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Patient Health Monitoring Using Wireless Sensor Network and Cloud Computing using QualNet

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ABSTRACT

WSNs (Wireless Sensor Networks) have long been employed in scientific study. In fields including transportation, business, healthcare, industrial automation, and others, WSN enables compelling information gathering solution. Local wireless sensor networks, the internet, and cloud technology for storing sensor data make these applications better. The approach we suggest is based on a similar idea. Earlier Medical organizations have correctly identified a Wireless Body Sensor Network, which is used manually for patient surveillance. The current collection and processing of patient data requires a number of choices and causes significant delays in real-time data accessibility. These problems mean that only clinics and hospitals have the ability to monitor patients. medical administration and data processing Data is gathered by multiple sensors from various locations, processed, and quickly transferred to the physical world using cloud storage.

Kerywords: - Sensor Networks, Patient Observation, Agent Technology, Cloud Computing and WSN.

I. INTRODUCTION

In hospital healthcare monitoring systems, it is crucial to continuously monitor object movements. WSNs are a significant technological advancement for collecting a variety of data from users and their surroundings. Distributed nodes with wireless infrastructure, computation, and sensing capabilities make up WSNs. The nodes are unorganized and operate separately from one another. The WSN has some restrictions, including how data from sensors positioned throughout the environment is processed, how tools and software are used, how long a sensor's battery lasts, and how many sensors may be combined onto a single platform. Businesses may quickly increase their capacity thanks to cloud computing without having to spend money on new infrastructure. As long as they have access to a network connection, users can access data and computer resources using the cloud computing concept from any location, at any time.

In the past, various research programmed have focused on healthcare. The project will use information and computing technology (ICT) to make administrative, technical, and medical processes more effective. Patient monitoring is essential in recovery rooms, respiratory therapy, transport out-patient care, Cath labs, radiology, ambulatory, home gastrointestinal departments, and sleep applications, as well as emergency rooms, operating rooms, critical care, and the intensive care unit (ICU). This leads to a variety of problems, including difficulties with patient surveillance. Many basic healthcare facilities in rural areas still rely on paper-based systems and have no electronic systems at all, causing patients to store their own data. By measuring physiological parameters like blood pressure, temperature, and heart rate, among others, patients are physically observed. Patients' readings are noted on the medical chart that is given to them, and their treatment strategy is based on that information. Sharing information between different healthcare organizations can be challenging. Since a patient's condition may alter at any time while they are being monitored by a doctor, patient monitoring is essential. To continually track physiological data, the sensing component of a traditional wireless body area network (WBAN) system can either be implanted or etched inside the human body. Diabetes and heart disease affect a large number of individuals worldwide and can cause heart attacks, renal failure, and stroke. Real-time monitoring is therefore essential for these people in order to prevent any abnormal events that can harm their health.

Hospitals need some sort of monitoring system to track items and medical equipment in order to give real-time healthcare informatics, ensuring security, effectiveness, and safety while reducing occupational risk. ICT makes it possible to significantly lower the possibility of human error in crucial circumstances. ICT not only enables but also greatly enhances the automation of the patient observation process. In this paper, we offer a resolution to this issue. The solution can be applied in a variety of other situations due to its generic nature. As a result, this research offers a way for incorporating Cloud Computing technologies into the healthcare environment. This framework's objective is to leverage our community-focused sensing apps to apply the constantly expanding sensor data, which can subsequently be used as a real-time Cloud service.

Wireless Sensor Networks (WSN) and Cloud Computing: An Overview is presented in this study. Section II explores related works, section III presents idea of Wireless Sensor Networks (WSN) and Cloud Computing, while Sections IV and V focus on the Proposed System Architecture, Simulation

Scenarios, and Results, and Section VI summarizes the paper's main points and final references.

II. RELATED WORK

In [11] suggested using cloud computing to gather patient data. He continues by saying that it takes a lot of time and effort to collect, enter, and analyse the vital data from patients. These methods typically take time and are prone to mistakes, which causes a delay that precludes access to real-time statistics.

