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THE APPLICATION OF INTERNET OF THINGS IN LOGISTICS

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Abstract:
Already now is increasingly used integration the principle of the Internet of things in the logistics chain, and it is generally expected that this trend will continue to strengthen. The main role will play a higher level of automation and the expectation greater efficiency and accuracy. Assistance should seek a combination of new smart sensors, information and database systems capable of processing large amounts of data in real time. The Internet of Things connects devices, that can include various sensors for monitoring multiple values and gain massive amounts of valuable data. For processing such data, and presenting the results of their analysis is introduced technology called "Big data". Application of the Internet of Things and technology Big Data in logistics can provide many competitive advantages, like as for example supervise product in real time and their circulation in supply chain, forecasting the future trends or optimization of supply chain management.

Key words: *Intertnet of Things (IoT), IPv6, RFID, Big Data*

1 INTRODUCTION

The Internet of Things (IoT) is currently one of the most frequently mentioned new terms of information and communication technologies. Perception of the term Internet of Things and its definition may often vary depending on the area of application.

2 INTERNET OF THINGS

The Internet of Things is the network of physical objects or "things" accessible via the internet, these objects have built-in technology to interact internal conditions or external environment. IoT is composed of sensors and end devices carrying out certain activities connected to the data network over which they communicate and systems for storing and processing data. Each thing is uniquely identifiable. IoT is most often equated to machine-to-machine (M2M) connections but, as noted, definitions of IoT are nearly as diverse as its applications. Internet of Things, giving a digital presence to objects of the physical world, is becoming part of our daily lives. It is happening in different forms: smartphones and their downloadable apps, home multimedia systems, RFID identification and tracking. Many more applications are expected in the coming years, connecting our phones, cars, appliances, buildings, toys, cities, environment, and social networks, towards a richer world. These applications will result in unprecedented amount of data.

Devices can include various sensors for monitoring multiple values – acceleration, flow, chemical, gas, temperature, humidity, vibration, position, motion and many other. In technical terms, devices can communicate with many different ways. The most commonly used wireless networks Wi-Fi, Zigbee, RFID (Radio-Frequency Identification), NFC (Near Filed Communication), GPS (Global Positioning System), GSM network, LTE or Bluetooth low energy (Fig. 1).

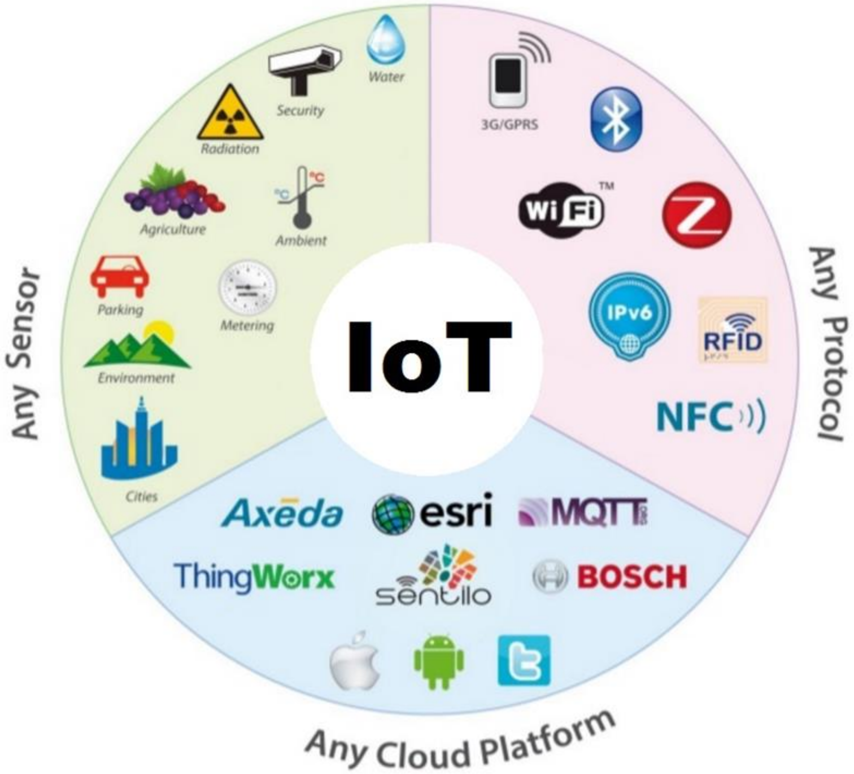

Fig. 1 *Various sensors, protocol and cloud platform in IoT*
Source: Alex Mateo [1]

