EXPLORING A REAL-TIME PUBLIC TRANSPORT TRACKING, ANALYSIS AND INTELLIGENT MANAGEMENT FRAMEWORK USINGIOT ECOSYSTEM ARCHITECTURE

Kaushlendra Sharma, Department of B.Sc. Computer Science and Artificial Intelligence, School of Informatics, Loyola Academy Degree & PG College, Hyderabad, Telangana 500015, India.
Corresponding author: kaushal03sharma17@gmail.com

Abstract.
Background: According to the 2011 Census Report of India, 18.1% of the nation's population opted for public transportation to travel to work. This seemingly small figure of percentage accounts to a whoopingly large number (240 million approx.), considering the massive and growing population of the country. Along with this and the rising present & future issues such as climate change, increasing fuel price, soaring up of passenger traffic, escalation of road accident rates, the desire for comfortable commuting and many more, suggests that an increased percentage of population shall likely settle on public transportation for the purposes of maximum travelling. Henceforth, with the dawn of the world of digital solutions and by looking at the current set of problems in the public transportation domain, there's a huge possibility to innovate the present ways of transportation services. The public transportation facility can be enhanced by providing the following solutions such as live location tracking, info on seat availability and vehicle health, arrival and departure time, etc.
Methodology: This paper focuses to explore and design a IoT [Internet of Things] based system which aims to provide a digital interface via a mobile/desktop application to citizens by mapping the live location of the public transport such as Buses, Taxis, Local Trains and Ferries. This architecture is supported by a variety of technologies such as Global Positioning system [GPS], Sensors [Infrared, Camera & Engine Sensors], Micro-controller, Embedded Systems Programming, Cellular Networks, a Back-end Server System, Mobile application and many more. Google Maps API is used to design the mobile application interface, which shall provide info on the transport vehicle's live status of location and related data. In the following content, a dedicated explanatory approach is defined in order to reach the goal of a smartand intelligent transport management service system.
Scope: This framework of transport management contributes to the goal of a futuristic society by employing necessary tools and technologies. A widely scalable solution, which aims to smartly engineer the traditional transport infrastructure resulting in an intelligent, serene and secure system of service. The IoT network pushes for a boost in the sector of innovation and business, which certainly can contribute to the economy and establish regularity & tranquility in the process of service. The architecture also provides enough liberty to engross various tech disciplines such as Big Data, Artificial Intelligence, Cloud Computing, etc., in order to improve its future sphere of working. This research paper presents a general contour of the features of the advanced transport system and discusses unique steps in order to transcend the conventional systems of working. It further discusses the present digital & tech developments and future prospects in the modern transport sector.

INTRODUCTION

With the massive growth in the domain of Science and Technology in the last 60 years, the world has witnessed a significant amount of innovation and creativity, all leading to spin a process of change in people's lives. Considering the example of Computers, a digital electronic machine (*running a series of computations and programs*) has integrated itself as an important entity in every process of work such as Administration, Business, Medical, Research, Design & Creativity, Personal use, etc. However, the world yet offers a tremendous set of opportunities to tweak up the methods of functioning of various traditional activities & operations, and thus increase the scope of modernization.

The sector of public transportation offers a large range of possibilities which can help exceed its conventional styles of management & functionality and deliver smart and beneficial solutions to the society. Public transportation (also known as *Public Transit* (or) *Mass Transit* (or) simply *Transit*) is essentially a system of transport for the commuters which follows a structure of group travelling and is generally designed to work on a fixed schedule & operates on pre-determined routes. A fair amount of charge is also collected from the passengers as a fee for travelling a specific trip. The service of public transportation can be provided by either government institutions (as part of civilian infrastructure) or by private ownership. Public transport can be of various types such as – *Airline* Transport, *Bus & Coach* Transport, *Train* Transport, *Ferry* Transport, etc. In terms of safety and security, studies have confirmed public transportation to be the most secure.