The effectiveness of a Wireless Body Sensor-based Mesh Network for Health Applications is discussed in [10]. Important data from the Wireless Body Sensor Network can be sent to the spine community using Wireless Mesh Networks (WMN) (WBSN). A concrete cloud computing architecture was proposed in [9], who also provided an application scenario and the tools needed to build the cloud. the equipment required to create the cloud.

An edge work for WSN cloud coordination was presented in [12]. Data from every sensor that can be communicated is gathered into a single message and sent to the cloud for storage. A novel concept in calculation is needed for that. A foundation for incorporating the idea of distributed computing into WSN was put forth in [4]. This device offers approaches for data capacity, access control, and customer supervision. Gain control and data capacity.

An approach that combines cloud computing and WSNs was proposed in [13]. In this scenario, the cloud functions as a virtual sink to gather detecting data from many sources, and handling programming is used inside the cloud to prepare the collected data. Similar works has been discussed in [14]-[19].

III. WIRELESS SENSOR NETWORK & CLOUD COMPUTING

A. Wireless Sensor Network

The field of wireless technology known as wireless sensor networks (WSNs) is very new.

Sensor Networks have been effectively adopted for patient monitoring backbone networks after being first developed for military applications like battlefield surveillance. The sensor network could be modelled using a database. The classification that an electronic network will be given is referred to as a "network model." The most important special structures in applied mathematics are most likely to continue to be network models. This sensor model clearly describes the functions of communication software in a generic and structured manner, which helps with network development. The network user's hardware or software within the network shares much more than the network itself. The method shown here is merely a simple specialization of the concepts of the straightforward approach to making use of network model structure. Software that implements the network's various routing protocols controls all WSNs.

The wireless sensor network is the most popular network for linking devices (WSN). Applications for the WSN network include environmental monitoring in hard-to-reach places, patient health monitoring via the WSN, industrial monitoring, and air pollution monitoring. WSN geographically dispersed sensor networks connect with sensed data under these circumstances. Despite the wide range of uses for the WSN network and the ease of device connectivity, there are some restrictions on the network. These restrictions include the inability to process data sensed by environmental sensors, store temporary data when many sensors are placed in the same area, use tools and software, or integrate sensors into a single platform. The WSN middleware programmed are also made to fill the gap between low-level requirements and high-level standards. Additional app-related problems as well as the challenging nature of network operations need to be resolved. Cloud computing (CC) is essential to the WSN network because of these limitations.

B. Cloud Computing

It's not uncommon to hear the term "cloud computing" used to denote a wide range of different computing techniques involving a large number of machines connected via the Internet as one. It is based on "Pay-Per-Use" services. Software as a service, platform as a service, and infrastructure as a service are all forms of cloud computing. Healthcare services, on the other hand, can be accessed with only a stable Internet connection. Emergency room staff are linked to previously recorded data and connected to ambulances using an application programming interface (API) built on cloud-based hospital management technology Doctors have access to critical information gathered by ambulances and entered into the patient's electronic health record. There was a time when physicians in the ER had to manually send and receive faxes with patient information.

Because it adds additional capabilities to a current system without requiring new infrastructure, training, or software licence, cloud computing is advantageous. It only needs a little amount of management involvement or service provider participation. People can exchange resources and data online thanks to a technology called cloud computing.

Customers may benefit from a range of benefits from cloud computing, including reduced energy and information system waste, increased data centre productivity, and lower operating costs. The following are some advantages of cloud-based healthcare software for patients and healthcare professionals:

- Patient Privacy & Security: The Cloud service provider's expertise allows for better security (Privet Cloud) to avoid the leaking of critical healthcare data and processes.
- Disaster Recovery, Reliability, and Redundancy: A redundant Cloud architecture ensures data security and operations are reliable.
- Scalability: The Cloud's elasticity ensures that resources for dynamic data flows are available at any time, everywhere in real time.