Cisco estimates that 50 billion devices and objects will be connected to the Internet by 2020 [2]. More devices generates more data. A new report from ABI Research estimates that the volume of data captured by IoT-connected devices exceeded
200 exabytes in 2014. The annual total is forecast to grow seven-fold by the decade's end, surpassing 1,600 exabytes or 1.6 zettabytes in 2020 [3]. For evaluating the often enormous amount of data which are generated by the device we can use Big Data which can bringing analytical information in real time. So that in the future all devices, whose number is constantly grow, be able to communicate with each other will be necessary fulfil one more basic prerequisite. And that is support for IPv6.

3 IPv6

IPv6 (Internet Protocol version 6) is the most recent version of the Internet Protocol (IP), the communications protocol that provides an identification and location system for computers on networks and routes traffic across the Internet. The Internet Protocol is a must and a requirement for any Internet connection. It is the addressing scheme for any data transfer on the web. Every device on the Internet is assigned an IP address for identification and location definition. IPv6 uses a 128-bit address, allowing 2^{128} (approximately 3.4×10^{38}) unique addresses. IPv6 provides other technical benefits in addition to a larger addressing space. In particular, it permits hierarchical address allocation methods that facilitate route aggregation across the Internet, and thus limit the expansion of routing tables. The use of multicast addressing is expanded and simplified, and provides additional optimization for the delivery of services. Device mobility, security, and configuration aspects have been considered in the design of the protocol. IPv6 application to the Internet of Things has been being researched since many years. The research community has developed a compressed version of IPv6 named 6LoWPAN. It is a simple and efficient mechanism to shorten the IPv6 address size for constrained devices, while border routers can translate those compressed addresses into regular IPv6 addresses. IPv6 will be (and actually it is already) a key enabler for the future Internet of Things.

4 RFID

An example of a technology that is widely used in logistics is RFID. RFID is an automatic identification technology. The RFID system mainly consists of two parts: the Reader and the RFID Tag, between them through radio frequency way to communication. Each tag has a unique electronic code, be attached to each object to identify the different objects, and some labels can also store related objects of simple information. The working principle of RFID is: the reader sends out radio waves of specific frequency energy to the electronic tags, electronic tag receives the radio waves. If is a passive tag, the induced current obtained with the energy stored in the chip information sent to the reader, if is an active tags, the active information in the chip of a particular frequency of the signal sent to the reader. Reader receives the feedback signal sent to the information system for processing. Compared with other identification technology, RFID identification system have more advantages, such as no-contact, high degree of automation, durable and reliable, recognition speed, adapt the working environment, enabling both high speed and multi-tag identification and so on. Currently, RFID is emerging as an important technology for revolutionizing a wide range of applications, including supply chain management.

5 BIG DATA

The term “Big data” has commonly been used for datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze within a tolerable amount of time. The data is too big, moves too fast, or doesn’t fit the strictures of your database architectures [4].

Big data can be described by the following characteristics - called 3Vs+1(Fig. 2):

- **Volume** – The quantity of data that is generated.
- **Variety** - The next aspect of Big Data is its variety. Data comes from different sources and is being created by machines as well as people.
- **Velocity** - The term ‘velocity’ in the context refers to the speed of generation of data or how fast the data is generated and processed to meet the demands
- **Veracity** - The quality of the data being captured can vary greatly. Accuracy of analysis depends on the veracity of the source data.

