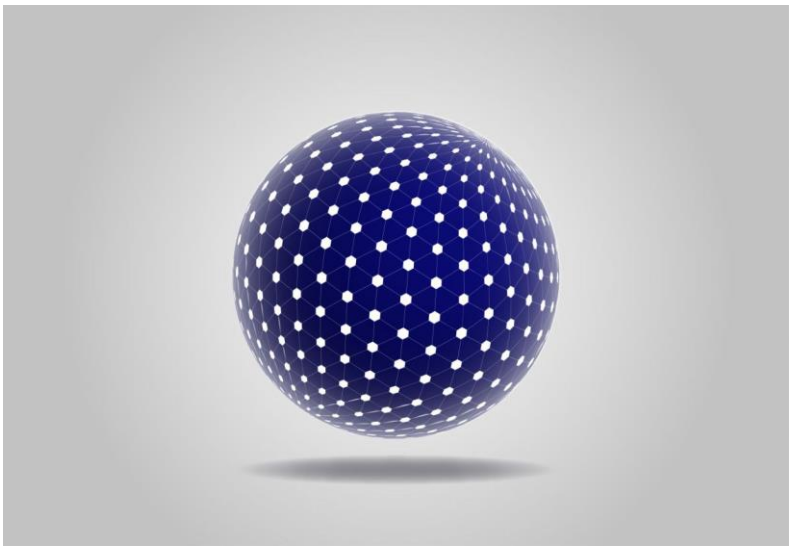

Internet of Things in Logistics and Transportation

Internet of Things (UFCEVK-15-2)

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Internet of Things in Transportation and Logistics

Introduction

The 'Internet of Things' (hereinafter abbreviated as IoT) refers to a network of embedded systems that use machine-to-machine communication to relay information and exchange data between one another through the internet. (Comer, 2015)

These embedded systems or devices can range from simple household appliances such as a light switch, to more advanced devices such as security systems or industrial equipment. By using resources such as cloud networks, open-source data, analytic tools, low-cost computing and mobile technologies, these devices can collect and share data with minimal human intervention. This helps to establish seamless communication between humans, processes and devices.

Given that IoT is a very broad field of computer science, the primary focus for this document will be on IoT's impact on Logistics and Transportation. This document will discuss how incorporating IoT into Logistics and Transportation services increases efficiency for both the customer and the service provider. We will also discuss issues currently faced by the industry, emerging solutions and aspects that could be improved in the future.

What is Smart Logistics?

Based on the modern developments in Information and Communication Technology (ICT) smart logistics can help to bring to reality the concept of a modern integrated logistics system using real-time processing and comprehensive analyzation of information in a timely manner, alongside the incorporation of self-adjustment capabilities. With the creation and usage of technologies such

as sensors, bar codes, RFID technology, etc, modern day logistics and transport systems have gradually evolved from mechanization to automation. (Song, Yu, Zhou, Yang, He, 2020)

IoT Architecture.

The general architecture of the IoT consists of four layers. From bottom to top these layers are, firstly the Sensing Layer, which uses advanced sensors to collect various physical data such as logos, audio, video etc. Secondly, the network layer consisting of infrastructures for communication and networking used to deliver the data collected from the sensing layer to the higher layers. Thirdly, the processing layer uses hardware platforms and intelligent algorithms to access, store and process the data. And finally, the application layer, which provides the services to IoT users. (Song, Yu, Zhou, Yang, He, 2020)

IoT Technologies and their Purposes in Logistics and Transportation.

There are several enabling technologies that are widely used for the deployment of successful IoT based products and services in smart logistics, the most essential of which are described below.