When compared to more traditional ways, the biggest advantages of Cloud Computing are the significant savings in both money and time.

IV. THE PROPOSED SYSTEM ARCHITECTURE

Transportation, conflict zones, health, and agriculture are just a few of the areas in which WSN and cloud integration might be used. To monitor patients, healthcare facilities now use Wireless Body Sensor Networks (WBSNs), which are often constructed in an ad-hoc context and frequently experience network outages. This method suggests a wireless body sensor network. WBSN offers a variety of functionalities to enhance environmental monitoring. It employs wireless sensors to identify patients and determine physiological characteristics. Additionally, we are saving the results in the cloud device's Qualnet software. The system will support patient observation models that are specified by Bayesian classifiers and accept agent training to produce intelligent determination over fluctuations in needed readings of observed parameters and consequently the original readings. The primary contribution of this paper supported the integration of a wireless sensor network with cloud computing, which may view a patient's medical record. As a result, an agent is programmed to carry out some serving tasks on the sensed data, which reduces network traffic and shortens network intervals.

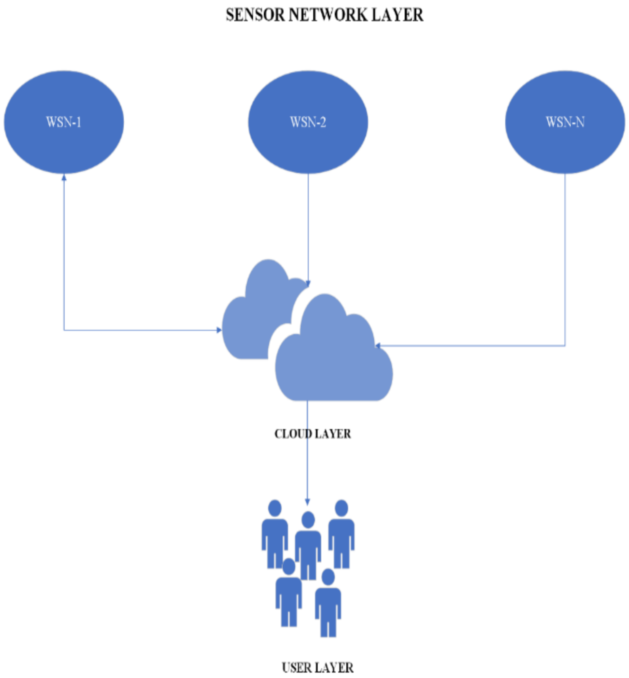

Figure 1: WSN to Cloud Integration.

The suggested system architecture and its many components are shown in figure 2. The Aggregator Agent, Patient Agent, Doctor Agent, and Nurse Agent are the four agents that make up the system architecture. A few patients who serve as patient agents have been connected to the cluster head. Different cluster heads are used to transmit data to the Access point, which is used to access patient data. As a result, the information has been delivered to the base station where the Aggregator Agent is stationed. Received data is examined for any anomalous readings transmitted by the Patient Agent, and the Aggregator Agent begins announcing this information to the Doctor and Nurse Agents. The Aggregator Agent subsequently sends the patient's data to the Cloud computing system, where it is processed and stored in a database. A portable mobile device houses the doctor and nurse agents, who provide information to the doctor and nurse now on duty as well as to the doctor and nurse assigned to the case. The doctor and nurse agents alert the medical agents and allow them to access patient data, including sensor readings from the past and present. Patient Agents, which are sensors attached to portable handheld devices and may receive and send readings from the sensors monitoring the patient's physiological data, would be included to the proposed system in order to accommodate mobile or distant patients. Cloud computing has been used to store the patient's data in the cloud storage system. As a medical Internet of Things, the suggested system allows for the online viewing, tracking, and unique identification of all the data that is connected to it.

