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CHAPTER 1

NOVEL APPROACH FOR PREDICTING COVID-19

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The COVID-19 pandemic took everyone off surprise throughout the world. More than 3 million fatalities have resulted from the more than 150 million cases that have been documented. Although these numbers are alarming, it's conceivable that there are more occurrences than these data indicate. We must first comprehend the idea of "Percent Positive," also described as the "Positive Rate," in reference to COVID19 diagnostic tests before we can fully comprehend the term. The proportion of COVID-19 diagnostic tests that are positive out of all the tests done in a relatively short period of time is known as the Percent Positive (PP) (e.g., weekly)[1]. A high PP may be interpreted in one of two ways: either it suggests that human transmission rates are high or that further testing are required by the government municipalities. A lower PP indicates a lower population-wide transmission rate. Transmission rate and PP go hand in hand, presuming that preventive solutions for reducing spread are already being implemented, because as governments expand their testing capacity in an effort to reduce the PP, more data on the pandemic's spread become available, supplying the knowledge required to implement of such interventions[2], [3]. A PP of less than 5.0% should be attained, according to the World Health Organization, in order to stop the pandemic from spreading. One may argue that thorough COVID-19 testing, together with other steps, could result in a decrease in the virus that spreads COVID-19 sickness (SARS-CoV-2)[4].

The World Health Organization (WHO) Country Office in China received the first report of an unidentified etiology pneumonia that was found in Wuhan, China, on December 31, 2019. Since then, both the fatality rate and the number of corona virus infections have risen. The Corona virus to spread from one location to the whole nation in under 30 days. On February 11th, the World Health Organization classified it as COVID-19 (WHO).A significant number of individuals lose their lives to the deadly illness Covid-19 each day. The whole world has been impacted by this viral illness, not just one particular nation. In the last ten years, a number of viruses including SARS, MERS, the flu, and others have appeared, although they only survive a few days or months. Despite the fact that many researchers are working on these viruses, few of them are diagnosed since there aren't enough immunizations to protect against them (i.e., Scientists or researchers). The Covid-19 disease is presently spreading around the globe[5].

On January 30, 2020, three Indian graduate practitioners who had just returned from Wuhan, the pandemic's birthplace, were found to have the first cases of COVID-19 in India. Kerala declared a state of emergency on March 23, and the rest of the nation did the same on March 25. On June 10, India's recoveries for the first time outnumbered its current cases. Both the number of new as well as active cases and infection rates started to drop in September. Instances peaked daily at over 90,000 in mid-September before falling to around 15,000 in January 2021. A second wave that started in March 2021 was even more destructive than the first, resulting in shortages of medical supplies including oxygen tanks, hospital beds, and vaccines in several areas of the nation. India has overtaken the United States in terms of new cases that were still active by the

end of April. On April 30, 2021, it was the first nation to record more than 400,000 new cases in a 24-hour period. Experts predict that the virus may spread across India rather than completely vanishing. At late August 2021, S. Swaminathan said that India may be in an endemic stage, when the nation is becoming used to living with the virus. India only has 22,487 incidents countrywide as of March 2022. The post-pandemic responsiveness has been steady, with 58.8% of the community completely immunization and 70% receiving at least one dose. Victims of the rare coronavirus illness first developed a throat infection before developing respiratory problems. Nobody can thwart the covid-19 sickness since it is a sleeping enemy. To protect healthy people, Covid-19 infected people must be separated, go through thorough screening, and adopt the necessary safety measures. Due to the fact that COVID-19 transmits from person to person and follows a chain-like process after coming into touch with an infected individual, artificial intelligence-based technological gadgets may assist stop the virus from spreading. As the function of healthcare medical researchers has expanded, electronic personal health data has become increasingly widespread[6]. Electronic health data are becoming more widely available, which presents a tremendous potential for research and real-world applications to enhance treatment. Machine learning algorithms may be trained with this data to enable them make better predictions about diseases.

Problem Definition

Medical systems throughout the globe continue to face a variety of issues as a result of this pandemic, including an increase in the need for hospital beds, a severe lack of medical equipment, and the infection of several healthcare workers. Making rapid clinical decisions and using medical resources effectively are thus crucial. Nucleoside polymerase chain reaction (RT-PCR), the most often used COVID-19 diagnostic test, has long been in low supply in impoverished countries. As a result, infection rates rise and important safety precautions are put off. In this paper, we provide a machine-learning algorithm that, by posing a few straightforward clinical concerns, forecasts a positive RT-PCR result for SARS-CoV-2 infection. All SARS-CoV-2 testing conducted in Israel during the early months of the COVID-19 epidemic was utilized to train the model. Our strategy's objective is to be implemented globally in order to priorities testing in the general population and conduct efficient viral screening[7].

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CHAPTER 2

REQUIREMENTS FOR PREDICTING COVID-19

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Functional Requirements

The functional requirements of this system include allowing the user to get a probability prediction value of being diagnosed with covid-19 by answering the basic questions asked related to their health which is then served as a request to the flask server which then handles the query, the user can also go back and try out again as well. To know about the virus and prevention users can also navigate to different pages available in the interface (web page) to detail information[1].

Non-Functional Requirements

Non-functional requirements of the project are as follows:

Performance

The amount of the dataset and processing capacity affect the performance of this prediction system. The system makes good use of resources including memory, CPU, and storage. Using Google Collab (Google Collaborative Projects), you can get a powerful memory-based GPU that can handle a lot of Python code[2].

Scalability

Healthcare is a business that provides treatment to millions of people while maintaining high standards of quality, value, and outcome. Specialists can design models to give smart healthcare using technology-enabled healthcare. Machine learning and its applications are gradually gaining traction in the healthcare industry[3]–[5]. It has the power to examine data and can influence it in the same manner as clinicians do.The system calculates the likelihood of the user getting diagnosed with Covid-19, as well as information on the virus and how to avoid it. Although researchers are still working on virus early detection in humans, the prospect of machine learning replacing rt-pcr for this virus shortly appears to be promising[6].

Usability

Diagnostics is one of the most common uses of machine learning in healthcare, as it provides a variety of approaches and strategies that can aid in the diagnosis of medical problems. When successfully implemented, machine learning technologies can aid with integration.

Computer systems in the healthcare environment improve the efficiency and quality of medical care by assisting medical experts in their work. As a result, anyone can use this system. The user can then answer health-related questions to obtain the probability value. The method can also be used to raise public awareness about the infection and how to avoid it.

Interoperability

The system is built by importing various packages of python which includes sklearn, pandas, matplotlib, NumPy, re, seaborn and many more.

Availability

The open-source community has made significant contributions to the identification of this virus through a variety of methods. Since COVID-19 can be transmitted through proximity to affected individuals, public health officials have identified contact tracing as a valuable tool to help contain its spread. Many healthcare industries in this market have done some great research tech giants have also taken a step in understanding.

Around the world, several major public health authorities, institutions, and non-governmental organizations have been working hard to create opt-in contact tracing technology.

To help with contact tracing, Apple and Google will release a comprehensive solution that incorporates application programming interfaces (APIs) and operating system-level technology. Given the pressing requirement, the solution will be implemented in two stages, with robust user privacy measures in place.

Machine Learning

Machine Learning (ML) emerged from the field of Artificial Intelligence, which is a branch of computer science. Machine Learning (ML) is a multidisciplinary topic that combines statistics and computer science techniques to perform prediction and classification assessments.Machine learning is a branch of computer science that deals with programming systems such that they may learn and improve on their own.

Learning here refers to identifying and comprehending the input data as well as making informed decisions based on the information provided. It is quite difficult to examine all possible inputs while making decisions. Algorithms that apply the principles of statistical science, probability, logic, mathematical optimization, reinforcement learning, and control theory to construct knowledge from specific data and experience are developed to solve this challenge[7].