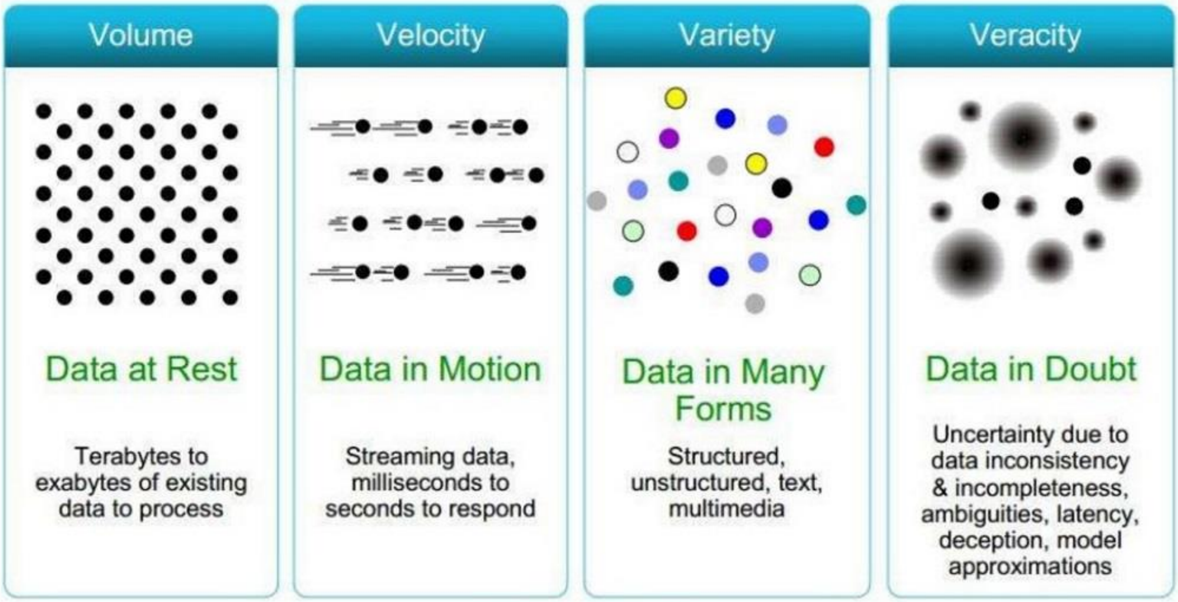

***Fig. 2** Basic characteristic of Big data – 3Vs+1*
Source: Dr. Victoria López [5]

Today's digital world is expanding at a rate that doubles the data volume every two years. In addition to this exponential growth in volume, two further characteristics of data have substantially changed. Firstly, data is pouring in. The massive deployment of connected devices such as cars, smartphones, RFID readers, webcams, and sensor networks adds a huge number of autonomous data sources. Devices such as these continuously generate data streams without human intervention, increasing the velocity of data aggregation and processing. Secondly, data is extremely varied. The vast majority of newly created data stems from camera images, video and surveillance footage, blog entries, forum discussions, and e-commerce catalogs. All of these unstructured data sources contribute to a much higher variety of data types. it includes not only structured traditional relational data, but also semi-structured and unstructured data.

Raw data is often of little value, but may even merely be a heavy monetary and environmental cost by devouring valuable resources, e.g. in infrastructure such as storage hardware, and energy for running this infrastructure. It is the information the data potentially carries that has the real value, and the tools for extracting this value are found in Big Data Analytics. The real value of big data is in the insights it produces when analyzed—discovered patterns, derived meaning, indicators for decisions, and ultimately the ability to respond to the world with greater intelligence. Big data analytics is a set of advanced technologies designed to work with large volumes of heterogeneous data. It uses sophisticated quantitative methods such as machine learning, neural networks, robotics, computational mathematics, and artificial intelligence to explore the data and to discover interrelationships and patterns.

This emerging field involves several coexisting and interdependent levels. Firstly, the data must be collected, e.g. using sensor technology in an industrial setting or in distributed sensor networks by extracting traffic data from cellular networks, or through embedded technology in the Internet of Things. As the data has been collected it requires scalable, robust and secure storage solutions that support huge volumes of data, e.g. using virtualised cloud environments. Processing Big Data, in turn, puts demand on computational frameworks and models that need to be fault tolerant, flexible and light weight, e.g. by supporting iterative and stream computing, as well as local processing of data. Computing and storage solutions form basis for advanced data analysis, including machine learning and statistical modeling.
Comparison of traditional methods and large data:

Traditional Methods

- More power
- Summarize data
- Transform and store
- Pre-defined schema
- Move data → compute
- Less data / more complex algorithms

Big Data

- More machines
- Keep all data
- Transform on demand
- Flexible / no schema
- Move compute → data
- Mode data / simple algorithms

Big Data and Cloud

Big data analytics offers the promise of providing valuable insights that can create competitive advantage, spark new innovations, and drive increased revenues. Cloud computing has the potential to enhance business agility and productivity while enabling greater efficiencies and reducing costs. IT organizations should look to cloud computing as the structure to support their big data projects. Big data environments require clusters of servers to support the tools that process the large volumes, high velocity, and varied formats of big data. Clouds are already deployed on pools of server, storage, and networking resources and can scale up or down as needed. Cloud computing offers a cost-effective way to support big data technologies and the advanced analytics applications that can drive business value.

