The Usage of Internet of Things in Transportation and Logistic Industry

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Abstract Internet of Things (IoT) is quickly escalating technology. IoT is a network of objects or things surrounded with electronics, software, sensors, and network connectivity, which enables these objects to accumulate and exchange data. To develop a system which will automatically monitor the transportation and logistics applications and generate alerts, or take appropriate intelligent decisions using concept of IoT with AI. The Internet of Things has numerous opportunities in transportation and logistics sectors, like IoT vehicles can be monitored with respect to their movement, location, whether it is running or stopped, or at any risk, etc. All these can be monitored intelligently using the IoT systems. Vehicles are used for logistics purpose for carrying heavy loads which are packed inside the truck. During such times, it is very important to measure the indoor conditions of the truck like temperature, humidity, light conditions, etc. which can be monitored with sensors. Apart from the payment service near the tolls or any parking places can be automated with the vehicle tracking number, the driver id number, etc. IoT also helps in the guidance and navigation control systems of the vehicles (road transport, air transport, water transport). Transportation authority is highly possible with the use of IoT. Here, various vehicles can be monitored and controlled by means of a central control hub connected through the network. It also offers live and integrative services for monitoring the delivery status indicating the location using GIS mapping. IoT could facilitate in monitoring the traffic and gives the suggestions to take other lines. IoT has given a hopeful way to build powerful systems and applications by using wireless devices, e.g., Android, sensors. By integrating other technologies like big data analytics and artificial intelligence we can have endless applications on intelligence IOT for transportation and logistics industry. **physical objects + sensors and microprocessors = IoT**.

Keywords IoT · The internet of things · Big data analytics · Artificial intelligence · Transportation · Logistics · IoT applications

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1 Introduction

At present, the most top-priority vision and mission of any logistics companies is to make sure that the products can be delivered in on time, effective monitoring and managing of goods and controlling on supply chain management, product lifecycle of goods and providing quality services. The goal of any logistics company is embedded with effective tracking of goods, control on inventory management and monitoring of warehouses, automation of in house business operations, effective delivery of goods and take care of securing storage of goods and monitoring condition of goods while transporting with error-free operations. In the logistic industry, the accomplishment of Seven R's principles includes "right products need to move—in right measure—in right situation—in right time—at the right cost to the right places and to the right customers." This job is very difficult; therefore, it is inevitability to make use of new solutions to reach better goals. By establishing IoT technologies with help of intelligence connections, data analytics using artificial intelligence, IoT restructuring the operational process in logistics industry. By providing numerous features and applications, IoT with big data analytics using artificial intelligence together has innovative solutions that are broadly introduced in the field of transport and logistics sector. The applications are supply chain monitoring and management, transportation and vehicle tracking system, inventory management system, safeguard of goods while transporting and automation of operations are the major IoT applications of logistic systems. This paper discusses the IoT and its architecture for transportation and logistics sectors. It also outlines the various possible opportunities.

2 IoT Architecture for Logistics Industry

An IoT architecture is an integrated system with sensors, protocols, actuators, cloud servers and communication layers. Based on industry and basic business operations, the IoT architecture may vary from one industry to another industry. But the basic IoT architecture three layers are: **The client side (IoT devices layer)**. **IoT Gateway layer (Operations on the Server Side)** and **IoT Platform Layer (A pathway for connecting clients and operators)**. The main stages in the IoT architecture are four. They are sensors and actuators; Internet gateways and data acquisition systems; edge IT and data center and cloud storage. Fig. 1 proposed IoT architecture for logistics industry.

Stage 1: Wireless Sensors and Actuators using Network Things: In this stage, sensors and actuators are used to college data from the surrounding environment and having ability to convert into digital data for further analytics.
Stage 2: Internet Gateway and Data Acquisition: In this stage, the data captured by sensors are converted into digital form and store data for further analytics. With help of internet gateway, data can be collected from different sensors through different wireless network mechanisms like Wi-Fi, Bluetooth, Zigbee, etc.
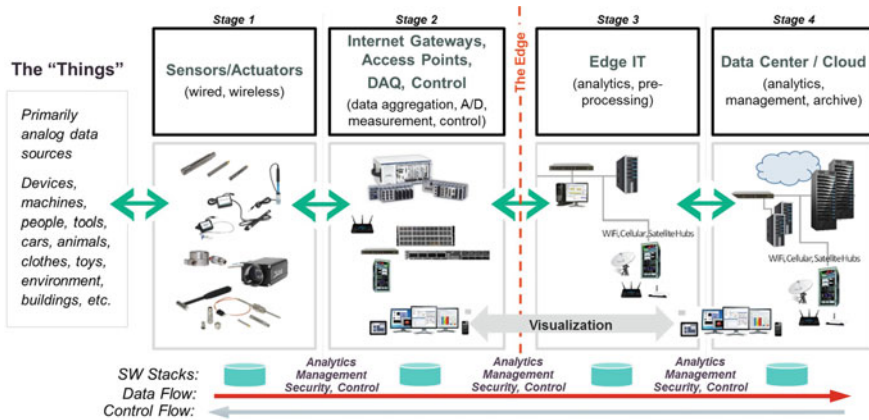
Fig. 1 Proposed IoT architecture for logistics industry

