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## Design of an Automated Pollution Monitoring System with Blockchain and LoRaWAN

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**ABSTRACT:** This paper propose an automated air quality detection system using LoRaWAN and Blockchain. There is an old solution of air quality detection in that there are some limitations and possibilities. To overcome those we are developing a new system with more security and cost effectiveness. In this proposed system we are using LoRaWAN protocol for long range transmission and Blockchain to store data in decentralized fashion and retrieval of the data that was recorded with IoT sensors. In this proposed system data will be collected automatically without any third party interfacing in between.

**KEYWORDS:** IoT, LoRaWAN, Blockchain, Automated

### I. INTRODUCTION

Air pollution is perceived as a modern-day curse. Air pollution has many negative effects, including on human health, damage to ecosystems, food crops and the built environment. The World Health Organization (WHO) stresses that air pollution is the biggest risk to human health. Air pollution takes many forms and provides many parameters for measuring and tracking changes over time. Long-term historical pollution data can be difficult to reconstruct or estimate - for many pollutants, our global data range is limited to recent decades. Air pollution is a very big factor of human life because of that some solutions are needed to check the quality of air. Many organizations have proposed the solution but those solutions have some problems regarding security, cost. In the old system the data was collected manually and there was third party interference. To overcome that system we proposed a system which will be cost effective and will be decentralized. In this work, to solve the problem of single point of failure (centralization) a blockchain based solution is proposed which, automatically integrates the data received from IoT sensors into the Blockchain (BC).

### II. RELATED WORK

Comprehensive theoretical research and proposed solutions have been made in the field of pollution surveillance with different approaches. Some examples of these solutions are methods used by the Queensland government, Semtech. In addition, modern pollution monitoring laboratories near the area are being tested. Collect data using these placed sensors. This area can be located at a distance from laboratories and it is not always possible to use sensors to maintain and read data on a regular basis. In this section we will discuss the most suitable communication protocol. For small surface communication it is good to use WiFi or Ethernet Adapters but these methods are not suitable for long communication based on their consumption of high energy. To reduce the high energy consumption we have some other protocols such as DARAL- recharging sensor batteries over WiFi networks but these protocols have also some restrictions like it has fixed communication range. Another solution is the Low Power Wide Area Network (LPWAN) protocol, which helps modules communicate over a long distance using a relatively small amount of energy. The use of LPWAN increases battery life and reduces the total cost of maintaining IoT devices. Many organizations are

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examining many protocols for the long range communication. We have created a table to compare their communication range and select best of them. For the storing purpose we have to select a BC which will plays a critical role. Transaction verification, lock time, security, extension cost Capability, Application Use Case, Smart Contract Support(CS) BC has several options. Block time Trading range from about 0 seconds to more than 8 minutes. Verification fees range from \$ 0 to \$ 10 Regarding the transaction. The scalability of BC is also an important aspect, this transaction directly affects the verification rate.

	WIFI	LoRa	SigFox
<b>Speed</b>	<347 mbps	50 kbps	300 bps
<b>Range</b>	>32 m	15 km	40 km
<b>Gateway requirement</b>	No	Yes	Yes
<b>Security</b>	WPA/ WPA2	AES 128 bit, Encrypting Data at 3 level	VPN +SSL
<b>Type</b>	Licensed	Unlicensed	Unlicensed

Table 1 Protocols

Support SC is important because SC can drive BC for a variety of uses in Data Storage in cases that do not fall under CC. Collecting data from sensors often lead to high transaction fees and Block-time make the BC incongruous for this use case. With the help of above table we have decided to use LoRaWan protocol for long range communication and BC for storing purpose.

Zigbee also consumes less power, so it also fits for IoT network but has low range of communication. For high range communication rule is either power must be more or bandwidth must be less.

ELC is a define type of Ethereum node which, only stores and synchronizes the recent transactions and requires less amount space than Ethereum full nodes.

### III. DESIGN

An innovative architecture is proposed in this article creation of a communication protocol with low energy consumption , high-level communications. In this proposed system data is sent to the web with an IoT sensor BC server or directly via the LoRa network (TTN), to keep data safe and unrecognized , can also do the wifi sensors are used to connect to the Internet to reach BC from the web server layer, Once the data was in BC stored on it after the recovery of local database for fast data processing in offline mode. As the data is above the threshold which is defined in the Arduino, a GSM module is used to notify the registered contact via SMS.

As the size of the module therefore increases the battery is used. If the sensors are kept long distances, change batteries frequently and monitoring battery status is not a viable option. BC supports SC and also provides a light and complete client. One of the major advances in the designed architecture is the use of Ethereum Light Client (ELC). In this design we can transfer data from both IOT or directly from BC. So because of long range communication we will use data transmission from IOT only. In figure data can be transfer from IoT device by using LoRaWAN.

