Internet of Things with the Industrial Marketplace

Subjects: Computer Science, Cybernetics

Contributor: NEBOJSA BACANIN , Kazhan Mohammed Salih , Tarik Rashid , Dalibor Radovanovic

There is no doubt that new technology has become one of the crucial parts of most people's lives around the world. By and large, in this era, the Internet and the Internet of Things (IoT) have become the most indispensable parts of our lives. Recently, IoT technologies have been regarded as the most broadly used tools among other technologies. The tools and the facilities of IoT technologies within the marketplace are part of Industry 4.0. The marketplace is too regarded as a new area that can be used with IoT technologies. One of the main purposes of this paper is to highlight using IoT technologies in Industry 4.0, and the Industrial Internet of Things (IIoT) is another feature revised.

IoT Industry 4.0 IIoT IoT applications telemedicine COVID-19 marketplace

1. Introduction

The human connection is one of the most important types of communication available on the Internet. The Internet is a global network that allows humans from all over the world to communicate with one another. A human-organized network of computers and smartphones is required to access the Internet. Personal computers and smartphones are examples of such devices. As a result, it has come to be known as "the Internet of People".

In a matter of a few years upcoming, the Internet will grow and evolve into the Internet of Things (IoT), shifting away from human-to-human communication and toward computers interacting with one another, which is also known as machine-to-machine (M2M) communication [1]. This new mode of communication will have a profound impact on the way people communicate and compute in their daily lives.

Kevin Ashton was the first who, in 1999, used the term Internet of Things [2]. Since 2008, the total number of things connected to the IoT has outnumbered the total number of people living on the planet. The IoT is expected to make it possible for everyone to access and provide a vast amount of information about equipment and locations in the future.

The IoT can be used to connect a variety of objects to a network, including artificial articles, plants, and animals. This can be counted as one of the fundamental differences between the IoT and the rest of the world. The IoT is still based on the Internet, but it is the most logical evolutionary and technological step forward for the Internet in recent history.

2. Industry 4.0 and the Industrial Internet of Things

In the last few years, the IoT has rapidly expanded as an overarching concept that is used both to use extended Internet technology as a global network that interconnects various artifacts and to incorporate such a vision into technology (including, e.g., RFIDs, sensors, protocols for physical and network layers, etc.) [3][4]. The IoT and IIoT, besides the digitalization of industrial manufacturing, can be considered as having instigated the fourth industrial revolution (Industry 4.0) [5].

Several industries use the IoT. The redesign of the industrial IoT model will speed up the advent of the next industrial revolution, also known as "Industry 4.0" [6][7][8].

One of the foremost characteristics of Industry 4.0 is the IIoT. The IIoT is supposed to be an excellent aspect of Industry 4.0, which will include highly efficient technology arrangements in many of the current industrial fields like transportation and manufacturing [8][9]. In addition, the IoT is a component of the Industry 4.0 concept, which emphasizes the idea of consistent digitalization and connectivity between all productive units, while still retaining the advantages of the traditional manufacturing process [9][10]. This section briefly reviews some points within Industry 4.0 and the IIoT. Some functions of Industry 4.0, the IIoT, and IoT are presented in **Figure 1** [11].

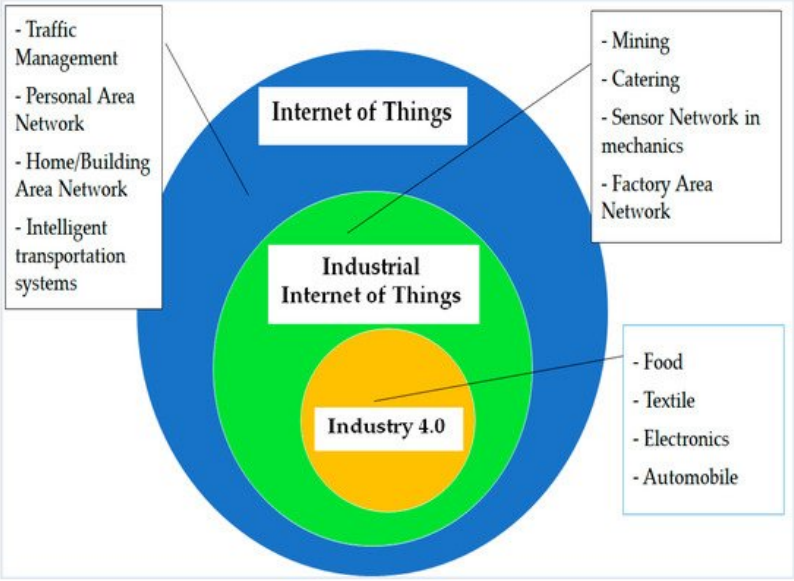

Figure 1. The IoT, IIoT, and Industry 4.0.