1) Radio Frequency Identification (RFID) is used to automatically identify, and track tags attached to objects by using electromagnetic fields. It does not require the tag to be visible to the reader and enables identification from a distance. Low-frequency (LF) tags are used to identify products and to collect data. High frequency (HF) tags are used as electronic tickets and electronic ID Cards in smart warehousing. Ultrahigh-frequency (UHF) tags are used for smart transportation, and Ultrawideband (UWB) tags are used to manage valuable

instruments and personnel in smart logistics as they can perceive precise positioning of people or objects. (Song, Yu, Zhou, Yang, He, 2020)

2) Wireless Sensor Networks (WSNs) are used to monitor, record and organize the collection of data at a central location. This can be used to monitor the status of transport vehicles in smart transportation and item status monitoring in smart warehousing. (Song, Yu, Zhou, Yang, He, 2020)

3) Wireless Communication Technologies are used to send the data collected from the sensor nodes to the base station and the designated client, as well as making it possible for the devices in the network to communicate with each other without a physical connection. (Song, Yu, Zhou, Yang, He, 2020)

4) Middleware is used to provide a standard data interface to connect the hardware of IoT and to provide data and other necessary resources for the system software. Middleware architectures are mostly service-oriented to support an unknown and dynamic network topology. This helps to provide a unified standard interface and public services for the application on different operating systems thus reducing development time and quality of the application software. (Song, Yu, Zhou, Yang, He, 2020)

Applications of Smart Logistics

1) Smart Logistics Transportation

IoT technologies are used to monitor the status of vehicles and cargo as well as the driver in real time. Data from these sources are combined and processed in order to help improve the efficiency of transportation, reduce the cost of the transportation and reduce chances of the cargo being damaged during transit. (Song, Yu, Zhou, Yang, He, 2020)

2) Smart Warehousing

IoT technologies are used to improve the product management process by assisting with the utilization of the warehouse space in an optimal manner, as well as to monitor and adjust the environmental conditions within the warehouse to store products. This can be done by using multi agent systems with decision making capabilities in order to process the data of the products and the environment and identify how to store products in the most efficient manner and decrease the power consumption. (Song, Yu, Zhou, Yang, He, 2020)

3) Smart Loading/Unloading

A major determinant of the speed and cost of logistics is loading/unloading, which is significantly improved by the use of IoT technologies. IoT can be used to automate the equipment being used, and to help position the equipment to make the process more efficient. It can also monitor the status of the equipment and dispatch other necessary equipment to help manage these resources. (Song, Yu, Zhou, Yang, He, 2020)

4) Smart Carrying

Recent advances in IoT technologies help enable us to use networks based on wireless communication technologies and automated guided vehicle systems to transport goods both within the organization, as well as to the end consumer. This helps to further increase the efficiency of transportation whilst at the same time reducing the cost of transportation. (Song, Yu, Zhou, Yang, He, 2020)

5) Smart Packaging

Sensors such as RFID, NFC, Bluetooth, smart labels and networks can be used to make smart packaging which enable companies to read and recognize the contents of the package easily. Smart packaging improves package tracking and tracing which significantly reduces product misplacement and helps businesses make decisions on the go and reduce product recalls. (Song, Yu, Zhou, Yang, He, 2020)

6) Smart Distribution

Smart Distribution involves the use of IoT technologies to help manage intelligent distribution centers and helps to develop smart approaches to delivery services. Data collected by the IoT devices along with the help of information processing systems can be used to allocate work in the distribution center to manage tasks and improve efficiency. Intelligent delivery approaches such as intelligent containers and autonomous vehicles

helps to ensure that the packages are delivered on time and in good condition. (Song, Yu, Zhou, Yang, He, 2020)

7) Smart Information Processing

Logistic information based on IoT technologies are used to design and improve logistics management models and logistics information systems. These models provide vital information such as optimized delivery paths, procurement processes and intelligent payment methods to logistics managers, which are used implement future strategies and control necessary functions in logistic systems. (Song, Yu, Zhou, Yang, He, 2020).

Current Challenges

Despite the many advancements in the field of smart logistics, there are a few issues that need to be addressed before smart logistics can reach its full potential. The three major challenges are in the areas of Privacy and Security, A Lack of Standardization and Issues in Resource Management. (Tadejko, 2015)