The conventional system of public transportation presents the following challenges –

- Unavailability of a Digital Monitoring Interface, which aims to provide a overview on the live status of the transport vehicle. The data received from the interface can help authorities maintain constant updates regarding the vehicle's live geographical location, vehicle's health, live data on seat matrix and video surveillance system to observe & supervise the internal situation in the vehicle.
- Inaccessibility of a Digital Analysis System in order to frequently evaluate the incoming passenger traffic and store the related data. This mechanism can thus create large scope for employing various mathematical models & statistical techniques to process the data received & design a meaning to it, thereby helping in improving the transport infrastructure.
- Demand of a Mobile/Desktop Application to provide live inputs to the end user (the commuter) on the geographical location of the transport vehicle and data on the arrival & departure time at respective vehicle stops & stations.
- Need of a Digital Feedback Mechanism & Review system in order to hear the passenger feedback & personal opinion and allow the sharing of the journey experience of the traveler. The system can help refine the service quality & grow the digital reach thus helping indirectly in revenue.

With the advancement of research and experimentation in the field of Information Technology and Electrical & Electronics engineering, new disciplines of technology have emerged and smart & intelligent tech-based solutions are available to be integrated into various systems in order to enhance their utility and performance. Accordingly, the concept of Internet of Things (IoT) perfectly fits onto the sphere of public transportation sector in order to modernize its working and achieve its respective goal, thus leading to a smart system of public transit. IoT is essentially a dynamic universal network mechanism with self-configuring capacity based on a definitive & interoperable communication protocol where physical & virtual objects have identities, physical features & virtual characteristics and work on intelligent interfaces, aimed to be seamlessly integrated into the information network to communicate data associated with nodes and their ecosystems. The IoT comprises of things (involving various kinds of physical objects or groups with sensors, with specific processing capacity, programs and additional tools) that have unique identities and are connected to a communication network (such as Internet) to exchange data with other machines and different channels. The framework of IoT is enabled by several technologies including - Wireless Sensor Networks (WSN), Cloud Computing, Big Data Analytics, Embedded Systems, Web Services, Semantic Search Engines, Internet and other Communication & Security Protocols, Mobile Phones, etc.

ARCHITECTURE OVERVIEW

This architecture is based on IoT Level-6. Multiple independent end nodes that perform sensing are engaged, which form as the fundamental building block of the architecture. The functionality is discussed below –

TRACKING THE GEOLOGICAL POSITION OF VEHICLE

The primary goal of the IoT system is to provide live position of the transport vehicle. To achieve this goal, the principal end-node employed is based on the technology of Global Positioning System (GPS), a space- based radio navigation system, to broadcast the live location of the vehicle by performing various longitude, latitude & altitude-based calculations. The system works under the influence of various satellite networks & radio signals which ultimately help execute the operation. A GPS Module such as NEO-6M module (or) Grove GPS Air530 module acts as the leading end-node which computes, organizes, stores & transmits the position data to other higher entities present in the framework.

MONITORING THE VEHICLE HEALTH

The secondary goal of the IoT architecture is to perform a timely inspection on the status of vehicle's health. To achieve this objective, the role of intelligent software & engine sensors comes into action. The engine sensors act as the another set of principal end-nodes. In modern motor vehicles, primarily cars, different types of sensors are spread across dimensions. Most of them are designed for engine management & performance maintenance to play an important part in the smooth running of the vehicle. They send important info to the vehicle's Powertrain Control Module (PCM) thus ensuring it to make critical & specific control decisions. The PCM fails to function properly, when the precise data from these sensors is not available, thus having negative effect on emissions, fuel economy & overall performance. The respective fundamental sensors employed are – Oxygen Sensor, Coolant Sensor, Throttle Position Sensor, Mass Airflow Sensor, Crankshaft Position Sensor, Manifold Air Pressure Sensor & Vehicle Speed Sensor. According to the vehicle's characteristics & advancements in its design, new sensors are always under development in the automotive industry. In the IoT framework, the information obtained from these engine sensors is directed to the monitoring node interface via the architecture's entities. The dedicated smart software supporting the monitoring node interface, keeps a timely check by closely observing the sensor data & its process. Any failure in the engine sensor operation (or) faulty functioning is immediately reported to the respective administration, in charge and the vehicle operator. This mechanism can thus possibly upgrade the transport service structure and allows timely maintenance & quality in system functioning.

