

# Securing Communication in the IoT- Based Power Constrained Devices in Health Care System



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**Abstract:** *One of the most appealing IoT application areas is medical care and health care. This promising technology is reshaping current health-care service that comply with treatment and medication at home. The core part of IoT constitutes sensors and various devices for diagnosis and imaging. Now-a-days sensors are becoming smaller, allowing them to be worn without interfering with daily activities.. To make sensors wearable and wireless, it should be small in dimensions and also the energy, memory, and processing power available also matters. Health services dependent on the Internet of Things are supposed to minimise cost, enhance the user's experience and improve their quality of life. IoT has many hurdles in its implementation, security is the most important. This paper throws light on the different methods of securing the medical sensitive data through the network.*

**Keywords:** *Internet of Things, Cloud Computing, Healthcare cloud, Security, Sensors.*

## I. INTRODUCTION

Recently, there is tremendous growth in usage of internet, and connecting things from real world to internet is nothing but Internet of Things. World is coming closer and completion of work has increased rapidly due to IoT. We can see many uses of IoT in different sectors like personal use, agriculture, smart irrigation, healthcare, education, home automation, environmental monitoring, smart cities, industrial automation, smart energy, etc. IoT is equally valuable in all areas. In healthcare it can save a life through fast detection of diseases and their immediate treatment. Agriculture has a major impact on economy of country and monitoring the health of the crops can help in producing good quality crops in a more faster way. Information about natural calamities can be also be given to farmers prior through environmental monitoring which may help them to save crops. Industry plays another crucial role in a country's growth, so if industrial work goes in smart way through IoT, it can be more profitable with good quality.

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Smart city involves a vast use of IoT. People can use services rapidly from anywhere in smart city, which can save their time. Although, we can say IoT is a boon but it can lead to risks, if proper security measures are not applied to IoT applications, data and devices. IoT needs continuous network access, so what if network failure or power failure occurs, for this, preventative measures are sharply needed.

Mobility is one of the factors important to be considering in IoT. Mobility and Cyber security might not be fully overlapping. Cyber security comes with adoption of new technology. Cyber security is needed for all types of devices on network and most of the devices in network can be mobile devices. For ex. smartphone. So, in IoT, the devices are connected to network and tasks are getting smarter. With mobility we are carrying technology in our pocket. We can say IoT involve mobility as in IoT applications smart approach is involved. For ex. Smart phone has sensors connected to applications which is the use of IoT and Smartphone itself is mobile, it moves along with us. We can say IoT and mobility are overlapping. Another example is connected car and there are many such implementations of IoT.

It is very important to set policies from security point of view for any device that connects to internet. The lack of frameworks would aid an organisation in identifying IoT-related threats and implementing appropriate controls. This is still a big problem in such areas, but that is changing and AT&T has established a four-part system for assessing IoT threats..

An organization's various stakeholders must be represented. The IT security team and business divisions, as well as the executive officers and board of directors, are among them. Determine whether or not there are any legal or regulatory concerns. Organization should use encryption, use latest hardwares and softwares, regular updates.

In initial phases of IoT adoption for small to medium business, it seems very easy and simple to implement and use it but as IoT hardware devices, software and users increases, the complexity grows and then businesses faces these challenges which might be through some bad experiences about security leakage. So businesses must have to implement strong security policies. IoT devices in the network produce a large amount of data. to tackle with such a huge amount of data is biggest challenge. Heterogeneity increases complexity in security.

IoT in simple words are things that sense data, process and share it to other things through internet.



IoT systems consists of sensors or devices that send data to cloud, software processes it and has ability to send data over a network without requiring human-to-human or human-to-computer interaction .Wiki leaks in March-17 made to think how much the data stored in cloud server is safe and secure in the future. In the near future IoT is poised to play a strong role in all aspects of health care. With the aid of health-care data, researchers and physicians can access a wealth of information that can be used to assess a patient's health and well-being, confirm whether the patient is displaying any disease symptoms, and eventually predict which disease the patient will develop.

Analyzing and forecasting a patient's health and well-being would necessitate a significant amount of storage and computation. Cloud computing has solved the issue of data storage and computation, allowing us to focus on other things. When such a large volume of private data is obtained from various patients, we must ensure that the data is maintained in its integrity. The data collected through the body sensors should be transmitted to the central medical server of the hospital and should be accessible to only the specified doctors, as the patient's body data is sensitive data. Here in this paper we discuss the various security methods proposed to protect this sensitive data.