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CHAPTER 3

MACHINE LEARNING ALGORITHM

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The initial stage in machine learning is feeding the machine learning model into the selected algorithm. Training data must be either known or unknown to build the finished machine-learning algorithm. The kind of training data utilised has an impact on the algorithm. The Machine Learning algorithm receives fresh input data to test its functionality[1]–[3]. The forecast and outcomes are then verified twice. The algorithm is repeatedly retrained until the desired outcome is attained if the projection does not pan out as predicted[4].

Types of Machine Learning

Machine learning is classified into four types (Figure 1). They are:

1. Supervised Learning
2. Unsupervised Learning
3. Reinforcement Learning

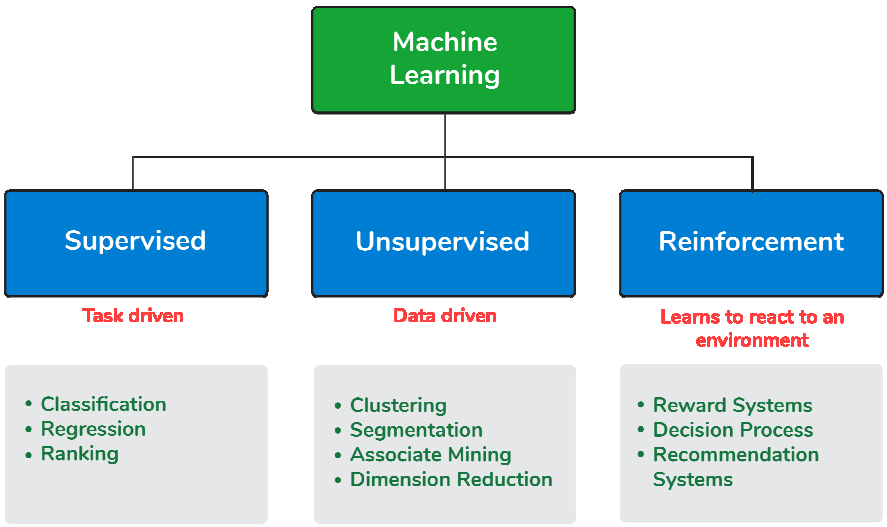

Figure 1: Illustrated the Types of Machine Learning.

i. Supervised Learning:

A pre-labelled set of input variables that is training data and target data make up supervised learning. The input variables are used to build a mapping function that maps inputs to a fuzzy inference system[5]. It is divided into two groups called algorithms:

- Classification
- Regression

ii. Unsupervised Learning:

Unsupervised learning is a method of machine learning where the model doesn't need supervision. Let the model work out what it requires to understand on its own instead. Mostly, it is focused on unlabeled data[6]. It is divided into two groups called algorithms:

- Clustering
- Association

iii. Reinforcement Learning:

The practice of acting appropriately to maximize reward in a particular scenario is known as reinforcement learning. Different computer programmers and software utilized it to choose the most practical course of action in a particular circumstance. In contrast to supervised learning, where the solution key is part of the training data and allows the model to be taught with the right response, reinforcement learning relies on the reinforcement agent to choose the best course of action. In the presence of a training dataset, it must learn from its experience. The computer has been designed to link a certain action with a particular choice. Reward or responses Signals are therefore generated. The system educated itself to choose the most rewarding actions using experience by encouraging and punishing itself[7].

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CHAPTER 4

ENVIRONMENT OF SOFTWARE

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PYTHON

Python is a high-level, object-oriented, interpretive, and multipurpose programming language. It was created between 1985 and 1990 by Guido van Rossum. The goal of the Python language is to be very intelligible. It has fewer syntactical features than other languages, and it often substitutes English terminology for punctuation (Figure 1). Python is a superb language for automation and speedy enterprise applications across a broad variety of platforms because of its lovely syntax, dynamic typing, and interpreted nature[1]–[3]. The Python interpreter may easily accept new C or C++ functions and data types. Python may also be used as a bespoke programming extension language[4].

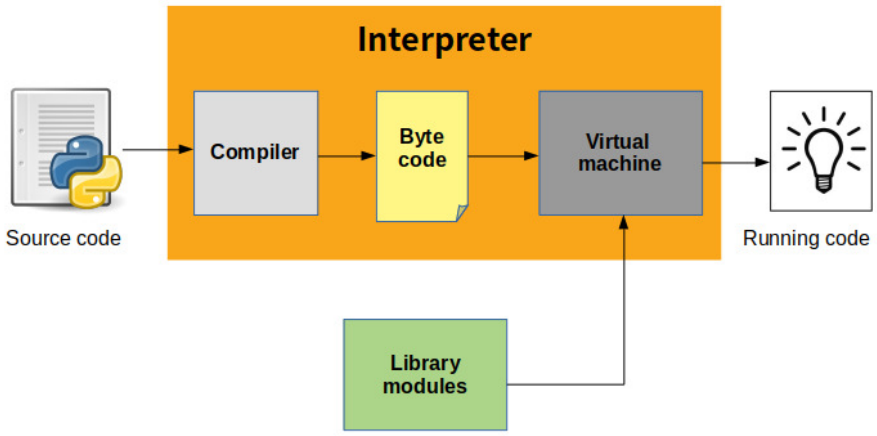

Figure 1: Illustrated the Python Program Execution Process[5]**.**

Applications of Python

- Easy to read, learn and maintain
- Portable
- Extendable
- GUI Programming
- Scalable

Python Packages

A directory of Python files plus a file called _init.py makes up a package (Figure 2). This means that any directory within the Python path that has a file with the name _init.py will be treated as a package by Python. A Package may be created by combining many modules[6].

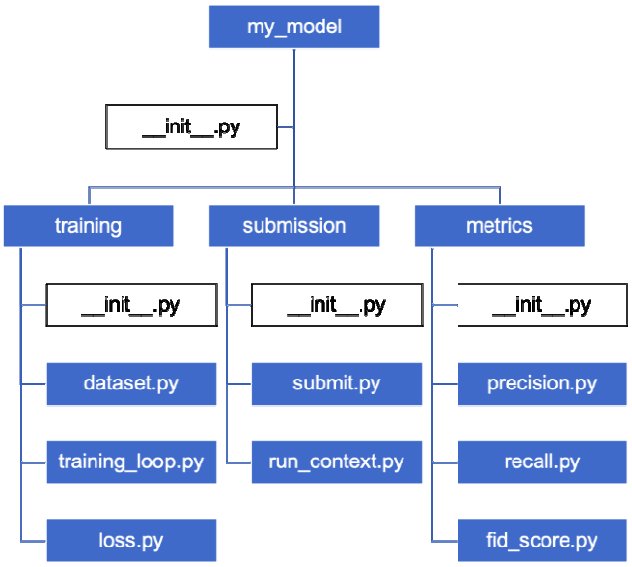

Figure 2: Illustrated the Python Packages.

Python Libraries

The best possible code solutions must be created in a well-structured and well-tested atmosphere for ML and AI algorithms to work. Python machine-learning libraries are widely accessible to help reduce the amount of time spent on development.

A Python library sometimes referred to as a framework, is pre-made software that may be used for important computational tasks[7]. The top Python machine-learning libraries are as follows:

A. Scikit learn python

B. NumPy Python

C. Python Pandas

D. Matplotlib

E. Seaborn

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CHAPTER 5

CLASSIFICATION OF PYTHON

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Tkinter

Python's default GUI library is Tkinter. It is fast and easy to generate graphical user interfaces when Python is combined with Tkinter[1]–[3]. Tkinter is a powerful object-oriented connector that is part of the Tk GUI toolkit. It's simple to figure out a GUI application using Tkinter[3]. All you have to do is completely out the below actions:

- Import the module for Tkinter.
- Build the GUI program's primary window.
- Include a widget from the list above in the GUI application.
- Step into the main event loop to respond to each user-triggered event.

Matplotlib

In conjunction with NumPy, the Python expansion for numerical mathematics, Matplotlib is a graphing library available in Python. It offers an object-oriented API for incorporating charts into Tkinter, wx-Python, and GTK+ programmes. Another procedural "pylab" interface intended to resemble MATLAB and based on a state machine (similar to OpenGL) exists, although it is not advised [4]. Matplotlib is used by SciPy. E.g. import matplotlib.pyplot.