2.1. Industry 4.0

The term “Industry 4.0” refers to the fourth industrial revolution, which is characterized by the digitalization of the system’s physical assets as well as the smart development of goods through the use of internet-based technology [12][13]. In the manufacturing fields, machines and sensors can be connected via the Internet to work better. Implementing Industry 4.0 would make devices and also sensors interconnected to the Internet; this makes the work easier. **Table 1** indicates how the industry improved from Industry 1.0, from 1784 to the present, with Industry 4.0 incorporating IoT technologies [14].

Table 1. Industry 4.0.

	Years			
	1784	**1870**	**1969**	**Today**
Industrial Revolution	Industry 1.0 Mechanization Steam power Weaving loom	Industry 2.0 Mass production Assembly line Electrical energy	Industry 3.0 Automation Computers and electronics	Industry 4.0 Cyber-physical systems Internet of Things networks

Industry 4.0, which is a vital German ambition, intends to modify intelligent plant production technologies, transforming and upgrading these with cyber-physical systems (CPSs), the IoT, and cloud computing [15][16][17]. It is necessary to include the IoT as an enabling tool for connecting and cooperating humsn in real-time with cloud-enabled infrastructure and cyber-physical systems, in the ongoing development that is currently guided by Industry 4.0 [18].

With the integration of advanced manufacturing systems with intelligent manufacturing processes, Industry 4.0 enables a new era in technology that fundamentally alters the supply chains, value chains of production, and business models of industries [17]. Cloud services have helped to revolutionize unique IT cloud infrastructures that allow the representation of devices, which allow the incorporation of technological applications and AI bots [18][19][20].

Aside from sensors, smart factories have successfully adopted many RFID applications [21][22][23]. This technology is critical for improving a variety of industrial automation tasks, including automatic identification of products, instruments, and other production tools, as well as inbound/outbound tool management [21][24][25].

The following examples will demonstrate the value of diverse and widespread uses in the automobile industry:

- Traffic management and toll collection system

The traffic management system plays an important part in ensuring the nation's economic stability [26][27]. With the increasing number of vehicles on the road, intelligent traffic signal timing depending on vehicle density can be managed using the IoT, locally deployed RSUs, and security cameras [26][28][29].

It informs the driver about the road condition (e.g., asphalt, wet, snow), traffic situation, and other unexpected information on the route, as well as emergency parking options [26][30].

2.Real-time vehicle navigationAn IoT-based real-time car navigation system has a huge impact on guaranteeing a safe and efficient transportation system [26][31].

When a vehicle encounters emergency issues such as an accident, an IoT-enabled model employing the SKM53 GPS module and the Haversine formula alerts the nearest rescue team for immediate assistance and speedy aid to victims [26][32]. The IoT applications can also be used to track school buses [26][33].

2.2. Industrial Internet of Things

The adoption of IoT technologies by the industry, the definition implemented by the German government in 2011 for the strategic planning of their manufactures, is also called IIoT or Industry 4.0 [3][34], in which today the new revolution of this industry is in use. To manufacture tangible products for the marketplace as well as to maintain the physical properties related to production, the Industrial IoT (or IIoT) should be understood as part of the larger IoT [35]. The IIoT, in smart manufacturing systems, will be able to produce a revolution in the process industry [35]. The IIoT can be considered one of the specific types of IoT; it is focused on its applications and use cases in modern industries and smart manufacturing, rather than on the Internet in general [5].

The IIoT, in a manufacturing firm, is undeniably empowering the industrial revolution (Industry 4.0) [36]. The IIoT differs from the customer IoT in that it focuses on interfacing smart gadgets in the fundamental framework, assembly, and procedure enterprises to create business points of interest [35][37]. The IIoT can be used for IoT technologies in the manufacturing sector.

An IIoT environment cannot be complete without WSNs and WSANs, and middleware that can monitor them [11]. More recently, the IIoT has emerged as an inferior model focused mainly on safety-critical applications in industrial operational applications [38][39]. IIoT technology and data analytics utilize (record, monitor, manage) real-time data to facilitate and illuminate money-saving choices [39]. In **Figure 2**, a proposed architecture for the manufacturing industry IIoT is demonstrated [40].