### II. IOT IN HEALTH CARE

It is a heterogeneous computing, communicating system of apps that connect patients and health providers. Few examples are headsets that measure brainwaves, Clothes with sensing devices, BP/Glucose/ECG/Pulse/ monitors and any wearable technology device. IoT has major impact in health care by reducing the cost and improving the treatment. IoT technologies in healthcare benefit patients, families, physicians, hospitals, and insurance providers.

**Patients** – Patients have access to personalized attention through wearable devices such as blood pressure and heart rate monitoring cuffs, glucometers, and other wirelessly linked devices. These devices can be set to remind you of some things like calorie counting, exercise, appointments, blood pressure changes, and much more.

The Internet of Things has changed people's lives, especially the lives of elderly patients, by allowing them to track their health in real time. This has a major effect on lonely people and their families. Family members and concerned health practitioners receive alerts from a warning system, if a person's normal activities are disrupted or changed.

**Physicians** – Wearables and other IoT-enabled home monitoring equipment will help physicians keep better track of their patients' health. Data from IoT devices can assist clinicians in determining the appropriate treatment process for their patients and achieving the desired results.

**Hospitals** - Hospitals can benefit from IoT devices in a variety of ways, in addition to monitoring patients' health. Wheelchairs, defibrillators, nebulizers, oxygen pumps, and other monitoring devices are all monitored in real time using IoT devices with sensors.

**Health Insurance Companies** – There are numerous opportunities for health insurers with IoT-connected intelligent devices. Insurance companies can leverage data captured through health monitoring devices for their underwriting and claims operations. This data will enable

them to detect fraud claims and identify prospects for underwriting.

Sensors are used in IoT are for/in video surveillance and lightning systems, intelligent devices for monitor environmental conditions, cameras, traffic lights, connected cars and many other smart devices in cities. Connected ambulance, intelligent medical devices, traffic flow optimization-connected traffic cameras, smart factory, smart roads, pet tracking, Smoke detectors, water metres, garbage cans, vending machines, and gas monitoring health of Buildings- periodically send a radio signal of suitable amplitude and phase characteristic to inform about the structure's state/health, water level for lakes, streams, sewages, gas concentration in the air for cities, laboratories, and deposits, soil humidity and other characteristics, inclination for static structures (e.g., bridges, dams), position changes (e.g., for landslides), lighting conditions either as part of combined sensing or standalone, to detect intrusions in dark places, infrared radiation for heat (fire) or animal detection, waste management, smart parking - Radio Frequency Identification (RFID) is useful for vehicle identification systems, smart health.

### III. RELATED WORKS

Patients always want the doctors and hospitals to assist them with high efficiency without revealing their identities to the cloud server For wearable devices such as bracelets, ornamentation, patches, caps, t-shirts, bands, glasses, wearable processes can be tailored to the "real body." This equipment has been used to contact the person who monitors the disease and personal health of patients. The information gathered is then been sent to the central and internal research centre. Three elements used to monitor are wearable devices such as cameras, machine buildings and exhibits. Wearable devices may provide natural statistics, including calories, steps, heart rate, blood pressure; time spent exercising, and so on. The effect of these devices is enormous and of course very strong, which has a good focus on monitoring the physical health of our users.

Various wearable devices as given below:

#### A. Pulse Oximetry:

This device measures the difference in skin blood flow associated with the cardiac cycle and checks the human body's oxygen saturation level. The pump oximeter, containing an image detector and light-emitting diodes (LEDs), is connected to the finger or ear. The red light sent or carried back into the human body tests infrastructure. The distinction between the level of the installation and the amount of deoxygenated hemoglobin helped to measure oxygen saturation. It is used to calculate the heart rate as Photo Plethysmo Graph (PPG).

#### B. Electrocardiography (ECG):

A waveform that monitors the heart continues to function and provides time information.

There is also restricted readiness for automation for ECG calculation based on wireless sensor devices.