SENSING THE INCOMING PASSENGER TRAFFIC

The tertiary goal of the IoT framework is to deliver a solution which allows the demonstration of seat matrix of the transport vehicle. The seat matrix is the arrangement which depicts information on the availability of seats and number of occupied & unoccupied seats in the vehicle. In populous regions of society, this knowledge can certainly help people in choosing the specific interest of transport vehicle for commuting. The concerned authorities can also create reports which analyze the incoming regular passenger traffic & can possibly issue public favoring policies. To sense the amount of crowd within the vehicle and at various service stops & stations, the other set of principal end-nodes involved are Passive Infrared Sensors (PIR). A PIR sensor is an electronic sensor that calculates the Infrared Radiation (IR), radiating from the surrounding objects. The principle behind the working of PIR sensor is, objects including human beings emit energy in the form of electromagnetic radiation at infrared wavelengths, the sensor thus operates on such wavelengths and therefore detects the presence of objects, falling in its line of sight. The lenses & mirrors in the sensor help focus the infrared energy and as a result a certain beam pattern is detected. The radiation beam is converted into a voltage signal and thus the presence of objects is triggered. The sensor data, later on, is transmitted to the respective higher entities in the IoT architecture. PIR-based motion detectors and imaging IR sensor can also be implemented as end nodes, depending on the nature of goal. Additionally, the intelligent software operating behind the micro-controller and server systems computes & sorts the data, received from the PIR sensors, into knowledge-based output. Thus, the user and the service head-operator can receive updates & info on the live passenger traffic within the transport vehicle.

ADMINISTERING VIDEO SURVIELLANCE

The quaternary goal of the IoT structure is to integrate a Video Surveillance System. A Video

Surveillance System is a group of one or more security cameras provide live monitoring and sends the recorded video & audio data to a remote user station. The other set of principal end-nodes involved in the IoT framework, which also form as the primary component in this system are the IP Cameras, basically sensors, which have great resolution & clarity. They are setup within the Transport Vehicle and at Stops & Stations. They are also known as Internet Protocol Cameras. They also use the technology of Power over Ethernet (PoE) to transmit data to the router, responsible for routing the sensor data to Network Video Recorder (NVR), which is integrated in the section of server system, seated at the higher hierarchical entity position of the IoT architecture. The technology of Motion Sensors can also be engrossed in the system. This mechanism can help avoid major incidents within the vehicle such as acts of violence or crimes. Identification of convicts traveling in the vehicle is also possible. An alert based-protocol is triggered (via the IoT system) when such incident is detected by the surveillance cameras. With the onboarding of Software Programming, Face-Detection System and technologies such as Machine Learning & AI, smart surveillance solutions can be delivered.

OPERATIONS OF THE MICROCONTROLLER

The microcontroller is a compact mini-computer which is constructed on a single VLSI integrated circuit chip. They consist of a micro-computer designed on a metal-oxide based semiconductor chip and are mainly used in medical operations, industrial sectors, automobile domain, etc. The microcontroller employs one or many CPU cores, Memory systems along with I/O peripherals. The memory system is developed in either of the forms such as - ferroelectric RAM, NOR flash memory or One-Time Programmable (OTP) memory. Microcontrollers are essentially designed for embedded system applications, but in recent times, Internet of Things (IoT) popularly use them. They are economical and aims to collect data, perform sensing & actuation alongside the physical device interfaces of the IoT framework. Microcontrollers also employ a respective Programming environment to allow the software development process in many high-level languages such as C, Python & JavaScript. Special libraries may be added with respect to the needs and design based on microcontroller's application. A huge mechanism of Software Development runs to ensure the microcontroller works under limit of the design constraints. The microcontrollers which can be used in the IoT architecture are
– STM32Wx (SoC), SAMA5D2, STM32F205 and STM32MP157. The microcontroller acting as the hardware gateway connects with all the end-sensor nodes. The task of the microcontroller is to direct the sensing process & send dedicated operational commands. It is also responsible to redirect the collected data across the Controller Service station for routing the data packets to higher entities in the IoT architecture.