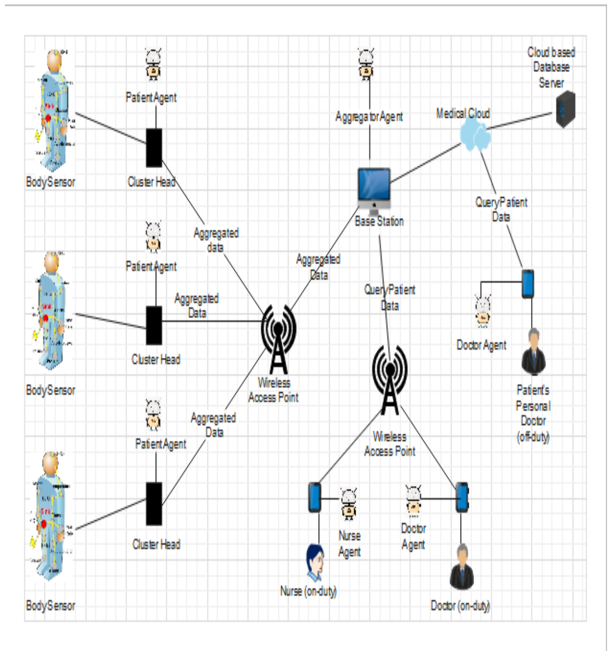

Figure 2: The Proposed System Architecture.

V. RESULT AND DISCUSSION

A. Simulation scenario

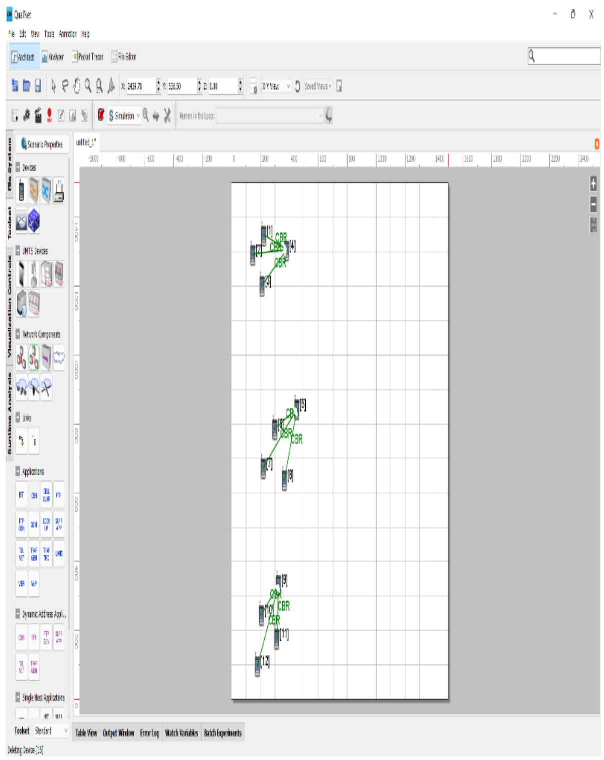

Fig. 3: Data Transfer between Patients to Cluster Head.

The cluster head has been connected to the group of nodes in figure 3. The cluster head, who serves as a patient agent, has received the information from the group of patients.