Pandas

Pandas is a set of tools for Python programmers to organize and analyse data. In particular, it represents the data structures and techniques for interacting with response variables and mathematical tables like importing pandas.

Scikit Learn

A free Python machine learning framework is called Scikit-learn (formerly known as scikit.learn and even sometimes referred to as sklearn).

It is intended to communicate with the Python numerical and scientific libraries NumPy and SciPy, and features support vector machines, random forests, gradient boosting, k-means, and DBSCAN, among other classification, regression, and clustering algorithms. E.g. import sklearn[5].

Numpy

NumPy is a Python module that stands for "Numerical Python." A powerful n-dimensional array object as well as tools for integrating C, C++, and other languages are contained within this fundamental package for computer programming. Along with other things, it's helpful in random number generation and linear algebra like installing numpy.

Seaborn

For plotting graphs and charts, Seaborn is a superb Python powerful application. Statistical charts appear nicer because of the attractive default styles and colour schemes that have been added. It has a matplotlib software underpinning and is closely connected to panda's data structures. Making visualizations a crucial component of data exploration and consumption is the aim of Seaborn. For a deeper understanding of the data, it provides dataset-oriented APIs that let us switch between the many pictorial representations for the same variables.E.g. import seaborn.

Html/CSS

The language used to represent the organization of Web pages is called HTML. Authors have always had the ability to:

- Post headers, text, tables, lists, images, etc. in web documents.
- Click a button to immediately access internet material through hypertext links.
- Create forms that will be used for transacting with distant services, for example when making purchases, making bookings, or searching for data.
- Directly merge spreadsheets, audio, video, and other apps into existing papers.

Markup is a language used only by authors to specify the HTML page structure. Types of content such as "paragraph," "list," "table," and others are designated by language components.Colours, layout, and typography are all described in CSS, a language used to describe how computers are displayed. It allows the presentations to be modified for various device types, such as gigantic monitors, tiny screens, or printers. CSS is independent of HTML and is compatible with any XML-based markup language. It is easier to administer websites, exchange style sheets throughout pages, and modify pages for various scenarios thanks to the isolation of HTML and CSS. [6].

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CHAPTER 6

ACUTE SEVERE RESPIRATORY SYNDROME CORONAVIRUS 2

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The acute severe respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection that is the source of the continuing epidemic of coronavirus illness (COVID-19) was first discovered in December 2019 in Wuhan City, Hubei Province, China. Since then, the illness has been an area for the primary purpose around the world, infecting more than 22, 00,000 people and claiming more than 1, 53,000 lives. According to studies, close encounters and respiratory droplets are the major methods of transmission. The virus may remain on the surface for 72 hours, making the infected surface a potential source of transmission. Fever (88.1%), dry cough (68.1%), exhaustion (39%), shortness of breath (19.0%), sputum production (32.9%), persistent chest pain, headache (14%), sore throat (13.9%), chills (11%), nasal congestion (4.9%), nausea (5%), diarrhoea (4%), hemoptysis (0.9%), and pink eyes and lips (0.8%) are just a few of the symptoms experienced by those who have the virus[1].

A COVID-19 infection often emerges as signs and symptoms 5–6 days after the infection. The expected period from the onset of the first COVID-19 symptom to death is 41 days. Compared to patients below the age of 70, the range is smaller for those over 70. Patients with COVID-19 and those who have the SARS-CoV virus have several symptoms[2]–[4]. People with COVID-19 infections may exhibit a few minor illnesses, such as the common cold, fever, and dry cough that are linked to SARS-CoV. These patients often heal in two weeks. However, COVID-19 targets the lower airway when upper respiratory disorders including rhinorrhea, sneezing, and sore throat occur[5].

Additionally, individuals with COVID-19 infection had certain gastrointestinal symptoms, such as diarrhoea, but MERS-CoV or SARS-CoV patients did not experience these symptoms to the same degree. COVID-19's seriousness varies. High respiratory recurrence may take three to six weeks to recover from in those with serious conditions like dyspnea. Numerous COVID-19 fatalities advanced to the critical stage, which is marked by multiple organ failure, septic shock, and respiratory failure. According to studies, COVID-19 infections are more likely to occur in persons with underlying diseases including cardiovascular disease and hypertension. The National Health Commission of China (NHC) notes that of the verified COVID-19 cases, several patients first displayed chest tightness and palpitations. According to the NHC study, 11.8% of the patients who passed away had severe heart damage and high rates of cardiac arrest while being treated at the hospital[6].

In COVID-19 individuals, the frequency of cardiovascular symptoms is rather significant, which encourages the occurrence of an immune system issue as the illness progresses. Another study found that 173 individuals had severe illnesses with comorbidities of hypertension of 1099 patients with laboratory-confirmed COVID-19 cases that were collected from 552 hospitals and 30 provinces, autonomous provinces, and boroughs in mainland China. The two most prevalent symptoms were found to be fever 43.8% upon admission and 88.7% while in the hospital and

cough (67.8%). The severity of the symptoms was rated as moderate, severe, or critical, according to China CDC Weekly. In severe and critical cases, the patient's breathing volumes of more than 30 per minute, blood oxygen saturation below 93%, respiratory failure, and septic shock were all noted. Clinical digenesis of the infected patients was done based on the symptoms and exposure. Confirmed instances were identified using throat-swab samples. The preferred technique of diagnosis has been real-time reverse transcription polymerase chain reaction using samples from the patient's upper respiratory tract taken from a throat swab. The severity of the disease cannot, however, be predicted from the early and mid-period symptoms alone[7].

It is impossible to accurately diagnose an infection based on a small number of symptoms since the illness is unpredictable and the virus is constantly developing. Our suggested approach uses a specially developed collection of symptoms based on their frequency and intensity to try to predict COVID-19.

The main characteristics of the feature set lean the prediction in the direction of a certain class. Three categories not infected, somewhat infected, and seriously infected have been established for the prediction. Only a small number of the symptoms associated with COVID-19 instances have been picked. Fever, respiration rate, and cough are among the symptoms that 90% of confirmed cases have in common. Furthermore, the studies cited in the preceding sentence support our decision to include acute respiratory syndromes, hypertension, cardiac conditions, and chest discomfort as attributes in the dataset. To categorise the characteristics or symptoms into the aforementioned classifications, we use the support vector machine (SVM) classifier.

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CHAPTER 7

INTRODUCTION TO BLOCKCHAIN TECHNOLOGY

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Blockchain

The public record of every Bitcoin transaction that has ever taken place is kept on the blockchain. As fresh blocks are added by miners to it to record the much more recent transactions, it is continually evolving. In chronological sequence, blocks are added to the blockchain. The blockchain is downloaded automatically when a miner joins the Bitcoin network and is recorded on each node, or each PC connected to the Bitcoin network using an application that verifies transactions[1]–[3]. From the very first transaction, known as the genesis block, through the most recent updated block, the blockchain contains complete information about addresses and balances. For example, we may check into our cryptocurrency wallet to discover the exchanges in which we obtained the first Bitcoin. The blockchain suggests that it does not difficult to search any block investigator for transactions linked with a certain Bitcoin address. As a result, it is a single connected network that consists of a block with a few exchanges in each block. It creates assets, provides a decentralized, permanent data recording facility that can be used by a group of customers inside an organization, and functions as a shared ledger that records all transactions[4].

Every transaction may be questioned, while also controlling the confidence of all users. The data remains in a database, database for the duration of the network since the blockchain is forever. It started with the study paper released in 2008 under the pseudonym "Satoshi Nakamoto" to delve more into the historical context of Bitcoin. It resembles an academic article in appearance and was sent over a mailing list for cryptography. The original idea behind Bitcoin was to provide an instalment transaction system that allowed for electronic transactions while still sharing features with real money. The agribusiness industry may transparently process transactions without the need for a middleman thanks to blockchain technology. This breakthrough improves how confidence is given by eliminating the requirement for the local authority; rather than trusting an intermediary, trust is placed in cryptography. It helps to rebuild confidence between both farmers and consumers, which may lower market exchange prices[5].