NETWORKING OF IoT ENTITIES

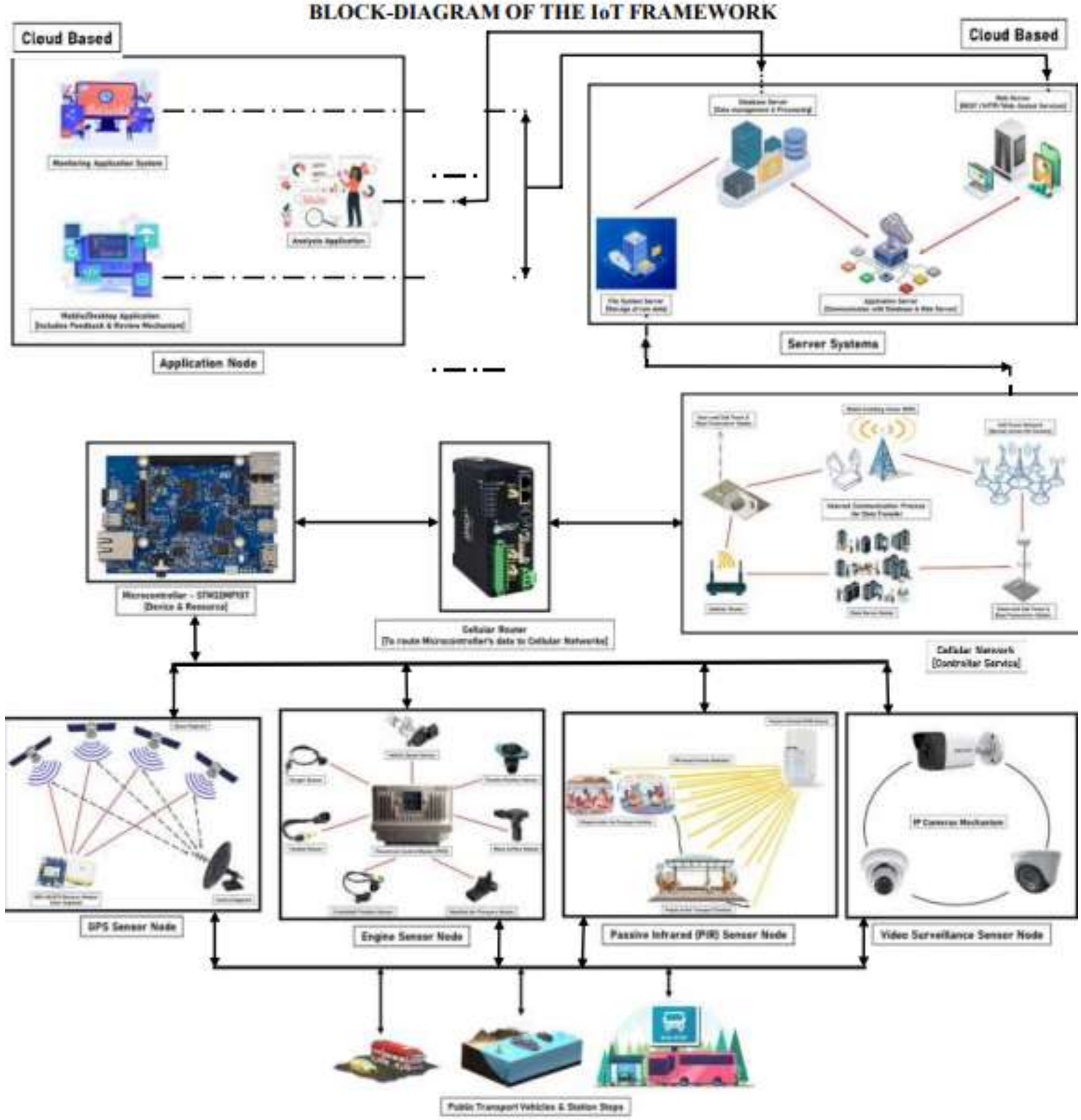
The Controller Service entity of the IoT structure is a networking service that runs on the framework, used for the purposes of data sharing & receiving across devices. It also interacts with the Web Service entity of the structure to coordinate with the process of information exchange over the link. A computer network, as we know is a collection of a large set of computers, sharing services, provided by the network nodes. The network nodes use certain communication protocols (such as TCP/IP, UDP or ICMP), to exchange data over the connection network. The communication protocols, generally divide the data file into packets, transmits them over the network and reassembles them at the destination node. The nodes of the network commonly are, Servers, Hosts & Networking hardware (such as Hubs, Switches, Routers, Bridges, etc.) The network is further characterized by the transmission medium to carry signals, bandwidth, network size, topology and operational process. The type of network best suited for IoT trends is that of WWAN (Wireless Wide Area Network). The large area coverage of WAN ranging from 100 to 1000 km, is a long-distance transmission medium, essentially designed to provide network broadcasting right from a city/state to country. The Cellular Network Technology is used to succeed this transmission, primarily 4G LTE or 5G. The network essentially exchanges data via telecommunication interfaces. The nodes involved in sharing the data essentially are GSM (Global Systems for Mobile Communications) Antennas (Transmitter), cell-sites consisting of Base Transceiver Stations (BTS) & Mobile Switching Towers. In this cellular system, the GSM or LTE (Long-Term Evolution) Antennas are used to transmit data in the wireless form, mainly through Radio-Frequency (RF) waves, with respect to standard telecom frequency band. The binary data (Digital Signal) from various devices & nodes is converted to Radio Waves via various Electronic Processers. In many