**C. Blood Pressure:**

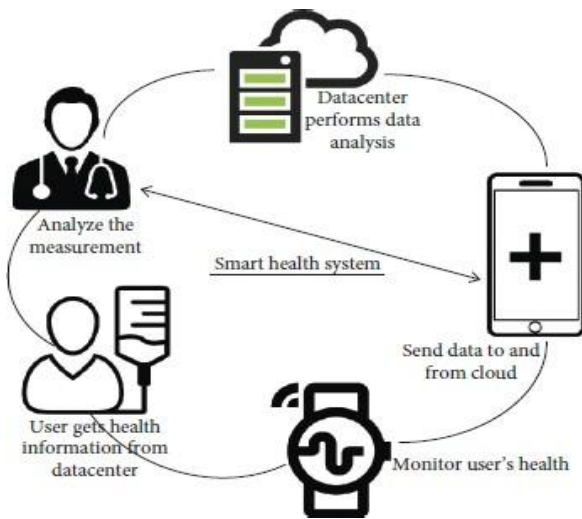
The energy used by blood pumping into the blood vessels helps to quantify it. The oscillometric approach is used to calculate these types of sensors for the hand frame and systolic readings.

**D. Electromyography (EMG):**

The muscle research works by looking at the muscle's electrical signals. For all electric signals EMG is the spatio-temporal DRM. The EMG signal therefore provides an efficient way to monitor human muscles' activities.

**E. Electroencephalography (EEG):**

The electroencephalogram (EEG) is a description of human brain functions. The Wireless Intelligent Sensor (WISE) is a low-frequency control system with EEG data acquisition, wireless connectivity, analogue signal synchronisation, and low-level real-time signal processing capabilities.



**Implantable Devices**

Artificial Implants are implanted under the jar of the human body to help improve a component or structure. Implants are more widely used for multiple applications including neural prosthesis, orthopedics, heart stent, artificial pacemakers, etc. Any organic material such as apatite, silicone, titanium can be extracted from the outside layer of the implanted equipment, and the contents must be chosen according to the human body's specifications. Ceramics, metals and polymers may be manufactured from materials used for artificial devices. The following are other equipment listed:

**A. Glucose Monitoring:**

A mixed membrane in the tumor tissue is the competent procedure for the implantation of the sensor. During the 30s, body sugar levels can be tracked and data transmission occurs approximately every 5 minutes. When the sensors are in place and the level of glucose can be regulated, an alternative to the insulin level is given.

**B. Implantable Neural Stimulators:**

These types of electrical stimulation trigger electric impulses to relieve chronic pain in the human spinal cord or brain.

**Applications of IoT in Healthcare**

Patients and adults can live independently with the help of healthcare apps. IoT sensors are used during this period for diagnosing and re-evaluation of their wellbeing and sending alerts in unlawful circumstances. The IoT device itself will advise the patient appropriately when other minor problems are detected". "The sections below cover the different IoT uses in healthcare.

They are split into two general types of health applications made for IoT: single step and mixed mode.

**A.Single status applications:** such applications designed for a specific disease.

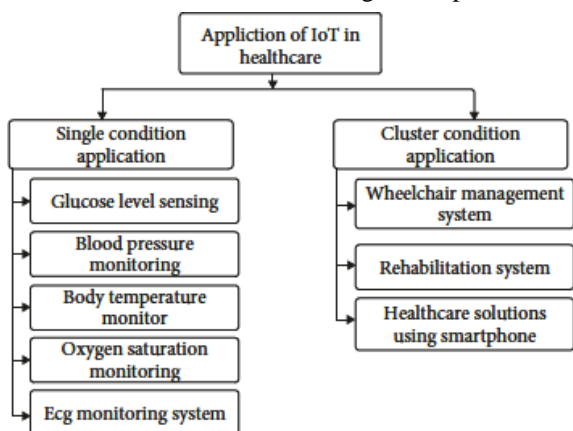
- **Glucose Sensitivity:** Diabetes is a metabolic condition if the sugar level at a long-term period is above average. The blood sugar control system generates blood glucose of some kind and helps to prescribe a healthy diet, appropriate tests and medications. It is currently proposed an m-IoT configuration process that is not permitted based on glucose.To this end, different sensors are linked in patients through the correct provider of IPv6 connectivity. In the operating system, it creates an IoT-based communication unit that transmits the information gathered to the level of blood sugar. A collector of glucose, a computer or a smart phone and the processor is included in this package. A standard IoT- based detector for glucose levels is also proposed.
- **Blood Pressure Monitoring System:** High blood pressure shows the heart pumping through the body powerfully. The method of IoT promotes the diagnosis and treatment of health problems, including blood pressure (BP), hemoglobin (HB), levels of blood sugar and abnormal cell growth. An IoT system for blood pressure, diabetes and obesity treatment.
- **Body Temperature Monitoring:** Body temperature control and tracking is an essential component in health applications. The homeostasis change depends on the temperature of the body, based on the m-IoT principle. Telos Bmote software body-sensor sensors have clear and efficient internal performance. On the top of an IoT unit, the body temperature control device is centered on the home port. It supports the control and calculation of the temperature infrared detection and RFID module.
- **Oxygen Saturation Monitoring System:** The Pulse oximeter is used to measure oxygen in the blood continuously. The use of IoT with pulse oximetry is useful for technical applications. The benefit of IoT-based pulse oximetry is addressed by coAP-based health care system studies. Ninin shows the function of the Wrist OX2 oximeter machine. This system is wired to Bluetooth and links the sensor directly to Monere. To track remote patients, an IoT-based norm and low-pulse oximeter is used. The IoT network allows this system to continuously monitor the health of patients.