Stage 3: Edge IT Systems (for Data Analytics and Pre-processing): In this stage, the data which are collected from stage 1 and stage 2 are processed in stage 3 using edge IT environment. Here, the data refined and converted into valuable information which is used for decision support systems by using machine learning and artificial intelligence.

Stage 4: Data Centers and Cloud: In this stage, the business processed data means historic data is stored in data centers for further business analytics and business operational data means transaction data can be stored separately for business truncations using cloud-based storage.

Four Stage IOT Architecture Diagram

IoT architecture for logistics system consists of five different layers. These layers include the **infrastructure layer, service layer, communication layer, sensing layer and application layer**. Transportation is mainly used for shifting goods/cargo or living beings from one place to another place. Transportation system as a study area involves the study of so many parameters under different circumstances. All these parameters should be sensed and transfer to service layer through a proper communication channel. From the service layer, appropriate decisions were taken for controlling the system as per the requirement by using big data analytics and AI. The appropriate and sensed data are stored in the infrastructure layer, as shown in Fig. 2.

1. **Application Layer**: In this layer, requirements, components, tasks to be executed are goods, junction, terminals, service areas, people, road and vehicles.
2. **Sensing Layer**: In this layer, tasks to be executed are parking detection, compass terminals, camera, fee collection, environment monitoring, vehicle monitoring, logistics tracking, microwave detection, passenger flow detection.
3. **Communication Layer**: In this layer, tasks to be executed are 3G/4G/5G networks, **Wi-Fi, Wired Network, Optical Fiber, Public and Private Network**.
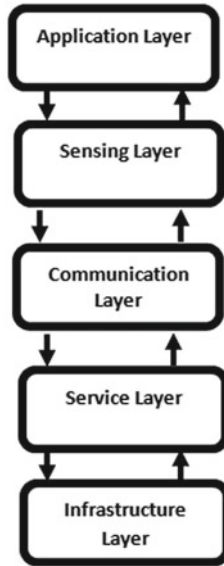
IOT Architecture for Logistics Industry

Fig. 2 Various layers in IoT architecture for logistics system

4. **Service Layer**: In this layer, tasks to be executed are logistics service platform, passenger vehicle platform, fleet vehicle service platform, highway integrated platform, intelligent traveling service platform.
5. **Infrastructure Layer**: In this layer, tasks to be executed are geographic information systems mapping service, cloud computing, cloud storage, big data.

3 IoT Opportunities for Transportation and Logistics

The Internet of Things has numerous opportunities in transportation and logistics industry. These opportunities include various applications or needs of a transportation system. Using IoT vehicles can be monitored with respect to their movement, location, whether it is on running or stopped, or at any repair, etc. All these aspects can be closely monitored intelligently using the IoT systems. In most of the cases, vehicles are used for logistics purpose or for carrying any heavy loads which are packed inside the truck. During such times, it is very important to monitor and control the indoor conditions of the truck like temperature, humidity, light conditions, etc. Apart from the payment service near the tolls or at any parking places the vehicle status can be monitor or tracking can be done automatically with the help of vehicle id number. IoT also helps in the guidance and navigation control systems of the vehicles (road transport, air transport, water transport). Transportation opeartions can be

govern as per the need of the organization and it is highly recommened the usage IoT Technologies. Here, various vehicles can be monitored and controlled by means of a central intelligence connected through the network. This also helps in managing the imports and exports of materials and goods. It also offers a live and interactive service for monitoring the delivery status indicating the location using GIS mapping. IoT could help in monitoring and suggesting the possibility to avoid traffic and to take other ways to reach the destination in an optimistic way. IoT applications in transport and logistics are:

1. Logistics Applications.
2. Control and Guidance Systems.
3. Inventory Solutions.
4. Fleet Telematics and Management Solutions.
5. Security and Surveillance.
6. Commerce Applications.
7. Solutions for Supply Chain Management.
8. Passenger Entertainment.
9. Smart Vehicle Applications.
10. Navigation Tracking and GIS Mapping.
11. Tolls and Reservation Ticketing System, etc.