cases, the Electronic Processers & Transmitters are jammed into one single electronic module. The cellular radio system cell-sites divide a land area in hexagonal shapes, each having a corresponding radio-base stations, essentially comprising of Cell Tower. Each hexagonal slot has its own frequency band. Optical fiber cables are used to connect these cell towers across the globe. The elements of the BTS are Mast/Tower, Sectorial Antennas, PDH & SDH Microwave, Waveguide cables, Rectifier, Generator, Radio Base Station, Duplexers, Data Distribution Frame rack, Transceiver Unit, Trunking, TX Cabinet & Shelter. The BTS converts the radio waves received from the antennas to high frequency pulses, and are further directed to destination towers for final processing. With the same mechanism in reverse, the receiver antenna gets the signal, thus transmitting data. The WWAN, is required to be setup under a Private Cellular Network to enable the controller's full flexibility on data management and handing of routing process. The advantage of this step is to keep information segregated from public devices, networks and servers and ensure the data is not vulnerable to damages, hacks or attacks. The 4G technology runs on a data speed of 20-100 Mbps, thus supporting high resolution formats. Multiple Input Multiple Output (MIMO) & Orthogonal Frequency-Division Multiple Access (OFDMA) Technology supports the working of 4G LTE. MIMO uses multiple transmitter receiver Antennas inside the device module and the Cell-Towers. The incoming 5G technology is ideally designed for the purposes of IoT applications. It uses Advanced MIMO technology and operates on millimeter waves. Along with seamless connectivity, the speed delivered is at 20 Gbps. It handles a 100x increase in traffic capacity & network efficiency. Therefore, the Microcontroller within the IoT framework operates on Cellular Networks to send & receive data along the infrastructure. The Server- end section interacts with this network data, and performs dedicated operations.

