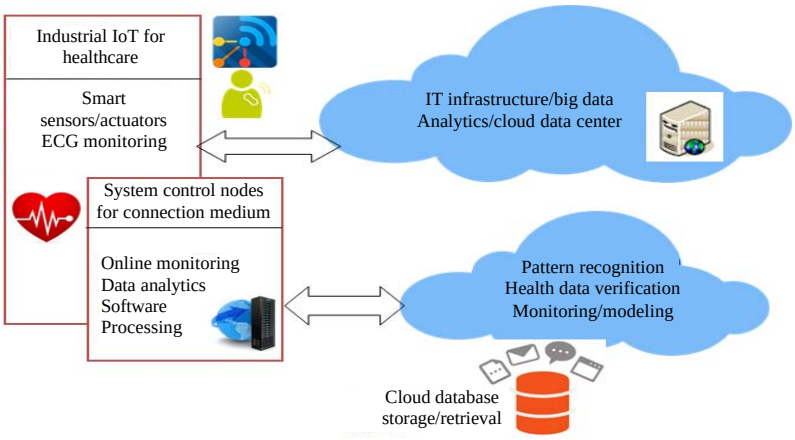

Fig. 3: ECG monitoring system in the IIoT cloud systems

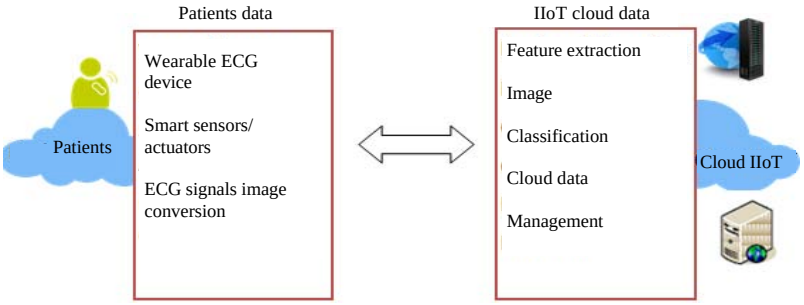

Fig. 4: Depiction of patientsdata on ECG signal image segments and the IIoT cloud data in healthcare applications

software processing to process ECG images. Cloud data center for analysing the images through proper IT (Information Technology) infrastructures. Pattern recognition module to classify the images and to enable the feature extraction in images. Then finally storing the images in cloud data center that has been connected to cloud databases for further retrievals.

Patients data on ECG signal image segments and the IIoT cloud data in healthcare applications

Analysis and modelling: Numerous features have been analysed and extracted from the ECG signal in the cloud data center. The features comprise Heartbeat Rate (HBR), time durations of Upbeat Wave (UW), time interval for Atrial systole (A), atrial Diastole (D). The routine of the ECG images was encountered in terms of noiselessness and healthiness against various issues such as security in cloud data center. Noiselessness is a degree of how much the electrical signal is inaccurate remarkably. To measure noiselessness, we have analysed and used Signal-to-Noise Ratio (SNR) which is an unbiased measurement. SNR is defined by the following Eq. 1 and 2:

$$\text{SNR db} = 20\log \frac{(\text{ECG signal})}{\text{ECG noise}} \quad (1)$$

$$\text{SNR} = \frac{\sigma^2 \text{signal}}{\sigma^2 \text{noise}} \quad (2)$$

Hence, it's essential to calculate the SNR values and to find the optimal SNR db value for mapping the signals to the correlated perfect images. We have analysed the SNR ratio values through various techinues such as Wavelet Filtering method (WF) and pilot estimation method for denoising the signals data mapping in the cloud data center.

RESULTS AND DISCUSSION

We have evaluated the proposed cloud based IIoT architectures using a Java-based simulator program that works better. The simulation environment comprises cloud data center components and an ECG data analysis module. To decrease the overhead and delay, ECG image files are duplicated. Hence,

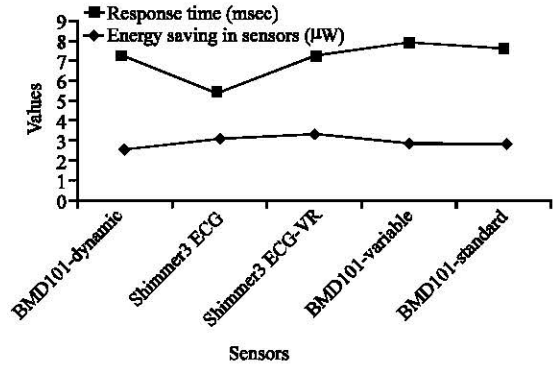

Fig. 5: ECG Sensors energy saving (µW) analysis wrt response time (msec)