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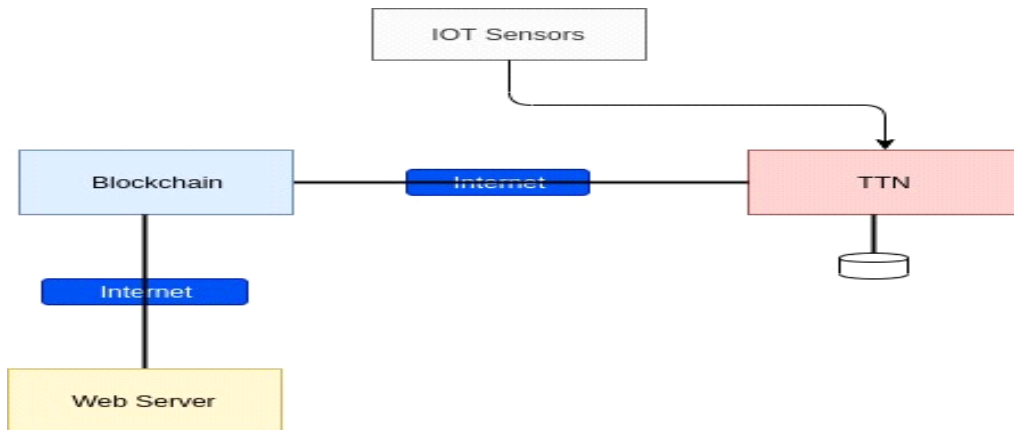


Fig 1 Design

ELC is a define type of Ethereum node which, only stores and synchronizes the recent transactions and requires less amount space than Ethereum full nodes.

## IV. IMPLEMENTATION

In the proposed approach, an Arduino Uno is accompanying a WiFi module for connecting to the internet. The Arduino Serial port communication is carried out. There will be sensors connected to the Arduino with LoRa module accompanying with it to send the data received from the sensors to the LoRa Gateway having python script running on it. The received data will be in encrypted format. LoRa Gateway will be remotely connect to the The Things Network (TTN). TTN decrypts the encrypted data sent from the LoRa sensor nodes. Then TTN will store the data to local database. This data in Blockchain will be stored decentralised and will be retrieved to the pollution monitoring server. Once the data is transacted, it is available on the BC and the pollution data will be accessible over the BC network and in the pollution monitoring web page. The data will also be notified via SMS if rises above threshold.

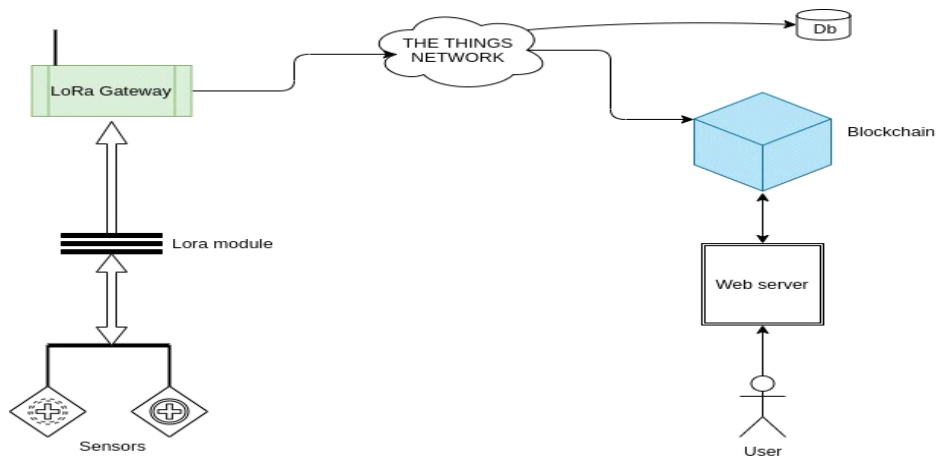


Fig 2 IMPLEMENT

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## V. EVALUATION

It is done on the basis of four different point:

1. Security
2. Reliability
3. Scalability
4. Accessibility

Reliability are provided with the security in data transmission. In this case, the data received by the gateways from sensors were lower than other approaches and transacted into the BC directly from the gateway itself. As a result, this approach ensures integrity and accuracy of the data made available in the public domain. The scalability of the proposed PMS system can be divided into three Back-end, front-end and sensors. the scalability of BC depends on the LoRa network and The Things Network. At moment, verification time of the Blockchain transaction takes 10 seconds maximum, meeting the temporal requirements. In this case of use and the number of sensors in the sensor node Can be easily changed as needed Number of data fields not monitored in the current model. The logic of the current configuration.

## VI. CONCLUSION

In this work, energy efficient long distance communication ,competent and decentralized pollution monitoring system has been introduced. LoRaWAN communication protocol to provide long range and low power enabled communication. This helps in communicating with IoT sensors in environment far from gateways.

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