1) Privacy and Security

One of the aspects of IoT is a network of devices which are interconnected with each other. These devices are constantly exchanging information; thus, it is essential to figure out how to reliably store these vast amounts of data and interpret it in the most efficient way. Furthermore, since logistic services deal with a lot of

customers personal data such as the product purchases, their identity, location, contact information as well as payment information. It therefore raises many privacy and security concerns, hence reliable security and privacy protocols are essential. (Tadejko, 2015). Using block chain technology along with IoT is a possible solution to this problem. The concept of block chain technology is using sequential, encrypted and chained blocks to store synchronized data that has been validated across peer-to-peer networks. It uses IoT enabled sensors to ensure that only the legitimate person will receive the broadcast transaction. This helps to maintain the integrity of the transported products and a creates a complete record of the overall shipping process that can be maintained, which can further help in tracking the package. It also helps to validate the payment transaction, thus reducing the risk of fraudulent activity and helps keep customer information secure from any outside sources trying to access the confidential data. (Humayun, Jhanjhi, Hamid, Ahmed, 2020)

2) Standardization

The field of IoT demands the need for appropriate legal and systematic regulations, one of which mainly regards the aforementioned privacy and personal data concerns. The rapid rate of growth of IoT technologies further makes it difficult to adapt existing laws and regulations as needed. Standardless IoT raises several risks such as unauthorized access and use of personal information which enables attacks on other systems, thus potentially endangering the personal safety of individuals. Thus, it is necessary for these core concerns of IoT users to be

addressed by a set of minimum standards (including robust privacy standards) which businesses should be enforced to mandate. (Tadejko, 2015).

Some steps have already been taken such as in 2014, where the European Union published an Opinion (Opinion 8/2014 on the Recent Development of the Internet of Things). This opinion establishes that European Data Protection Law applies even if the data controller is outside of the European Union. This opinion was subsequently codified into European Union Law via the General Data Protection Regulation (2016/679), forcing many service providers to follow a set standard of regulations regardless of the location or place of operation of the data controller. In March 2015 the Alliance for Internet of Things Innovation (AIOTI) was created by the European Commission, and the Digital Markets Act and Digital Services Act were adopted in 2022, tackling interoperability and strengthening standardization across many digital logistics sectors. (Tadejko, 2015).

In January 2015, the Federal Trade Commission of the United States (FTC) released a report on “The Internet of Things: Privacy and Security in a Connected World” (FTC Staff Report, 2015), which provides a series of concrete steps that businesses can take to enhance and protect consumers privacy and security (Tadejko, 2015).

3) Resource Management

Once again as the IoT technologies are an interconnected network of devices and other such technologies, which in turn are connected to the internet, thus it is necessary to manage a large variety of protocols, data formats and sensors. Therefore, resources provided by these devices must be efficiently managed and provisioned. (Song, Yu, Zhou, Yang, He, 2020).

Future Directions

With the sudden development and improvement of Artificial intelligence (AI) Technologies recently, these advancements are slowly being integrated into IoT Technologies as well. With IoT and AI Technologies working together to improve current logistics operations, the future possibilities for smart logistics are near limitless. For instance, AI can help smart users manage their operations by using external data and machine learning to self-learn and adapt to various conditions such as demand and resource availability. (Song, Yu, Zhou, Yang, He, 2020).

AI technologies, IoT, big data and cloud computing can be used together to further improve smart warehouse management as well. An intelligent algorithm can help classify and mange items and automate the storage process. Cloud computing could allow users to have access to the stock available in the warehouse in real time. AI robots and automatons can be used to help in the loading and unloading process of goods as well as unmanned transportation and distribution. AI algorithms can be used to help with intelligent

packaging by calculating the recommend packing material and size of the boxes. AI based Speech recognition programs can be used to build customer service agents which can recognize key knowledge points and search the necessary information whilst also as predict consumer behavior. This helps lessen the work of manual customer service agents and assists them by improving customer service quality as well as overall work efficiency. (Song, Yu, Zhou, Yang, He, 2020).

Conclusion

All things considered, IoT technologies have had a major impact on the field of logistics and transportation. Where logistics and transportation services are a modern necessity, intergrating IoT and emerging smart technologies can help vastly improve this field. The future for smart logistics, especially with the emergence of AI, has countless possibilities. However, we must be aware of the major issues associated with IoT such as the risks and threats caused by a lack of privacy regulations or standardisation in the field. These must first be addressed in order to achieve the perfect balance between business and commerical efficiency, alongside rigid consumer security and privacy. Once this perfect balance is struck, the most ideal form of smart logistics can be achieved.

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