- ECG (Electrocardiogram) Monitoring System:** The ECG monitoring unit has the option of displaying the user / patient ECG waves. A patient's medical report is published by gathering ECG signals and uploading data to the cloud network. Provides user input on the basis of the collected information. With a traditional analogue to digital transformer, the IIO-OTG microcontroller transforms ECG signals and downloads a binary file output from the cloud network for analysis and identification of irregular conditions for human health. The full advantage of these machines decreases waiting times and decreases facilities in hospitals and emergency departments.

**B. Consolidated status requests:** These applications can treat certain diseases together.

- Wheelchair Management System:** Comfortable wheelchairs are suggested by experts to save the lives of the elderly and individuals with disabilities. IoT plays a significant role in speeding up this process in this region. Smart wheelchairs are fitted with different sensors to track seat movement and also to display the status of patient / user.
- Rehabilitation System:** The process of regenerating population growth issues and a lack of life skills can be improved by IoT. The capabilities of physically disabled people can be strengthened. In order to strengthen the recovery mechanism, the Body Sensor Network was introduced. Ontology-based automation architecture reveals that IoT can be a great way to manage information in real time. The Early Childhood Education programmed, the intelligent city medical recovery programmed and the integrated goal technology programmed are many of the services that IoT has created.

**Healthcare Solutions Using Smartphone:** The electronic device control system with sensors has so far been seen on the Smartphone. Specific mobile applications are offered in the healthcare sector to support patients, provide medical training and provide initial training. A range of software and hardware products that portray the Smartphone as a useful tool in healthcare are being developed.



This can be achieved through anonymous authentication discussed by Abid Mehmood.et.al[4].The proposed scheme uses rotating group signature scheme based on Elliptic curve cryptography to provide anonymity to the patients.

Mohamed Elhoseny et al. [5], proposed steganography techniques and hybrid encryption algorithms to hide digital information in an medical image. The encryption scheme is formed by combining Advanced Encryption Standard-AES, and Rivest,Shamir and Adleman – RSA algorithms. The paper also aims in improving the security of medical data transmission by integrating steganography and hybrid encryption techniques.

In the paper proposed by Haiping Huang et al. [1] an health care system is designed that proposes secured medical data transmission from Wireless Body Area Networks(WBAN) to Wireless Personal Area Networks(WPAN). Homomorphic encryption based on matrix scheme is used to ensure privacy. It also enacts privacy-protecting policies in order to improve connectivity between users' smartphones and embedded medical devices.

Signal Scrambling is another powerful method used in modern data communication schemes to secure data and provide synchronization between transmitter and the receiver. In the paper proposed by Shu-Di Bao et al.[2], sensitive health care data is secured and for added security, a small piece of data is used to partition and scramble the health care data. The scrambled data is stored in the cloud, while the tiny data is held locally for retrieval.

The term "cloud of things" refers to the combination of cloud computing and the Internet of Things. Mukhtar M E Mahmoud et.al.,s literature[6] analyses CoT architectures and platforms and also implementation of CoT in smart health care. Different energy efficiency methods in CoT that can be applied in health care is analyzed deeply in the paper.

IoMT is a new term introduced in the paper [7] by Ankur Limaye et al . The paper paves a way for researches on new optimization techniques that enable efficient execution of emerging IoMT. Edge computing is used to solve bandwidth bottlenecks. A benchmark suite HERMIT which comprises of applications spanning various domains in health care is introduced for IoMT.

Hadeal Abdulaziz Al Hamad et al.[3] in their paper focused on fog computing facility to secure health care private data in cloud. A tri-party one-round authenticated key agreement protocol was proposed based on bilinear pairing cryptography. Decoy technique is used to store and access private health care data.