Significance

Blockchain technology may provide proper solutions for many aspects of these problems:

i. *Information Security:*By offering private key encryption, a potent instrument that authenticates requirements, blockchain technology may securely connect all phases of harvesting crops and some other agricultural goods[6].

ii. *Supply Chain Management:*By reducing the cost of each entity's communication, blockchain technology is significantly more efficient than traditional systems in enabling the supply chain. These supply chain nodes potentially the farmer, the location where the crop was grown, the transportation firm, and the miller's warehouse represent a block of data whose specifics are regularly updated in the system.

iii. *Consumer Confidence:*Decentralized time stamping is used in the blockchain's accounting system to ensure that the data saved cannot be altered under any circumstances and is always visible. This gives customers the assurance they need that their transactions will be free of fraud[7].

iv. *Reduce the Cost of Farmers:*Becausemany agricultural goods are produced by families, this Blockchain technology may save transaction costs. Traditional e-commerce does not want to serve them because of the low transaction volume and tiny size, which keeps these players out of the market.

Platforms, Tools and Use Cases

Blockchain offers assurance as a means of handling the development of frameworks for certain applications in online security. Information and authority may be shared in Blockchain-based frameworks, and simple and reliable trade records can be created. While many of the prospective applications have complicated security requirements, several of the important advantages of Blockchain for online protection applications struggle with security features. Although solutions for enabling groups to engage in a pseudonymous manner and confidential Blockchains have been described, it is still unclear whether these approaches are appropriate for specific applications[8].

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CHAPTER 8

BLOCKCHAIN HYPER-LEDGER SAWTOOTH

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It demonstrates a collaborative technique where two distinct folds are shown to cover certain areas with different purposes. The goal of a metaheuristic-powered algorithm is to gather information about routine agricultural operations to predict prices and verify those prices over time. The blockchain hyper-ledger sawtooth demonstrates modular innovation, providing a secure route for partner communication, and a private organization, protecting the forecasting record, adding and updating equipment costs, and storing farming data and node transactions in the immutable ledger[1]. To do this, we configure, design, and implement two specific contracts to include the system's real stakeholders and take into account the growth of exchanges and transactions. While storing specific addresses in its system storage, another intelligent agreement updates the estimated product evaluation record and distributes it to the partners. The recommended cooperative methodology's findings point to an accurate cost estimate for agriculture items with a 95.3% accuracy rate.

The architecture of Blockchain Hyperledger Sawtooth

This architecture establishes the overall scenario of information recorded in the process operation environment and began forecasting with parallel processing, information management, organization, and monitoring of the protected ledger using genetic algorithms with metaheuristic support as well as linear and logistic methods based on regression, as shown in Figure 1 [2].

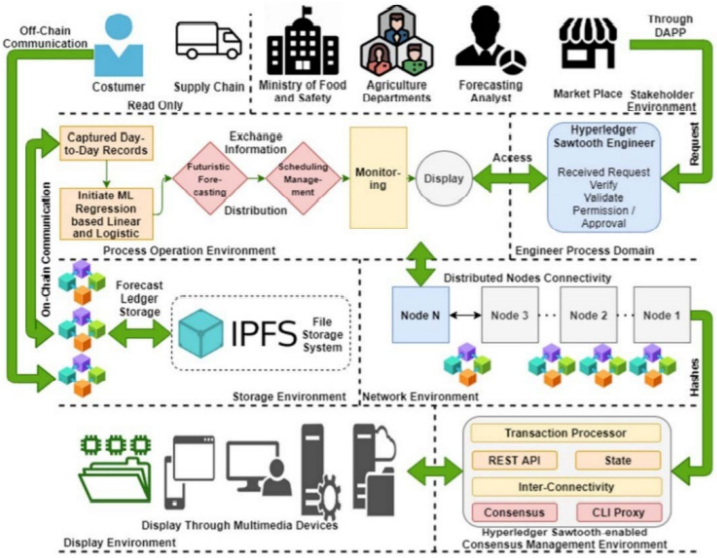

Figure 1: Illustrated the BlockchainHyperledgerSawtooth Architecture[3]**.**

It talks about the difficulties in predicting the prices of agricultural commodities and issues with privacy and security. We looked at several methods, tools, and procedures, as well as different sorts of answers to pertinent difficulties, but we were unable to identify a single method that could complete the whole work at once. To analyse the regular operations of commodities forecasting, scheduling, and management as well as ledger protection and preservation, a collaborative strategy was thus developed[4], [5]. The suggested system's collaborative nature depends on two distinct folds, including metaheuristics and blockchain technology for distributed ledgers. Utilizing the Hyper Ledger Sawtooth, which offers more transparent, reliable performance in data collection, assessment, analysis, scheduling, prediction, management, supervising, and preservation on the private network, transactions are delivered on the private network more efficiently with a higher rate of transparency. As a result, we have also offered answers to well-known problems that come up when using the suggested collaborative metaheuristic blockchain technique. Our next study will be primarily focused on the deployment of new difficulties[6].

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CHAPTER 9

BLOCKCHAIN BASED IOT SYSTEM FOR AGRICULTURE

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It is suggested to create a new blockchain-based IoT system to monitor the status of agricultural items. All SCM intermediates may see the location of the products and when they can be delivered since the status is updated on the blockchain. Values saved in the Blockchain cannot be changed by anybody since the records kept there are immutable. However, any SCM employee has access to the records[1]–[4]. This process may be expanded in the future to include different schemes. Utilizing blockchain and IoT requires a certain amount of upfront investment. Farmers should take the initiative to use these types of new technology in the agricultural sector to enhance their quality of life, or the government may do so.[5].

Suggested System

The central government's department of agriculture, cooperation, and farmer welfare develop several programs for farmers. But a very important issue is whether these advantages reach the intended recipient. Farmers depend on government officials' assistance at every point in the supply chain. Even though several people have been hired at various levels to keep an eye on the situation, the problem persists. In this research, a blockchain-based approach to tracking the products is suggested. Figure 1 illustrates the suggested model's process.

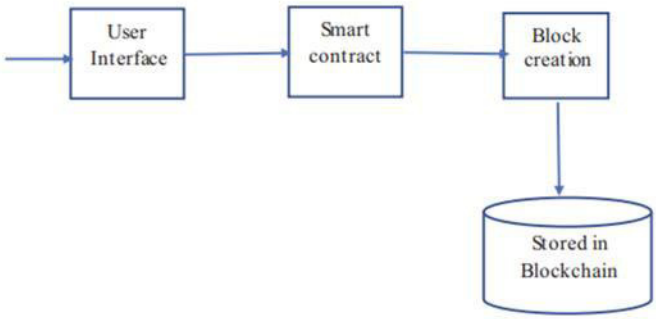

Figure 1: Display the Block diagram of Blockchain Technology for SCM[6]**.**

When farm products are transported from a farmer's location, all relevant information is measured and stored in the Blockchain, including the quantity, state of the products/quality, size, colour, defect-free status, natural/manure-free/organic status, time of cultivation, humidity, current market price, etc. A form is used to gather information about the commodities mentioned above. Using the criteria outlined in the smart contract, the data acquired via this form is verified. Normally, the quality and condition of the items must be confirmed before shipping them.

When the smart contract determines that the parameters collected via the user interface are accurate, a new transaction is started. The produced transaction is eventually included in a block via the mining process. As a result, the information about the products is now kept in a Blockchain-based immutable ledger.[7].The state of the items within the container is often determined by variables including temperature, humidity, and the presence of certain chemicals. As a result, the suggested system uses the following sensors: gas sensor, humidity sensor, and temperature sensor. Mold may sometimes develop on the outer layer of fruits and vegetables as a result of unfavourable temperatures. The gas sensor assists in locating the gas produced by this mound. The state of the agricultural items is measured at each step of SCM and stored in the Blockchain with the aid of sensors installed in the storage facility and vehicle. As a result, at different points throughout the supply chain, both farmers and customers may be informedabout the state of the items. Every time the market price changes, the integrated software compares it to the price recorded in the blockchain and the current market price. When necessary, the smart contract's software agent incorporates the current market price into the blockchainto validate this requirement [8]. Once the input parameters are verified, a transaction will be created.