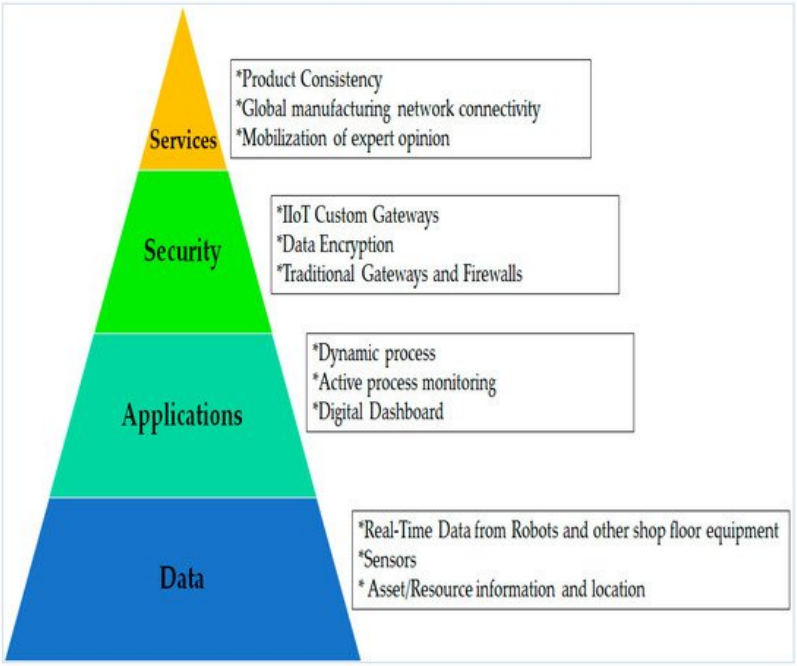

Figure 2. The proposed potential Industrial IoT (IIoT) architecture for the manufacturing industry.

According to [41], the IIoT connects many points of tools, data, and people throughout industrial environments, and it provides numerous major benefits once established.

- Automated Production

A key advantage that IIoT technology provides to its users is the ability to automate certain processes. Automated systems can be trained to conduct manual tasks that would normally be done by human workers on an assembly line using the IIoT. Automation in the IIoT reduces the amount of manual work that must be done by qualified personnel.

2.Maintenance and SafetyAutomated predictive maintenance and safety monitoring in manufacturing lines are common uses of the IoT. IIoT sensors provide firms with the capacity to examine numerous elements of performance and identify whether equipment needs to be updated or replaced or whether a worker is in contact with harmful working circumstances. For the protection of goods in transit, IIoT sensors may also monitor environmental elements like temperature and air quality.

3.Real-Time EfficienciesIt is common to utilize the IIoT as a preventative measure to avoid downtime due to equipment failures and other performance concerns because of its emphasis on gathering as many real-time data points and insights as possible. Having less downtime in the workplace leads to improved productivity and efficiency in the workplace.

4.Workforce-Equipment ConnectivityHuman workers run equipment in a more traditional factory or industrial setting, while automated machines follow their programming. The IIoT is one of the few technological solutions that breaks down barriers between workers and their equipment. Users acquire more direct insights from their tools, and tools learn over time as a result of human engagement.

3. IoT Marketplace

This section reviews some of the trends and facts related to the IoT technologies in the marketplace, and how the population has been affected in this area. Firstly, global pollution must be taken into consideration as this subject is directly linked with technology areas, especially nowadays.

It is undeniable that the population has increased throughout the world and that it will continue to grow at an alarming rate. Humans, devices, and “things” are all connected in the technology world, and population growth has had an impact on the number of interconnectors available, including those in the IoT technology domain as well. By 2020, nearly every person on the planet had more than six devices connected to the Internet, according to a report from Cisco [42], which explains how the world population has grown in comparison to the number of connected devices per person over the period from 2003 to 2020, and demonstrates how the number of connected devices will increase dramatically. It was predicted that the number of devices that could be interconnected with one another would reach nearly 50 billion by 2021, which represents more than three times the number of devices that were connected in 2010 when 12.5 billion devices were connected [42]. The population has a significant and direct relationship with new technologies, including the IoT, and this has had an impact on the number of smart devices that can be interconnected with one another on the one hand, and on the ability of the IoT to influence the marketplace on the other.

IoT technologies have emerged as one of the most important aspects of the environment’s domain; through the use of IoT technologies, millions of devices can communicate with one another and exchange information. As reported by Cisco [42], the total number of Internet-connected devices is expected to exceed 50 billion by 2020. According to a report by [43], one trillion networked sensors will be embedded in the world around us by 2022, with up to 45 trillion in 20 years.