What makes cloud computing such a cost-effective delivery model for big data analytics? Currently, 80 percent of data is unstructured (for example, e-mails, documents, video, images, and social media content) and 20 percent is structured (for example, credit card transactions and contact information) [6]. With the potential for so much data to reveal insights that can boost competitiveness, companies must find new approaches to processing, managing, and analyzing their data - whether it's structured data typically found in traditional relational database management systems (RDBMSs) or more varied, unstructured formats. Plus, combining diverse data sources and types has the potential to uncover some of the most interesting unexplored patterns and relationships. Data analytics is moving from batch to real time. At the same time, the technology for processing real-time or near-real-time information is moving past hype to early stages of maturity.

Real time supports predictive analytics. Predictive analytics enables organizations to move to a future-oriented view of what's ahead and offers organizations some of the most exciting opportunities for driving value from big data. Real-time data provides the prospect for fast, accurate, and flexible predictive analytics that quickly adapt to changing business conditions. The faster you analyze your data, the more timely the results, and the greater its predictive value. The scope of big data analytics continues to expand. Early interest in big data analytics focused primarily on business and social data sources, such as e-mail, videos, tweets, Facebook posts, reviews, and Web behavior. The scope of interest in big data analytics is growing to include data from intelligent systems, such as in-vehicle infotainment, kiosks, smart meters, and many others, and device sensors at the edge of networks - some of the largest volume, fastest streaming, and most complex big data. Ubiquitous connectivity and the growth of sensors and intelligent systems have opened up a whole new storehouse of valuable information.

Using cloud infrastructure to analyze big data makes sense because, Big Data may mix internal and external sources. While enterprises often keep their most sensitive data in-house, huge volumes of big data (owned by the organization or generated by third-party and public providers) may be located externally, some of it already in a cloud environment. Moving relevant data sources behind your firewall can be a significant commitment of resources. Cloud computing models can help accelerate the potential for scalable analytics solutions. Clouds offer flexibility and efficiencies for accessing data, delivering insights, and driving value. However, cloud-based big data analytics is not a onesize-fits-all solution.

6 APPLICATION IN LOGISTICS

The logistics sector is ideally placed to benefit from the technological and methodological advancements of Internet of Thing and Big Data. Today logistics providers manage a massive flow of goods and at the same time create vast data sets. Millions of shipments every day, origin and destination, size, weight, content, and location are all tracked across global delivery networks. Most likely there is huge untapped potential for improving operational efficiency and customer experience, and creating useful new business models. Consider, for example, the benefits of integrating supply chain data streams from multiple logistics providers; this could eliminate current market fragmentation, enabling powerful new collaboration and services.

Big Data analytics falls into one of three dimensions. The first and most obvious is operational efficiency. In this case, data is used to make better decisions, to optimize resource consumption, and to improve process quality and performance. It's what automated data processing has always provided, but with an enhanced set of capabilities. The second dimension is customer experience; typical aims are to increase customer loyalty, perform precise customer segmentation, and optimize customer service. Including the vast data resources of the public Internet, Big Data propels CRM (Customer relationship management) techniques to the next evolutionary stage. It also enables new business models to complement revenue streams from existing products, and to create additional revenue from entirely new (data) products.

In the logistics industry, Big Data analytics can provide competitive advantage because of five distinct properties. These five properties highlight where Big Data can be most effectively applied in the logistics industry:

1. **Optimization** - Optimization of service properties like delivery time, resource utilization, and geographical coverage. Large-scale logistics operations require data to run efficiently. The earlier this information is available and the more precise the information is, the better the optimization results will become. Advanced predictive techniques and real-time processing promise to provide a new quality in capacity forecast and resource control
2. **Goods, customers** - The delivery of tangible goods requires a direct customer interaction at pickup and delivery. On a global scale, millions of customer touch points a day create an opportunity for market intelligence, product feedback or even demographics. Big Data concepts provide versatile analytic means in order to generate valuable insight on consumer sentiment and product quality.
3. **Sync with customer business** - Modern logistics solutions seamlessly integrate into production and distribution processes in various industries. The tight level of integration with customer operations let logistics providers feel the heartbeat of individual businesses, vertical markets, or regions. The application of analytic methodology to this

comprehensive knowledge reveals supply chain risks and provides resilience against disruptions.