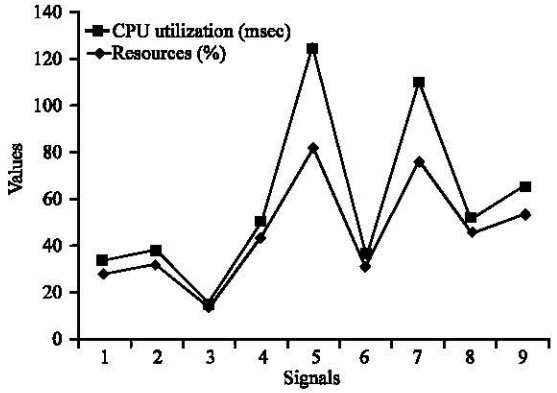

Fig. 6: CPU utilization of the cloud data centers vs. ECG signals transmissions

Table 1: Experiment result on ECG sensors

ECG sensor types	Energy saving in sensors (µW)	Response time (msec)
BMD101-dynamic	2.50	4.65
Shimmer3 ECG	3.05	2.28
Shimmer3 ECG-VR	3.34	3.87
BMD101-variable	2.90	5.01
BMD101-standard	2.80	4.84

the medical experts can easily access the image data for a particular patient from some other cloud data center.

We have analysed the BMD101 (Bio-signal system-on-chipdetection) ECG sensors and Shimmer3 (smallest, slimmest and most robust wearable wireless sensor) ECG sensors with variable variety and it is shown in Table 1 where the energy saving of the individual unit has been given in microwatts (µW). Also with respect to response time (milliseconds) has been depicted in Table 1 and Fig. 5. And we have tested the CPU, bandwidth and memory utilizations of the cloud data centers during ECG signals transmissions. And we have given the results of that in Fig. 6 and 7.

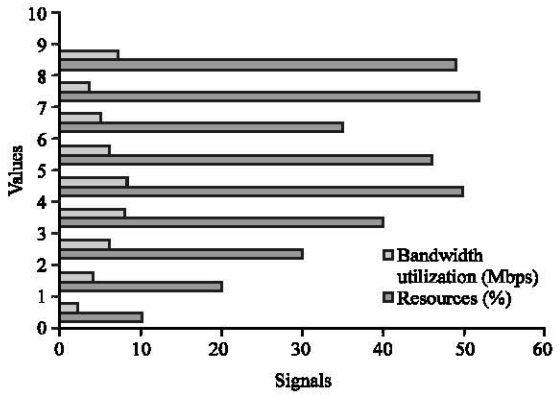

Fig. 7: Bandwidth utilization of the cloud data centers vs. ECG signals transmissions

CONCLUSION

In this manner, we can presume that modern IoT is a quickly developing segment. It's been expanding in exponential terms. On-going enhancements in sensor advances including scaling down, execution and cost and vitality utilization are making clever items more open. There must be a great deal more enhancements in the field of sensor investigation and location. Machines ought to enhance in process duration diminishments, cost reserve funds and business prepare changes. Reorient the business system around the modern web. Organizations biological system changes. It needs to comprehend the basic significance in the sending of mechanical web. Consequently, we can finish up that mechanical IoT is improving the world speedier and which gets reflected in the gross domestic product of the specific nation.

REFERENCES

Chen, M., Y. Ma, Y. Li, D. Wu and Y. Zhang *et al*., 2017. Wearable 2.0: Enabling human-cloud integration in next generation healthcare systems. IEEE. Commun. Mag., 55: 54-61.

Ghosh, A.M., D. Halder and S.A. Hossain, 2016. Remote health monitoring system through IoT. Proceedings of the 5th International Conference on Informatics, Electronics and Vision (ICIEV), May 13-14, 2016, IEEE, Dhaka, Bangladesh, ISBN:978-1-5090-1270-1, pp: 921-926.

Hai, T.H., E.N. Huh and M. Jo, 2010. A lightweight intrusion detection framework for wireless sensor networks. Wirel. Commun. Mobile Comput., 10: 559-572.

Ju, X., H. Zhang and D. Sakamuri, 2012. NetEye: A user-centered wireless sensor network testbed for high-fidelity, robust experimentation. Intl. J. Commun. Syst., 25: 1213-1229.

Le, A., J. Loo, A. Lasebae, M. Aiash and Y. Luo, 2012. 6LoWPAN: A study on QoS security threats and countermeasures using intrusion detection system approach. Int. J. Commun. Syst., 25: 1189-1212.

Sekaran, K. and P.V. Krishna, 2016. Big cloud: A hybrid cloud model for secure data storage through cloud space. Intl. J. Adv. Intell. Paradigms, 8: 229-241.

Sun, W., T. Fu, F. Xia, Z. Qin and R. Cong, 2012. A dynamic channel assignment strategy based on cross-layer design for wireless mesh networks. Intl. J. Commun. Syst., 25: 1122-1138.

Wang, Y., P. Shi, K. Li and Z. Chen, 2012. An energy efficient medium access control protocol for target tracking based on dynamic convey tree collaboration in wireless sensor networks. Int. J. Commun. Syst., 25: 1139-1159.

Zhang, Z., Z. Lu, Q. Chen, X. Yan and L.R. Zheng, 2012. Code division multiple access/pulse position modulation ultra-wideband radio frequency identification for internet of things: Concept and analysis. Int. J. Communi. Syst., 25: 1103-1121.