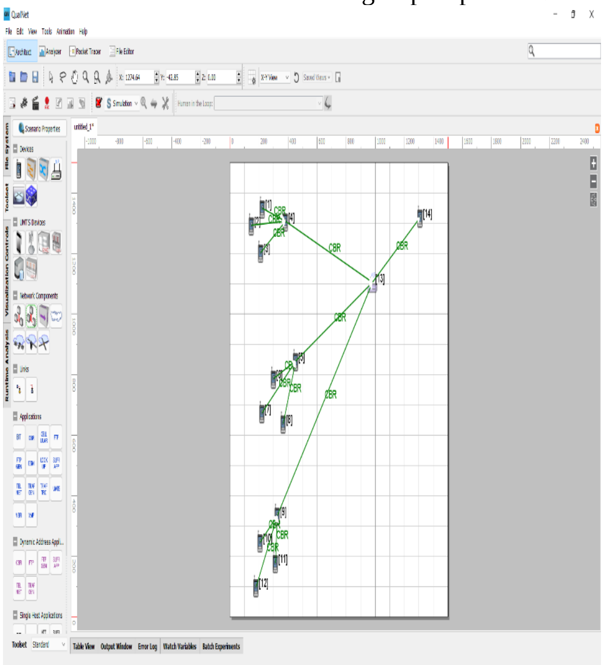

Fig. 4: Data Transfer between Cluster Heads to Base Station.

Figure 4 shows the information being sent from the three distinct cluster heads to the base station where the aggregator agent is situated to receive the information.

Figure 5 shows how data was sent from the aggregator agent to the doctor agent and nurse agent via a different access point.

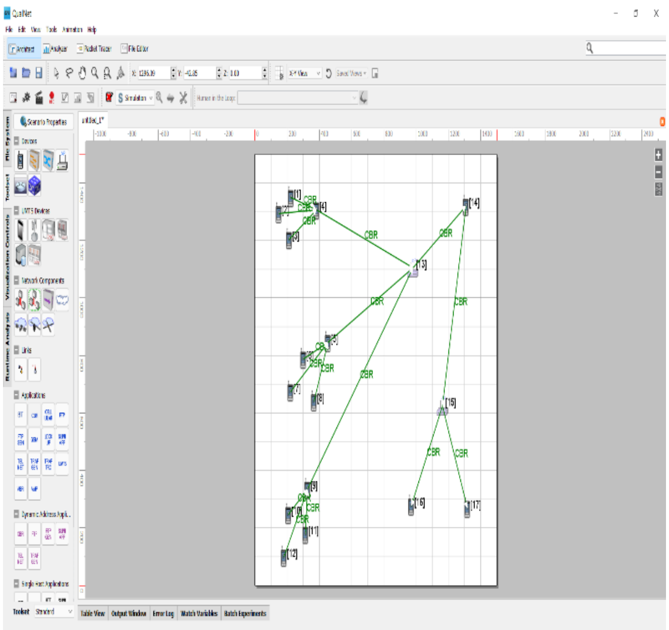

Fig. 5: Data Transfer between Base Station to Doctor and Nurse Agent.

B. Result and Discussion

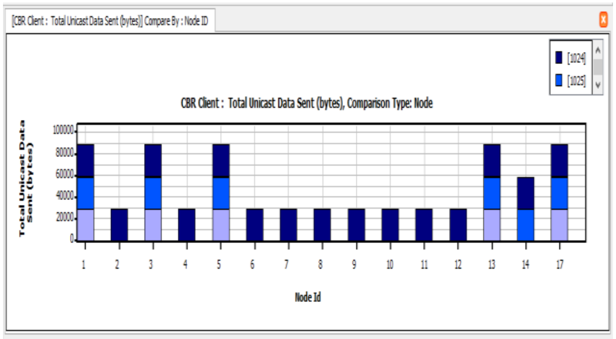

Fig. 6: Sent Data.

This figure 6 shows the total unicast data sent from every node in bytes.

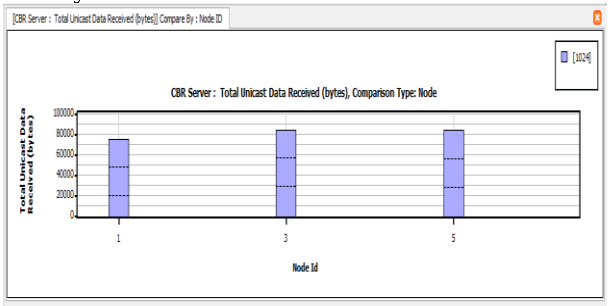

Fig. 7: Received Data.