4. **A network of information** - The transport and delivery network is a high resolution data source. Apart from using data for optimizing the network itself, network data may provide valuable insight on the global flow of goods. The power and diversity of Big Data analytics moves the level of observation to a microeconomic viewpoint.
5. **Global coverage, local presence** - Local presence and decentralized operations is a necessity for logistics services. A fleet of vehicles moving across the country to automatically collect local information along the transport routes. Processing this huge stream of data originating from a large delivery fleet creates a valuable zoom display for demographic, environmental, and traffic statistics.

The connected intelligence of IoT can be embedded across the logistics infrastructure and in the containers and products themselves. The Internet of Things can include connected intelligence in different elements of logistics infrastructure:

- **Vehicles** - Modern vehicles contain numerous sensors and electronic control units that generate large amounts of data. This data can be very useful for diagnostics, traffic safety, product development, etc. At the same time, the distributed and mobile nature of those systems makes them challenging to analyse. However, the benefits that can be obtained, for example by increasing fuel efficiency or by reducing the number of dangerous situations, make it an important area for both research and innovation.
- **Sites** - ports, yards, consolidation/deconsolidation centers, warehouses, and distribution centers, including: Mobile equipment - e.g. forklifts, yard tractors, container handlers, mobile cranes; Stationary or semi-stationary equipment - e.g. gantry cranes, conveyor belts, carousels, automated storage and retrieval systems; Site structures and ingress/egress points - e.g. sensors in dock doors, yard entry/exit gates, light poles, embedded in floors or under pavement, attached to ceilings and other structures.
- **Roads/Lanes** - Intelligence is starting to be built into roadways, railways, runways, canals/locks, and other transportation conduits. Because they cover so much more territory, the intelligence built into these is typically sparser than IoT in the vehicles and sites.

In addition, intelligence is increasingly being built into (or attached to) the products and items themselves and/or the containers they are moved in such as cases, pallets, intermodal containers, unit load devices (ULD), crates, tanks, cylinders, intermediate bulk containers (IBC), insulated shipping containers, and so forth. This intelligence could include RFID to identify items or containers (and their contents) as they pass by way points or dwell in any location on the journey. It can also include sensors to determine condition, such as temperature, shock, vibration, humidity, and so forth. The item may generate an alert when something goes beyond certain thresholds. For example, a container of temperature sensitive pharmaceuticals could generate an alert when it senses an excursion outside of the required temperature range, so that action could be taken before the drug's efficacy is compromised (Fig. 3).