Attribute Based signature (ABS) is a very useful technique for the privacy protection of users and suitable for anonymous authentication and privacy access control . LPPMSA scheme proposed by Jingwei Liu et al [8]is based on multi authority ABS to ensure that the sensitive information of users is not disclosed.

Block chain technology has strong potential to improve the management of medical data, as it does not suffer from issues like single point of failure, centralized data stewardship and system vulnerability found in traditional client – server and cloud based health care data management system.

[9] authored by Leila.et.al proposed light weight block chain architecture for health care data management reduces the computational and communication overhead compared to Bitcoin network.

Fengwei Wang et al proposed a new scheme PCML[10] to address the security issues and improve the accuracy of online medical diagnosis service. Based on Paillier cryptosystem with threshold decryption and distributed skyline computation, health care centers can securely learn a global diagnosis model with their local diagnosis models in the assistance of cloud. LIST[11] is proposed by Yang et al in

which patient data are encrypted end-to-end from a patient's mobile device to data users and it also enables efficient keyword search. Attribute based encryption is opted to provide fine grained access on encrypted data.

IV. REVIEW OF PAPERS

Table 1 summarizes the contributions and concepts explained in each paper along with the author name and year of publishing.

Ref. No	Title of Paper	Author and Year	Contribution	Concept Used /Remarks
1	Private and secured Medical Data Transmission and Analysis for wireless Sensing Health care System	Haiping Huang et al. (2017)	Proposes a secured medical data transmission from Wireless Body Area Networks (WBAN) to Wireless Personal Area Networks (WPAN).	Homomorphic encryption based on matrix scheme is used to ensure privacy.
2	A Method of Signal Scrambling to Secure Data storage for Healthcare Applications.	Shu-Di Bao et al. (2017)	The data is scrambled before storing in cloud.	Signal Scrambling.
3	A Security Model for Preserving the Privacy of Medical Big Data in a Healthcare Cloud Using a Fog Computing Facility With Pairing Based Cryptography	Hadeal Abdulaziz Al Hamad et al (2017)	Fog computing facility is used to secure health care private data in cloud.	Fog computing, Bilinear pairing cryptography, Decoy technique.
4	Anonymous Authentication Scheme for Smart Cloud Based Healthcare Application	Abid Mehmood et al. (2018)	Provides anonymous authentication to patients who do not want to reveal their identity	Rotating Group signature scheme based on Elliptic curve cryptography
5	Secure Medical Data Transmission Model for IoT – Based Healthcare Systems	Mohamed Elhoseny et al. (2018)	Provides a method to hide digital information in medical data	Steganography technique .Combination of AES and RSA algorithms to encrypt the secret data before hiding.
6	Enabling Technologies on Cloud of Things for Smart Healthcare	Mukhtar M. E. Mahmoud et al. (2018)	Analyses CoT architectures and platforms and also implementation of CoT in context of smart health care	Survey paper on CoT architectures in healthcare
7	HERMIT: A Benchmark Suite for the Internet of Medical things.	Ankur Limaye et al. (2018)	Optimization techniques that enable efficient execution of emerging IoMT	Edge computing.
8	Lightweight and Privacy – Preserving Medical Service Access for Healthcare Cloud . LPP-MSA.	Jingwei Liu et al . (2019)	Privacy protection of users and anonymous authentication of users and privacy access control .It ensures that the sensitive information of users is not disclosed.	Multi authority Attribute Based Signature.
9	Lightweight Blockchain	Leila et al. (2019)	Proposed light weight block chain architecture for healthcare data management to improve the management of medical data, reduces the computational and communication overhead compared to Bitcoin network.	Block chain.
10	Privacy-Preserving Collaborative Model Learning Scheme for E-Healthcare	Fengwei Wang et al. (2019)	A new scheme [PCML] to address the security issues and improve the accuracy of online medical diagnosis service.	Based on Paillier cryptosystem with threshold decryption and distributed skyline computation
11	Light weight Shareable and Traceable Secure Mobile Health System	Yang Yg et al. (2020)	End-to-end encryption of data from a patient's mobile device to data users and it also enables efficient keyword search.	Attribute Based Encryption (ABE) .

V. CONCLUSION

In this paper we have reviewed the IoT technologies with cloud computing in health care system. We have noted that there is a large scope in research to study and develop applications, devices and platforms that rely on cloud computing and IoT. In the coming years, there will be a lot of research into the protection of confidential medical data stored in the cloud.

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