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CHAPTER 10

INTRODUCTION TO BIGCHAINDB SUPPLY CHAIN MANAGEMENT (SCM)

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In recent years, attempts have been made to advance Supply Chain Management (SCM) and traceability of control in many contemporary industries. For instance, one of the biggest challenges in the agricultural industry is figuring out where the product is at any given time and where it will be in the future. The problem is that, like other systems, this one suffers from data centralization and trust concerns brought on by interactions with humans.In light of this issue of lack of confidence, a stage employing a data set and Blockchain technology is recommended. The major goal of this platform is to provide a solution for agricultural SCM and control through the internet using the Colombian farming negotiation process as a study case (Figure 1) [1].

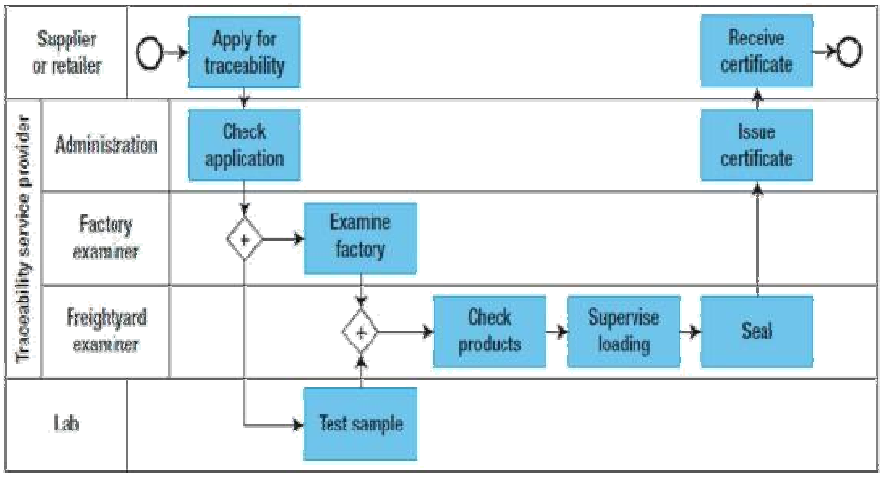

Figure 1: Illustrated that the supply chain using blockchain[2]**.**

A transaction-making or transaction-moving API is described by BigchainDB. Here, they employ resource and exchange IDs to represent the stored data with metadata. You may mark as invalid any fields that aren't being utilized in the current exchange. The design meaning of the application for the control of the agricultural products storage network will be created in the accompanying segment of stage engineering. As previously said, the project aims to develop a web platform that enables these things to be detectable using RFID labels for a better understanding of advances. The many levels include:

i. **Web Layer:**

In order to make the web layer more user-friendly, this layer will be constructed utilizing the Java Server Faces (JSF) web framework for Java and Prime Faces to show the platform and its interaction with the end user[3]–[5]. This layer will interface with the intermediary layer, which houses the business logic for storage and event processing, using RESTFUL services [6].

ii. **Backend Layer:**

The application layer will interface with the storage layer to handle transactions and house the logic for reading RFID tags. It features SQL CRUD operations and Blockchain[7].

iii. **Storage Layer:**

- Database: Two databases make up this layer. To assure the immutability of the application audit, we chose BigchainDB for the first option, a NoSQL database that would enable us to record platform transactions in Blockchain.
- The second is a SQL relational database that will hold the fundamental data necessary for the functioning of the web layer's events and actions, such as pointers to transaction blocks, pointers to users' registrations, etc.

iv. **Authentication Layer:**

A verification system is needed to utilise this platform, and developing such a framework would take a lot of work given how it was intended to be used from the start. In this instance, the web layer will be verified using the Azure Active Directory.

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CHAPTER 11

BLOCKCHAIN-BASED FARMER'S CREDIT PROGRAMME FOR THE AGRICULTURAL SUPPLY CHAIN IN AGRICULTURE

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With the growth in its community, agribusiness is expanding quickly and becoming very complex, causing it to become an independent and linked system. This has an impact on how the product or food is produced, processed, and distributed via the market to the final customer. Perishable food goods may be delivered throughout the world at a reasonable price, and demand and supply are not restricted to a country or area. As a result, both the vendors and the customers are compelled to adopt new ideas and technological advancements. In addition to meeting customer needs, vendors must also abide by government laws and regulations. The AFSC guarantees the viability of rural communities and the quality of service while also playing a crucial role in producers' and consumers' capacity to reach markets throughout the world[1].

The introduction of the Internet of Things (IoT) in agriculture has greatly boosted the sector. The process of Trans Emerging Tel Tech is automated in the manufacturing of Agricultural-Food using physical devices or sensor-based systems. Market expansion for incorporating blockchain technology into the process of harvesting, storing, preserving soil fertility, and all other crucial aspects of agricultural production (Figure 1).

Due to a lack of infrastructure and resources, these technologies have a limited number of viable applications in the conventional system[2]–[4]. Additionally, since there is a lack of confidence among the many stakeholders in conventional AFSCs, including farmers and distributors, frauds are more likely to occur. Additionally, owing to the dispersed ledger in conventional systems, centralized traceability of the route of agricultural food from raw to final goods is not feasible[5].

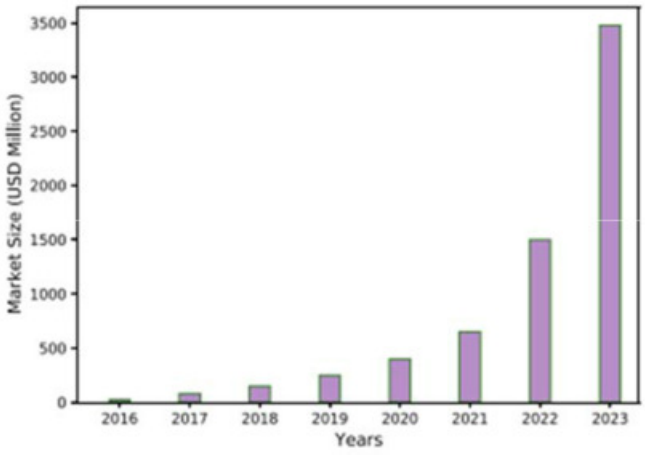

Figure 1: Illustrated the Market Growth of Blockchain using Supply Chain[6]**.**

Applications using distributed data are evolving thanks to blockchain (BC) innovation, which adds verification and trust among system stakeholders. This article suggests a framework, KRanTi, to advance the food production network by embedding it throughout the 5G network, which is inspired by the aforementioned situation. The 5G structure improves network efficiency to increase information availability. In KRanTi, a credit-based system is offered that enables linked farmers to purchase the necessary agricultural methods without the stress of moment instalment.

It is suggested to use a method of food quality assurance based on scores to guarantee perfect quality grading. The utilisation of Smart Contracts (SC) distributed across the Ethereum BC ensures trust, traceability, and transparency. The Inter-Planetary File System (IPFS), a standard architecture for accumulating information from all stakeholders, is used to provide the practical, affordable information storage service in AFSC. Results demonstrate how well the suggested KRanTi scheme has performed when compared to other established techniques, such as sub 1 millisecond latency, 99.99% dependability over LTE with 5G, flexibility, packet failure ratio, BC execution, cost-quality ratio, and information storage comparison[7].

System Model and Problem Formulation

The fundamental system flow of the suggested method is described in this part, which is followed by the formulation of the issue. Figure 2 shows the fundamental system flow of the suggested plan as well as the hierarchy of the AFSC stakeholder groups (Figure 2).