4 Types of Application Systems in Logistic

1. **Location Tracking Management Systems(LTMS)**:

In transportations and logistic industry, IoT can construct an intelligent smart location tracking management system which can be avail by companies to easily tracking drivers time to time activities while they are in driving, vehicle (asset) position and goods delivery status. If goods are delivered, the concern person is notified by an alert message. It assists in delivering goods, planning, compilation and screening of schedules. These activities are monitored dynamically in real time. So, Internet of Things technology improves location tracking management systems and pipelining company operations.

2. **Inventory Tracking And Warehousing Monitoring**:

Inventory tracking management and warehouse monitoring are the most important parts of the connected transport and logistic environment. The usage of small and low price sensors will permit industry simply trace inventory items, supervise current status of items, condition of the items, exact position of the items and build an intelligent warehouse system. With these technologies, workers can able to track items easily when items are needed and prevent any losses occur due to accidental damages and ensure safe storage of goods and minimize human errors in business operations.

3. **IoT Technology And Predictive Analytics**:

A predictive analytics is a center pillar and it acts as central system as backbone to help logistic industry to build effective business strategies to get better the managerial process, promote smart business insight and managing risks and many more. IoT enables electronic devices like sensor together huge amount of data and sends out them to the predictive analytics central systems for further analysis using data analytics techniques using AI. These systems can be applied for monitoring and managing business operations and identification of different faults before happing in the system and incredible leads to erroneous. The outcomes are dynamic in real time and prevent at the earlier stage of any damage.

4. **Internet Of Things And Block Chain In Supply Chain Management**:

Here, we have various challenges; for both logistic industries and their customers, they wish to have facilities to track the product (item) life cycle—from the source to till reached into the customer's hands. The RFID tag and some relevant sensors will monitor product temperature, status with the environmental factors like weather conditions, moisture, vehicle location and phases of transportation route. Here, data are captured, stored in the block chain; every item has a digital ID captures not only data about related product but also with product lifecycle.

5. **Autonomous Vehicles Or Self-Driving Vehicles**:

At present, we all witnesses the usage and implementation of self-driving vehicles or autonomous vehicles, which are used in transportation and logistics to take advantage of these technologies and integrated into business operations. IoT smart devices are accountable for collecting huge amounts of data, for decision making using data analytics and then turn them into useful smart intelligence driving routes and directions to optimize road traffic and minimize the distance to travel to deliver the goods. Using self-driving mechanism systems can minimize road accidents and cut down operating costs and optimize business operations for better improvement in industry.

5   Benefits of Integrating IoT in Transportation

By integrating IoT technology with transportation and logistics systems, many benefits are possible. These benefits include:

1. Distance can be traveled by the vehicle is optimized giving the benefits by reducing the fuel consumptions leading to the better profits in day-to-day activities.
2. Optimizing or redirecting the best possible routes during the deadly and dangerous conditions.

3. Through centrally intelligence controlled network, a service can be operated based on the demand or user request.
4. Public transportation and logistics are centrally connecting networks through a control of traffic based on the vehicle count.
5. Goods and cargo material can export, import, purchase and other shipping details can be maintained effectively.
6. Transportation and logistics revenue can be improved for the company owners.

6 Usage of Technologies in Logistics and Their Impact

See Table 1.

Table 1 Usage of technologies in logistics and their impact

The technology	The impact
Physical Internet (based on the IoT)	• Improved supply chain transparency, safety and efficiency • Improved environmental sustainability—more efficient resource planning
Data analytics	• Improvements in customer experience and operational efficiency in operations • Greater inventory visibility and management • Improved "predictive maintenance"
Cloud	• Enabling new platform-based business models and increasing efficiency
Block chain	• Enhanced supply chain security (reduction of fraud) • Reduction in bottlenecks (certification by third parties) • Reduction of errors (no more paper-based documentation) • Increased efficiency
Robotics and automation	• Reduction in human workforce and increased efficiency in delivery and warehousing (including sorting and distribution centers) • Lower costs
Autonomous vehicles	• Reduction in human workforce • Increased efficiency in delivery processes
UAVs/drones	• Increased cost efficiency (use cases: inventory, surveillance, delivery) • Workforce reduction

7 Conclusion

A detailed study is done in this paper about the IoT usage in transportation and logistics industry. IoT usage would help this sector with many opportunities and benefits. It is highly recommended to adopt the Internet of Things into transportation and logistics to make it more effective operations and profitable. At present, transportation and logistics are technologically progress and facing a lot of challenges and seek a rapid renovation and growth with upcoming inventory tracking and location management systems. IoT will revolutionize the transportation and logistics domain.

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