SERVER SYSTEMS

A server is basically a unit of computer hardware & software, that provides services to clients. A centralized machine where multiple clients connect over a network, to retrieve a service. For example, the service could be to access a web-page, performing computation, accessing data or even an email. The server works on the client-server architecture. A single server can offer service to multiple number of clients, depending on the hardware & software capability, and vice-versa. A request is generated by the client user and a dedicated response action is forwarded by the server. A server could be of many types such as – Application Server, Catalog Server, Communication Server, Computing Server, Database Server, Fax Server, File Server, Proxy Server, Virtual Server, Web Server, etc. A server is also known as a Data server. Data Centers play an important role in managing the data and directing it to the end user. A data center houses large number of data servers, each with different characteristics, computation ability and purposes. Environmental conditions need to be actively moderated in order to make the servers work properly. The common hardware associated with a server unit is – Motherboard, Processor, Hard Disks, RAM, Power Supply, Network Ports, etc. The software section of a server unit involves Operating System (OS), Applications, dedicated Algorithms and Programs designed to fulfill respective processing goals. In the business world, many server infrastructure providers exist, which operate on Cloud Computing, primarily they are – Amazon Web Services (AWS). Microsoft Azure, Google Cloud Platform, IBM Cloud Services, Adobe Creative Cloud, etc. The Data Center of the IoT architecture houses fundamentally 4 servers, they are – File Server, Database Server, Application Server and the Web Server. The data received from the Internet Service Provider's WAN, is processed into binary formats by the File Server's hardware and OS. This data, obtained from the four sensors (GPS sensor, Engine sensor, PIR sensor & Video Surveillance System), after traversing through various IoT structure's entities, finally reaches the Data Center for processing & goal execution. The File server is a server (within a network) that enables shared storage solutions and can be accessed by various Workstations. All the sensor data is stored in respective formats (Coordinates data, Passenger Traffic Data, Vehicle health data & Video-Audio data). The video surveillance data can be channelized to respective Streaming Applications (within the network) for live- monitoring. A software module, designed especially for the File Server Systems, ensures the raw data, continuously retrieved from end-nodes, is stored at designated locations within the server. The Database server is a server which uses Database Management Systems (DBMS) to provide database services to the network nodes. Types of DBMS are – Relational DBMS (RDBMS), Document DBMS (DoDBMS) & Columnar DBMS. The front-end part of the server displays requested data and the back-end handles tasks such as data analysis & storage. A Query language is used to operate the database system which returns results on being executed. Examples of Database applications include – Oracle Database, IBM Db2, Informix & Microsoft SQL Server. Every server uses its own query working process and structure. The components of DBMS are – Storage Engine, Query Language, Query Processor, Optimization Engine, Metadata Catalog, Log Manager, Reporting & Monitoring tools and Data Utilities. The Database Server is placed in connection with the File Server structure to access the data stored in the server's storage. A specific & intelligent Query algorithm is designed, in the back-end section, to store the raw unorganized data into the Database Server, thus resulting in sorted and knowledge-based information about the Transport system. This knowledge is accessed and brought into real-time interfaces by the Application Server, which computes queries on the front-end section of the Database server and stores the result. The queries are dynamically created as per user requests on the website/monitoring interface. An application server works at the junction of Web Server and the Database Server. It basically manages & processes the data. It is a service layer model. The features are – Clustering, Fail-over and load-balancing. Different kinds of application servers are – Java Application Server, Microsoft Application Server, Mobile Application Servers, PHP & Third-party Application Servers. The application server components are – Server Instances, Administrative Domains, Clusters, Node Agents, Named Configurations, HTTP Load Balancer Plug-in, etc. The next section of servers involves the Web Server. Web Server is used to host Web Applications, to deliver static/dynamic web content continuously on client requests. It is a server system that accepts Network Protocols, such as Hypertext Transfer Protocol (HTTP), created to process web operations. The end user such as a Web-Browser requests for a resource (web page) using the HTTP protocol and the server redirects the end user with the respective resource. Modern technologies such as Representational State Transfer (REST) and Web-Socket Services help enhance the communication mechanism. The Web Server receives the user request packed within HTTP, via the Internet. The server's OS is responsible for managing the TCP/IP and HTTP conversions. The user requests via the Application nodes, in the IoT architecture, that are – The Mobile/Desktop app & The Monitoring Application System. On receiving the request, the Web Server, being in network connection with the Application Server, forwards the request. The Application Servers decodes the request in its interface format and performs the respective query operation on the Database Server. Thus, the result obtained is packaged back by the Application Server in the HTTP format and sends to the Web Server. The Web Server sends the web-page, with HTTP back to the user node via the Internet. The user-node receives the web-page and thus the Application executes the respective request by displaying the output data on the website, running on the user node of application.

APPLICATION NODE

BLOCK-DIAGRAM OF THE IoT FRAMEWORK



The Live Location, Vehicle health, Seat Matrix and Video Surveillance data of transport vehicle's is to be accessed by a dedicated software or more commonly, an application. The IoT framework consists of 3 application nodes – Mobile/Desktop Application, Monitoring Application System & The Analysis Application. The Mobile/Desktop Application and Monitoring Application System can be developed by using Google Maps API (Application Programming Interface). The Mobile Application is an application software designed to run on a Mobile Device. They are similar to Computer Applications. The Mobile Application designed especially for the IoT framework consists of interactive User Interface (UI) and Data, which displays the above stated information. The main three layers included in a mobile app are the – Presentation Layer, Business Layer & Data Access Layer. The features of the mobile app, designed for the IoT framework are – Users & Accounts, User-Generated Content, Date & Location Management, Live GPS tracking, data on Seat availability, Feedback Interface, Admin Panel & Analytics Tools, Security, etc. The Desktop Application functionality is similar to the Mobile App. Web-based Applications can be accessed via the device Internet Browser in the form of Websites. Website basically consist of web-pages (displaying data & results in UI), created dynamically on user-requests, and accessed from the Web-based Applications, running on Web Servers. Henceforth, the data of interest can be accessed by the user, thus fulfilling the goal of Smart Public Transport System. The Monitoring Application System essentially is oriented towards Public Transport Service Administrator, to supervise critical elements which majorly affect passenger's experience. This system consists of the components such as – Live GPS Tracking accessibility, Live Data on Passenger Traffic (Within the Transport Vehicle and at Stops & Stations), Live Video Surveillance Interface (To Monitor the entire Transport Infrastructure within the Transport Vehicle and at Stops & Stations), Live and Periodical Observations on Vehicle Health Status (To ensure smooth experience of commuting). The UI is required to be made very flexible in order to support the onboarding of the all the components. The Administrator team, housing in a special facility with the Monitoring Application System, constantly supervises the Smart Transport Service processes. The Analysis Application is placed in network with the Database Server, in order to retrieve all the data generated by the sensors, in Transport system. The Analysis Application is a software employing various latest technologies such as Data Science, Machine Learning and AI, to conduct various studies and researches by statistically studying the input data and develop knowledge-based results to solve people's problem and look for development opportunities in the Transport System Service.