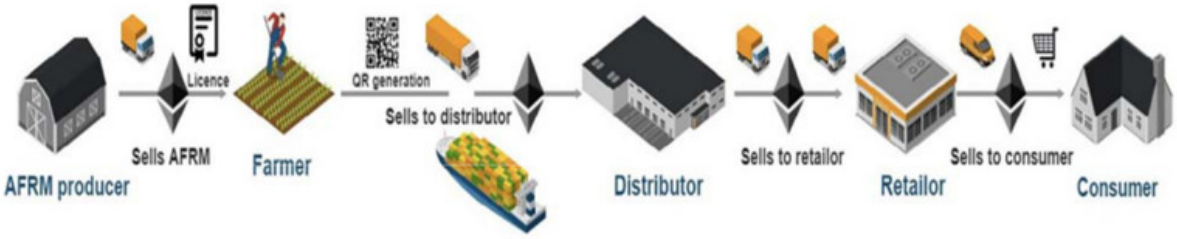

Figure 2: Illustrated that the AFSC System Model[8]**.**

We suggested KRanTi, a BC-based AFSC, which would assist society in resolving the issue of production tracking, AF efficiency, and enhances system sturdiness and stakeholder transparency. The stability of the AF is ensured by KRanTi using Ethereum BC to track stakeholder transactions and maintain track of the score given to each previous stakeholder. Additionally, KRanTi offers farmers a unique credit-based programme that allows them to save money for better AFRM products.

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CHAPTER 12

DESIGNING A SMART HONEY SUPPLY CHAIN FOR SUSTAINABLE DEVELOPMENT

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Intelligent agriculture systems can ensure food security at the point of production, combat fakes and mislabeled items, build confidence, and lower the cost of item difference. A smart production network might help elevate beekeepers out of poverty in the honey industry by improving market opportunities, increasing the value of their products, and reaffirming their role as vital contributors to sustainable agriculture. By doing this, the suggested approach improves biodiversity while reducing honey extortion, improving food security, and improving cleanliness. This article demonstrates how an open, image-based traceability system that is meant for sustainable progress may be created and used globally[1].

Traceability System

A detectability infrastructure that begins collecting data throughout the production process has the duty of first proving the honey is authentic and later on identifying contaminated honey[2]–[4]. This modification necessitates proving manufacturing cleanliness (volume and type), approving the chain of custody, and confirming the product at the final transaction (pollen signature). Each of these items needs a smart agriculture system for production, a smart consumer interface to assess the item's legitimacy, and a smart distribution system (Figure 1). It is shown how instant messaging, WhatsApp, WeChat, or any other specialised application may provide the information needed using open communication networks with verified customers and a mobile phone camera. Since the location (on the mobile phone) and customers are validated by the provider, these techniques are preferred over email or online submissions since they give more accountability.

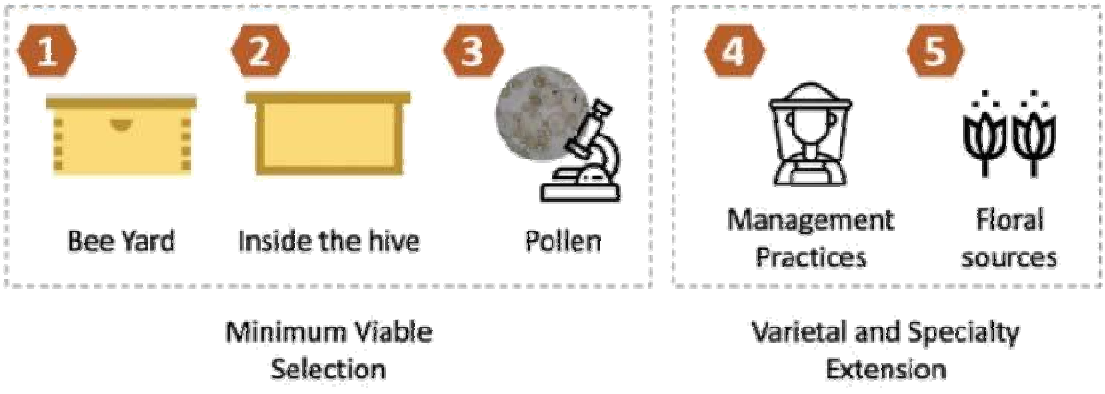

Figure 1: Display the Detectability Framework[3].

The beekeeper uses a trusted communication app to send a message to the system to join up. Their account details, camera data, the number of hives and fences they have, and what kind of beekeepers company are smallholder permanent, migratory, queen breeder, etc. are all logged as soon as the message is delivered. Then they are asked whether their honey has any unique characteristics, such as being a particular kind or raw, or if it has had only minimum processing, such as filtering as well as heating, and if these beehives are handled using any particular method, as mentin in Figure 2, such as least-toxic pest control or organic. Depending on the region and the original content, these answers may be written in any significant language[5].

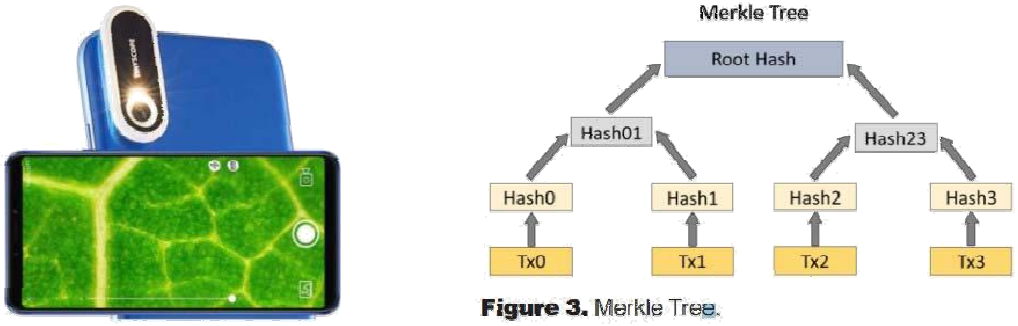

Figure 2:Represented theMarle Tree forSmart Honey Supply Chain.

Volume Verification

A system evaluates the beekeeper's stated quantity and kind of honey to see whether it makes sense in light of the data gathered. Checking the amount produced, reported varietals, and management measures taken are all part of the process. The location, local flora, time stamps, and internal hive photos gathered throughout the season serve as the main foundation for the volume verification. Actual volumes may be compared to a statistical range of predicted volumes using location data gleaned from the metadata of photographs. These volume checks include ensuring that the harvest volume per hive a) is consistent with historical averages for this area b) is consistent with what other beekeepers in similar climates reported for the same year, and c) is consistent with algorithmic projections of the maple syrup that could have been developed given known conditions in the ground, including proxies for hive health[6].

Chain of Custody

By boosting value congruence and trust19 and lowering the cost of product diversification, a traceability system may help open up higher-value markets. Increasing that confidence requires establishing a chain of custody system that guarantees the honey was not tampered with after leaving the apiary. The algorithm may be modified using data from hive measurements or bee counters to provide daily honey production rankings that are based on weight and take into account the influence of humans. Furthermore, the estimations may be changed up or down using historical data and the flying hours from previous years, which can be calculated retrospectively. When the temperature drops below 50 degrees Fahrenheit (10 degrees Celsius) and the bees use more energy, cluster hours may suffer as the system ages.

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CHAPTER 13

INTRODUCTION TO BLUETOOTH AND ZIGBEE PROTOCOL

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Today, a variety of various institutions and industries utilise the Internet for a broad range of diverse things, from personal usage for social networking and online browsing to use in the banking and equity markets sectors. In fact, there are billions of various types of gadgets connected to the Internet. Numerous categories of always-connected devices have emerged over the last several years, including smartphones, computers, smartwatches, and medical equipment. These are only a few examples of the various types of gadgets that make up the current global network. It is commonly understood that security will be crucial in allowing the majority of the Internet of Things applications planned (IoT). We should also keep in mind that the majority of these applications will make use of sensing and actuators that are integrated with both the Internet communications networks. Once these devices start supporting end-to-end communications with outside (Internet) hosts, they will be open to a variety of threats and attacks[1]–[4]. Due to this, we build and experimentally test the efficiency of anomaly-based intrusion detection inside an IDS architecture for the identification and avoidance of assaults in CoAP communication settings that are interconnected with the Internet. The security problem with wireless technology will become more significant as it becomes more widely used. Although the privacy and confidentiality concerns have been addressed by the existing security methods for wireless networks, unresolved vulnerabilities pose a danger to their accessibility and integrity (e.g., denial of service, session hijacking, and MAC address spoofing attacks, Blue bugging, BrakTooth).