Figure 7 above displays the entire amount of unicast data that was received at just Nodes 1, 3, and 5. The cluster heads, nodes 1, 3, and 5, are where the patient group's data was sent.

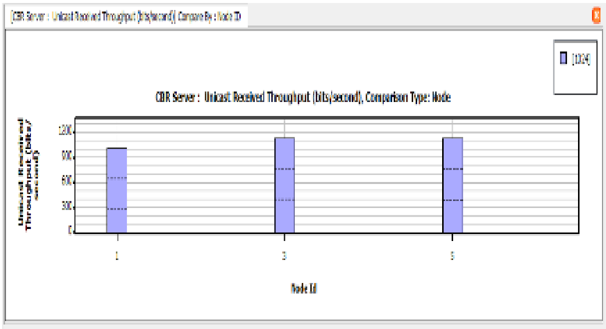

Fig. 8: Average Throughput

The unicast throughput at nodes 1, 3, and 5 that is received at the receiver is shown in bits/sec in figure 8 above. The cluster heads, Nodes 1, 3, and 5, receive data from the patients. And the graph above displays the information that was received. Throughput, which is expressed in bits per second, is the volume of data that can be successfully sent from one node to another in a given amount of time.

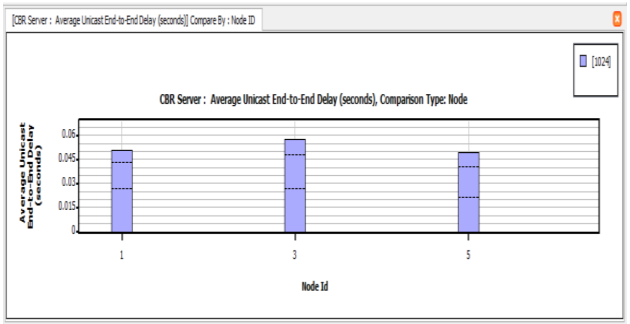

Fig. 9: Average Delay

The average unicast end-to-end delay in figure 9 depicts the amount of time that the simulation process took to send data. Due to the fact that delays only occur between 0 and 0.06, they vary in every node and are caused by the variation in packet sizes. The cluster heads where delay occurs are nodes 1, 3, and 5.

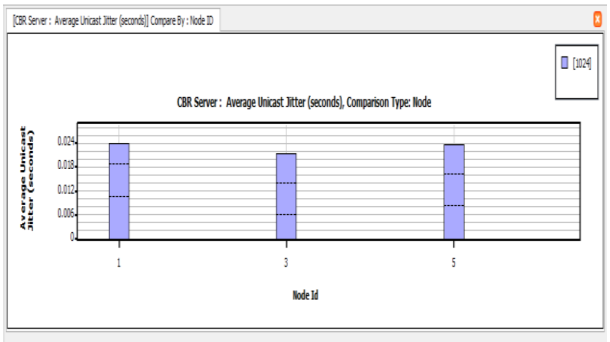

Fig. 10: Average Jitter.

The average unicast jitter is depicted in figure 10 above. The transmission delay between the current packet and the previous packet is known as jitter. Average jitter is calculated by multiplying the total number of nodes by the jitter. Low average jitter improves network performance.

Figure 11 represents the total packets dropped at MAC (Media Access Control) Layer.