CONCLUSION

Public-transport is destined to be actively used by the masses, even in the future times. To cope up with needs of the society and to promote technological use & its development, intelligent solutions on the basis of Internet of Things (IoT) system, were explored in the research paper. Right from finding the suitable concept of framework to building a connectional interface, the IoT structure successfully conveys a reliable & smart Public Transport mechanism. The solutions such as Live Position, Arrival & Departure time of the Vehicle, all at a single user interface, certainly ensure safety and comfort in the passenger's journey. Monitoring the Vehicle Health via Advanced sensor system helps the service providers avoid accidents, traveling troubles and ensures beforehand maintenance check. Any kind of harmful or malicious activity, involving vehicle components, can be certainly avoided with the mechanism. The travelers and the service providers, receive constant inputs on the passenger traffic at various service terminals, stations and stops. The traveler, can save time and resource by analyzing the seat matrix data, thus influencing critical personal decisions. If the vehicle is overcrowded, the traveler may look for some other medium for travelling. The advantage of such similar situations, to the citizens, is phenomenal. To ensure the safety of Women & Children, primarily, the Video Surveillance goal is also accomplished by the IoT framework. The security force and service operators can constantly monitor the situations at all places, associated with public transport system. Lots of innocent lives can be saved and violence could be avoided. New age technologies, such as ML & AI, can be adopted to identify the thriving criminals inside or around the vehicle.

Numerous hardware devices & equipments are used across the architecture. The Software side of the architecture is yet a huge challenge, when practical approach is employed. Though being largely challenging, it can give great outputs. Businesses can look on for establishing opportunities on the architecture which will certainly help in good revenue generation and process growth. The analysis application helps the service providers, be it government aided or private, in creating good customer policies by analyzing the incoming sensor data. The analysis could be, for example – How to improve Bus terminal infrastructure, Number of Buses required during morning period of time to stabilize large passenger traffic, Routes which lack Public Transport Services, Routes where public transport is to be minimized, type of passenger traffic, etc. With 5G Network Technology, the processes could be largely improved and made efficient & time-saving. High resolution based Live Video Monitoring with good Audio data could also be made possible with the technology. Different problems can be observed by Engineers & Developers in the transport system and new sensors with new goal tasks could be added to the existing IoT framework, reason being flexible and dynamic in nature. Technologically advanced &

smart future societies certainly excite the population, thus, this IoT architecture of Smart Public Transport Tracking, Analysis & Management system, is a step in that direction ofthought.

ACKNOWLEDGEMENTS

Sincerely thanking wishes to Mrs. D Arpitha Rani [Head of Department (H.O.D.) & Assistant Professor, Department of B.Sc. Computer Science and Artificial Intelligence (CSAI), School of Informatics, Loyola Academy Degree & PG College, Hyderabad] for motivating and influencing the author to act beyond the present level of intellect and take on new challenges & experience a new learning process. The generous act of compassion helped the author discover new fields of interest and gain inspiration, to make oneself better.

REFERENCES

1. Salih, T.A. and Younis, N.K., Designing an Intelligent Real-Time Public Transportation Monitoring System Based on IoT (Open Access Library Journal, Wuhan, 2021), 8: e7985.
2. Parag Gawade, Prof. Meeankshi A, IOT Based Smart Public Transport System (International Journal of Scientific and Research Publications, Volume 7, Issue 7, New Delhi, 2017), pp. 390-396.
3. Karthikeyan G, Jawahar M L, Smart Bus Management System (International Journal of Engineering Research & Technology (IJERT), Volume 6, Issue 8, Gandhinagar, 2018), ISSN: 2278-0181