ZigBee Protocol

The ZigBee Alliance unveiled the ZigBee wireless standard in 2004. It is based on the Wireless Personal Area Networks (WPAN) IEEE 802.15.4 specification. ZigBee is designed towards embedded systems and is often distinguished by very low energy consumption and low-rate transmission requirements. Stack protocol for ZigBee. With a transmission rate of up to 250 kbps and a uses a comprehensive of up to 1000 metres, this protocol may definitely reduce the frequency of replacement battery (up to 2 years). The Zigbee 3.0 protocol was created to transmit data through RF noise, which is often present in industrial and commercial applications. Version 3.0 improves on the last version. Zigbee standard however unifies the market-specific given specifications to enable any devices, regardless of their market classification and function, to also be wirelessly linked within the same network. A Zigbee 3.0 certificate program also assures the compatibility of goods made by various manufacturers. The complete Internet of Things is realized when Zigbee 3.0 networks are connected to the IP domains, enabling monitoring and management from gadgets like tablets and smartphones on a Local area Network (land, including that of the Internet.

Bluetooth Protocol

At a frequency of 2.45 GHz, Bluetooth enables wireless short-range communication between electrical devices. It is inexpensive, and even if the Bluetooth is disabled, a wire may be used in its stead[5]–[8]. It is possible to communicate if the two Bluetooth devices are within 50 metres of one another. Even if the Bluetooth range with mobile devices is only roughly 10 to 100 metres, the range may always be extended. The primary purpose of Bluetooth is to operate over and above other apps using protocol stacks (Figure 1).

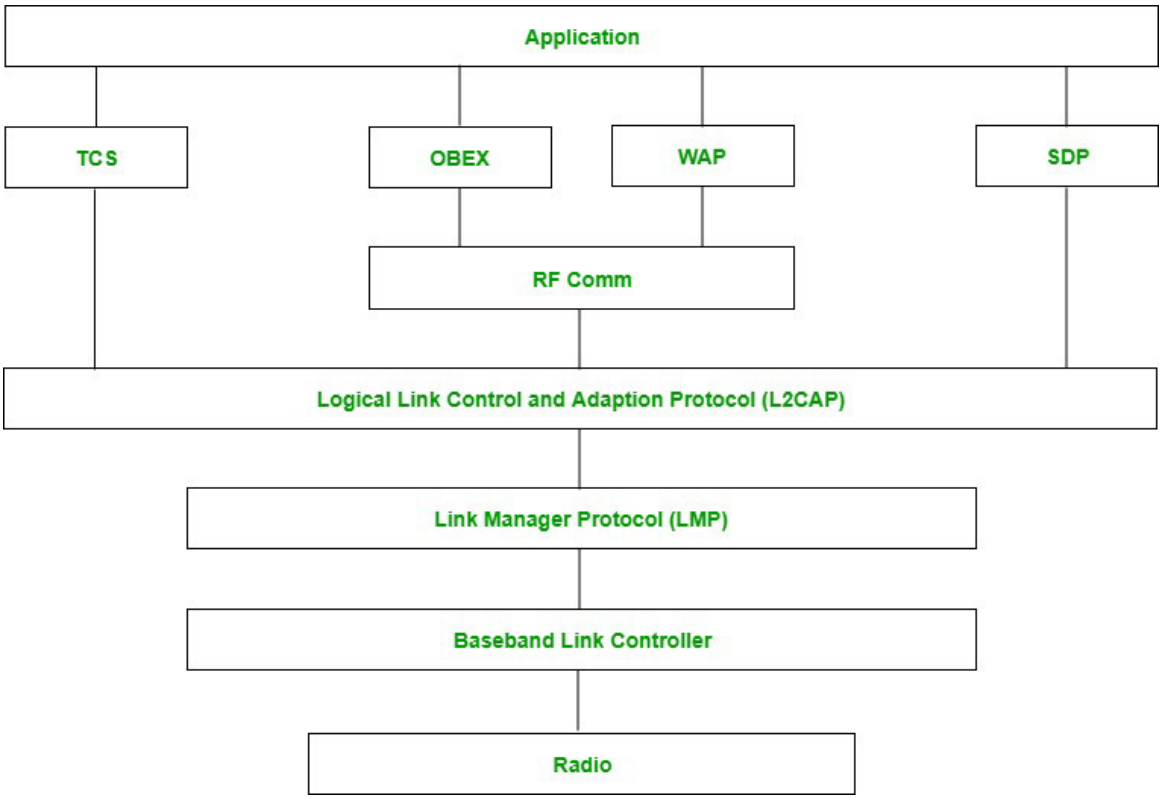

Figure 1: Illustrates the schematic diagram of Bluetooth protocol stacks[9]**.**

Bluetooth Architecture

The architecture of Bluetooth defines two types of networks:

Piconet

One main node, referred to as the master node, and seven active subsidiary nodes, referred to as slave nodes, make up the Piconet type of Bluetooth network. As a result, we can state that there are 8 active networks in total, all of which are located 10 metres apart. One-to-one or one-to-many communication between the principal and secondary nodes is possible. Slave-slave communications is not conceivable; only communication between the master as well as slave is potentially feasible. Additionally, it includes 255 secondary nodes that are in the parked condition and cannot participate in communication until they are switched towards the active state.

Scatternet

It is created by combining different piconets. A slave who is represented in one piconet might serve as the main or master in another. This particular node has the capability to receive a message from such a master inside one piconet and send it to its slave within the other piconet, in which it is operating as a slave. A bridge node is the name for this kind of node. In two piconets, a station can indeed be mastered.

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CHAPTER 14

FUNCTIONS OF THE CORE PROTOCOL

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To enable effective communication, protocol suites are collections of protocols that function at various tiers of the network architecture.The radio (RF) layer modifies and demodulates data before converting it to RF signals. The physical features of Bluetooth transceivers are described. It distinguishes between connection-less and connection-oriented physical connections.Baseband Link Layer: The baseband, which is analogous to the MAC sublayer in LANs, is the digital heart of a Bluetooth system. It carries out the piconets connection setup.Link Manager Protocol Layer: It handles link management, including authentication and encryption procedures, for previously established connections. It is in charge of establishing the linkages, keeping an eye on their condition, and gracefully dismissing them in response to instructions or errors.

The Bluetooth protocol stack's "logical link control and adaptation protocol layer" is frequently referred to as its "heart." It enables communication between both the Bluetooth protocol stacks higher and bottom levels (Figure 1). Data packets received from higher levels are packaged into the shape that lower layers need. Segmentation and multiplexing are also done by it.SDP layer, or Service Composition Protocol, is the abbreviation[1]–[4]. It enables finding the services offered by a different Bluetooth-enabled gadget.Radio Frontend Component is referred to as the RF comma layer. With WAP and OBEX, it gives a serial interface. Additionally, it offers logical link control and adaptive protocol-based serial port emulation (L2CAP). The ETSI standard TS 07.10 is the foundation of the protocol.