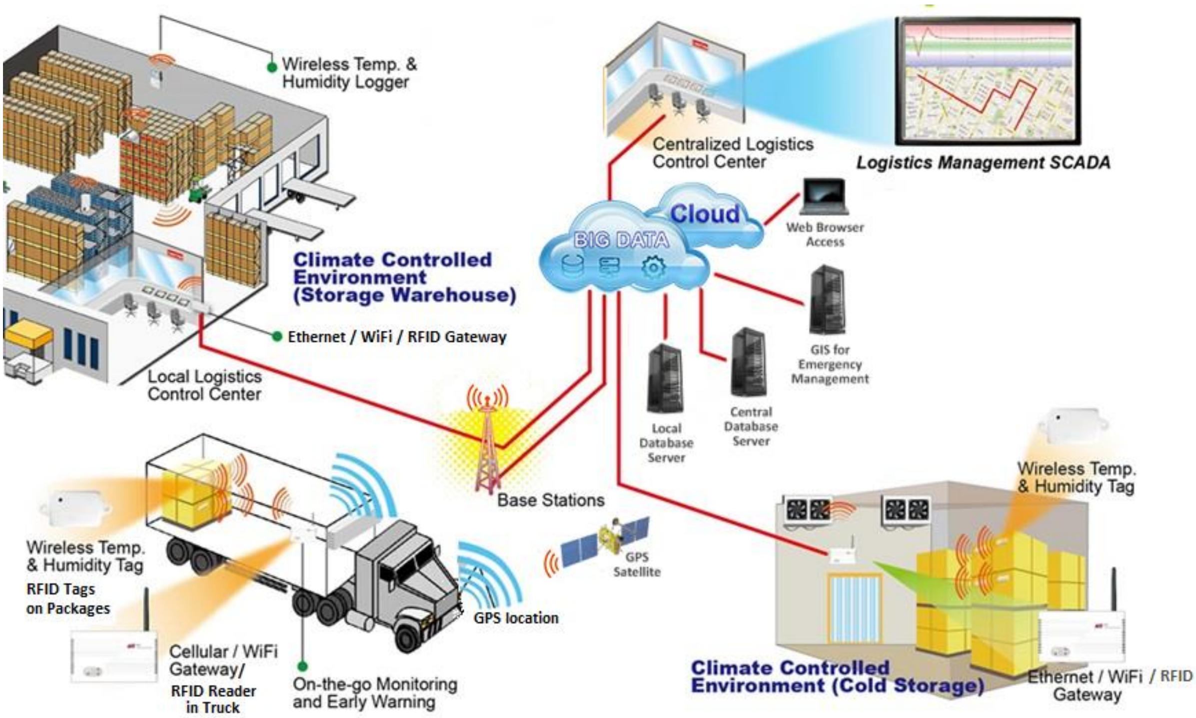

Fig. 3 *RFID include sensors to determine condition of packages*
Source: Author based on [7]

Some ways which the IoT will change logistics in the near term:

6. Pallets and forklifts will report their locations on GPS systems
7. Migration of data to cloud-based GPS and RadioFrequency Identification (RFID) technologies
8. Vastly improved pre-shipment planning incorporating real-time data
9. Automated temperature controls based on dynamic environmental conditions
10. Use of real-time traffic data in route planning and transportation decision making
11. Maximizing fleet efficiencies by reducing deadhead miles
12. The ability to lower fuel costs
13. Greater worker safety (reduced work-related injuries)
14. Increasingly flexible warehousing operations
15. Improved load production
16. Reduced asset loss/increase in physical security

To achieve this, there will be some key success factors required:

- Clear and standardized approach for the use of unique identifiers or ‘tags’ for various types of assets among different industries on a global scale
- Seamless interoperability for exchanging sensor information in heterogeneous environments
- Establishment of trust and ownership of data and overcoming privacy issues in the IoT-powered supply chain
- Clear focus on reference architecture for the IoT
- Change in business mindset to embrace the full potential of the Internet of Things

7 OBSTACLE, RISKS AND THREATS

Obstacle in greater and faster use of IoT is the absence of a unified protocol. At present, stand against each other two alliances with a different approach - Open Interconnect Consortium (OIC) and AllSeen Alliance. In the future, the problem may occur when all devices will not be compatible and there will be no communication between them or collecting the necessary data, because of the existence of two or more different protocols IoT.

Although the absence of a unified protocol for IoT can bring a host of complications, there are several serious threats that can disrupt deployment or massive utilization of IoT technologies in practice. The most frequently mentioned is the threat of data leakage. To prevent leakage of sensitive data, it is necessary to enforce strict rules associated with passwords, encryption of communication and data itself, a clear distinction, who owns a specific date, who has the right to approach them, and where the data resides. Another threat is congestion data. In the event that they are poorly chosen hardware or software resources may be situations where the data will not be saved, stored poorly, they will be stored in an inappropriate format, or not deployed a suitable solution enables the efficient analysis and processing. Last but not least the risk of deliberate attacks on data from the internet to the data damage or to overload the entire system and cause it to malfunction (e.g. DDoS – Distributed Denial-of-Service). These attacks can then mean blackouts for several hours, which can mean significant financial losses. Which is why companies have to deal with these security issues as a priority in the deployment of IoT.

8 CONCLUSION

With IoT enterprises can supervise their every product in real time, and manage their logistics architecture. They not only supervise the circulation in supply chain and share information, but also analyze the information generated from every procedure and forecast. By forecasting the information from the current procedure of their products, the future trend or the probability that accident happens is estimated, remedy measures can be adopted or the warning can be given ahead. This can improve enterprises ability of responding to the market. IoT can affect the whole supply chain. Firstly it can optimize the supply chain management. Secondly it can make sources to be used effectively. Thirdly it can make the whole supply chain to be visible so that it can improve the information of supply chain transparency. Fourthly the supply chain can be managed in real time and the lastly it can make the supply chain high agility and complete integration. IoT affects the supply chain management in manufacturing link, warehousing link, transportation link and selling link. It makes enterprises even all the whole supply change response to the varied market quickly so that the adaptability of the supply chain to market verification changes is improved.

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