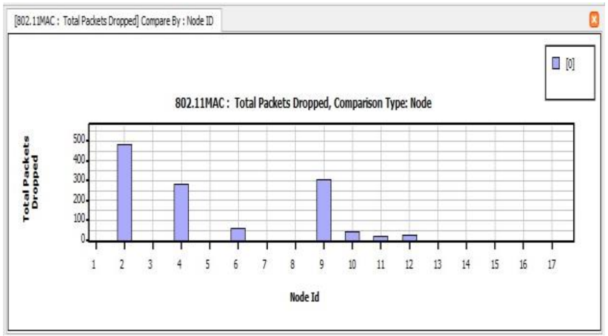

Fig. 11: Total Packet Drop

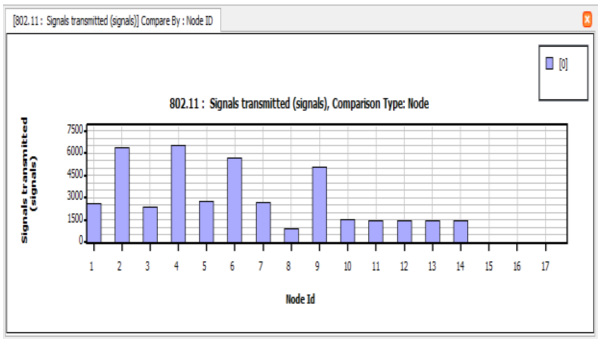

Fig. 12: Signals Transmitted.

The signals sent at the physical layer are shown in Figure 12. Data from the MAC layer is received and converted by the physical layer into signals or binary data before being transmitted through wireless media.

C. Storing Result on Cloud Storage

Qualnet Software provides us with data or results that are kept in the cloud. We can use any of the several cloud storage service providers, including Microsoft Azure, AWS S3, Google Cloud Storage, Google Drive, etc., to store the results. Hospitals employ all of these cloud services in the real world to store patient data and enable anytime, anywhere access.

Google Cloud Platform is being used as cloud storage in Figure 13. First, enter your username and password to access the cloud console. then perform a cloud storage search and construct a bucket to store the simulation's outcome. The gadget will store the result under the name we specify in the software.

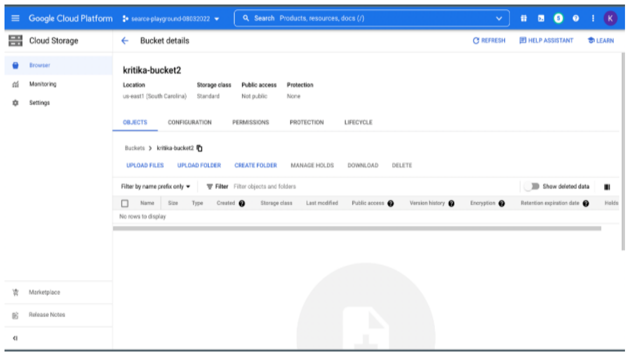

Fig. 13: Bucket created

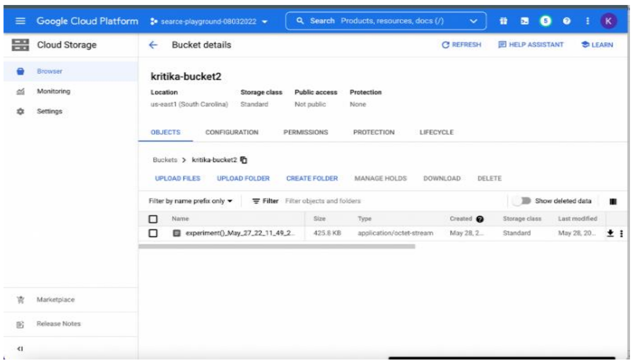

Fig. 14: Cloud Storage Data

Figure 14 shows how to manually upload a file to the cloud; however, you could alternatively do this by developing a script or piece of code. Small healthcare clinics and multispecialty hospitals might pay for cloud services in a manner akin to paying for Internet service because the uploaded data will be stored in the cloud where it will be accessible.

VI. CONCLUSION

Cloud computing and wireless body sensor network integration it can be said that the patient can be uniquely identified by the sensing network. Along with locating the patient in the network and keeping track of their condition, there is also data acquired from the patient. It is suggested to keep patient data on the cloud, which relies on pay-per-use services. Almost like paying for internet service, this enables tiny healthcare clinics to multi-specialty hospitals to pay per (cloud) service. The suggested WSN cloud computing framework will be the best method for managing users, controlling access, and managing storage.

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