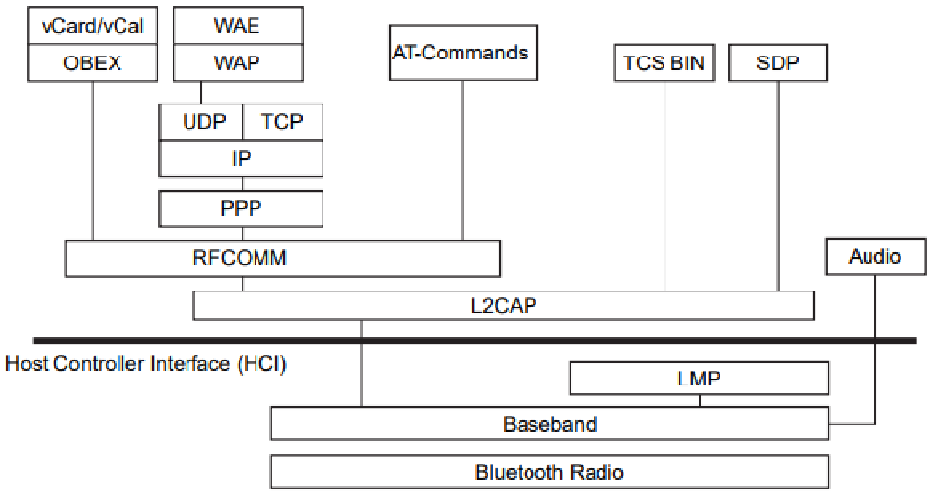

Figure 1: Illustrates the shows complete diagram of the protocols.

There is the various function of the protocol, which are as follows:

Connection Establishment/Release

Both connectionless and communication-oriented transfers of data are possible. The least dependable services are those that need no connection. The majority of the protocols provides services focused on connections. Connection-oriented services are usually preferable when a lot of data transmission is necessary.

Encapsulation

How the data is included in the frames or packet is specified by a protocol. All PDUs include a data field and three fields containing control messages in each packet. Addressing, Error Control, and Protocol Control were three control communication fields [5]–[8].

Segmentation and Reassembly

When an application entity delivers data to an application entities on another host, in a hierarchical architecture, the data transitions from of the application layer toward the physical layer within the same host. The data packet subsequently moves first from physical layer towards the destination's application layer while still travelling across transmission means. The data is divided into smaller blocks during this procedure, and additional control information is added for peer-level usage.

Segmentation is the action in question. Similar to this, the packet goes from the level lower to the higher level when it reaches its destination. The sender's lower level procedures attached control information towards the blocks, which the higher level protocols remove to get the real data. It's known as reassembly.

Data Transfer Management

The protocol synced them correctly to provide synchronization and sequencing if the transmitter can create information at a speed of 10 MBPS as well as the receiver can take it at a rate of 1 MBPS.

Multiplexing/DE multiplexing

The protocol's multiplexing feature is more closely tied to addressing. Protocols like upward multiplexing or downwards multiplexing employ one of the two forms of multiplexing. A single lower-level connection or numerous higher level interconnections are multiplexed in the upward multiplexing. As opposed to upward multiplexing, downwards multiple access builds a single higher-level interconnection on top of several lower-level connections.

Addressing

During communication, trying to address is indeed the process of defining an entity's address. Addressing is a broad notion that encompasses connection IDs, addressing levels, addressing scopes, and addressing modes.

Ordered Delivery

In a network, even if a communication machine is not directly linked, they are still connected. There is a chance that data packets won't arrive at their destination throughout the order they were sent. The data units' (PDUs') primary route across the network causes a break in the sequence.

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CHAPTER 15

ERROR CONTROLIN THE PROTOCOL TO FIND ERRORS IN DATA PROCESSING

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When data transfer occurs, it is important to properly monitor data loss and damage. The error control mechanisms specified in the protocol are used to find damage or errors in data processing. Error Detection and Data Retransmission are the first two processes in the error control process. Each PDU includes some error detection code that is transmitted by the sender for error detection. Knowing this code, the receiver determines if the code included in the collected signal is accurate or not. If an error is found, the receiver asks the sender to deliver the data again. On the other extreme, if no problem is found, the receiver sends a message to the sender confirming that the data was received correctly [1]–[5].

Flow Control

To handle issues like traffic jams, overloading, data loss, etc., flow control is also a crucial procedure. The receiving machine may restrict the download speed being supplied by the transmitting equipment by performing a function known as flow control. The simplest techniques for managing the data flow are the stop and await protocols. If the communicating devices have differing communication and reception data speeds, flow management is essential.

Other Transmission Controls

One of the key transmission controllers is timing and synchronization. The following are some extra services that a protocol may provide to entities who are communicating. Priorities, service quality, overall security.

Intrusion detection system (IDS)

An intrusion detection system (IDS) assists in the identification of assaults rather than blocking or preventing them. In order to be effective, an IDS must be a part of a complete strategy that also includes additional security measures and staff who are trained to handle emergency situations. Intruders may employ encrypted packets to enter the network since an IDS cannot look into them. Since an IDS won't detect these intrusions until they penetrate farther into the network, systems remain exposed until the intrusion is found. An IDS can read the contents of an IP packet, but the domain name may still be faked. It is more difficult to identify and evaluate the danger when an attacker uses a fictitious address. An important problem with an IDS is that false positives are often reported as alerts. False positives are often more common than genuine threats. An IDS's signature library determines how effective it is. If it is not upgraded often, it won't detect the most recent threats and won't be able to warn you of them [6]–[8].

A system called an intrusion detection system (IDS) watches network traffic for suspicious behaviour and sends out notifications when it is found. It is software that checks a system or

network for malicious activities or policy violations. Any illegal activity or violation is often recorded either centrally using a security information and event management (SIEM) platform or notified to an administrator. A SIEM system combines outputs from several sources and use alarm filtering methods to distinguish between legitimate and erroneous alerts. While monitoring networks for potentially harmful behaviour, intrusion detection systems also are prone to raising false alarms. Consequently, enterprises must adjust their IDS products after first installation. It entails correctly configuring intrusion detection systems that distinguish between legitimate network traffic and malicious activities. Additionally, intrusion prevention systems monitor network packets entering the system to look for any harmful activity and immediately transmit alerts.

Classification of Intrusion Detection System

IDS are classified into 5 types:

Network Intrusion Detection System (NIDS)

Network intrusion detection systems (NIDS) are installed at a predetermined location inside the network to monitor all network traffic coming from all connected devices. It carries out an observation of every subnet traffic passing through and compares that traffic to a database of known attacks. The warning may be sent out to the administrator as soon as an attack is detected or unusual activity is noticed. Installing an NIDS upon that subnet where firewalls are situated to check for attempts to breach the firewall is one example of how to use one.

Host Intrusion Detection System (HIDS)

Host intrusion detection systems (HIDS) are network applications that operate on separate hosts or gadgets. Only the outgoing and incoming packets from either the device are monitored by a HIDS, which notifies the administrator of any unusual or malicious behaviour. It compares the current snapshot of the computer system with both the previous snapshot. An alert is given to the administration to look into if the analytical operating systems were altered or deleted. On mission-critical devices, which are not anticipated to modify their layout, HIDS is being used as an example.

Protocol-based Intrusion Detection System (PIDS)

A system or agent that continuously remains at the front end of a server, regulating and interpreting the protocol between such a user/device and the server, makes up a protocol-based intrusion detection system (PIDS). By constantly monitoring the HTTPS protocol stream while accepting the associated HTTP protocol, it tries to protect the web server. This system would need to be present throughout this interface in order to employ HTTPS since HTTPS is unencrypted prior immediately accessing its web presentation layer.

Application Protocol-based Intrusion Detection System (APIDS)

A system or agent called Application Protocol-based Intrusion Detection System (APIDS) often lives inside a server cluster. By observing and analyzing communication across application-specific interfaces, it detects intrusions. For instance, this would watch the middleware's explicit SQL interface as it interacts with the web server's database.

Hybrid Intrusion Detection System

A hybrid intrusion detection system is created by combining two or more intrusion detection system methodologies. Host agents or system data is merged with network data inside the hybrid systems for intrusion detection to provide a comprehensive picture of the network system. In compared to other intrusion detection systems, hybrid intrusion detection systems are more effective. Hybrid IDS is shown by Prelude. Usually situated between a company's firewall as well as the remainder of its network, and it could be able to prevent any suspicious traffic from reaching the latter. Intruders that defenses or antivirus programs may have missed may be actively caught by intrusion detection systems, which respond to active assaults in real time.

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