While it is true that the number of interconnectors has increased as a result of new technologies, it should be noted that IoT technologies are also included in this topic. Using the infrastructure provided by the IoT domains, a massive number of devices and things can be connected to exchange information among themselves.

Aside from that, according to [44], the comprehensive IoT and the number of interconnected devices within IoT areas is expected to grow significantly from year to year, reaching 75.44 billion globally by 2025, representing a five-fold increase in ten years. **Figure 3** shows IoT-connected devices were and are predicted to be installed worldwide from 2015 to 2025 (in billions) [44].

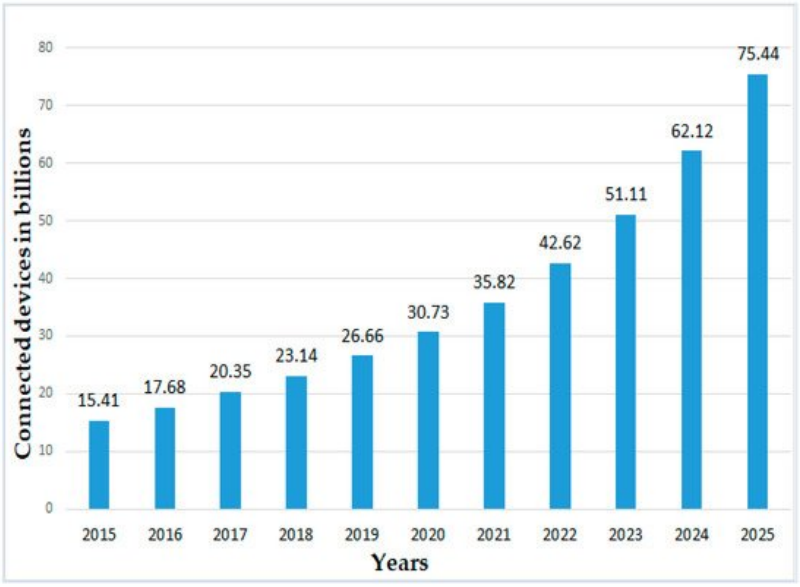

Figure 3. IoT connected devices installed worldwide from 2015 to 2025 (in billions).

The IoT has advanced in a variety of areas over the years, and it is expected to continue to grow in the future. IoT technologies have become one of the most significant revolts in the digital domains on the commercial marketplaces for a variety of goods. Recently, the IoT has had an impact on a variety of areas in human life; it is clear that the IoT is a gateway to the marketplaces that is currently trending, and that IoT technologies have had an impact on the majority of marketplace sectors. Numerous factors have had an influence and are being tracked, including the growing environment, management, production, transportation, and markets, among others.

Because Microcontroller for IoT technologies has been thought by many companies from many countries, the trends of IoT technologies are growing in the field of marketplaces. Various devices can be used within the facility of the IoT marketplaces, and as mentioned by [45], some of the IoT casting devices in the market are the Apple Airplay, Google Chromecast, and Amazon Firesticks.

In the IIoT sector, there is an increasing number of IT businesses, and some of the best providers have made the most progress: ABB, Cisco, Huawei, Intel, etc. [41]. This is where the vast majority of IIoT use-cases are now being implemented. To improve their operational visibility and real-time data understanding, businesses are turning to leading IIoT providers.

A joint initiative between Huawei and DHL will focus on cell-based IoT technology that can link high numbers of devices over great distances with little power usage. Data and insight into warehousing operations, freight transportation, and last-mile delivery will be provided by enhanced connectivity, which will result in a more integrated logistics in the value chain [41][46].

References [41][47] intended to collect real-time quality data and use the same data to identify trends that could help prevent faults before they occur. The researchers' goal was to keep production moving as quickly as possible by alerting the person in charge promptly if any of the equipment failed or there was a power loss.

Table 2 shows the IoT endpoint market segmented by industry, between 2018 and 2020, with segments spanning utilities and governance, to building, automation, and physical security, to manufacturing and natural resources, to automotive and healthcare providers, to retail and wholesale trade, to information and transportation [48].

Table 2. IoT endpoint market by segment, 2018–2020, worldwide (installed base, billions of units). Source: Gartner (August 2019).

Years / Segment	Utilities	Government	Building Automation	Physical Security	Manufacturing & Natural Resources	Automotive	Healthcare Providers	Retail & Wholesale Trade	Information	Transportation	Total
2018	0.98	0.4	0.23	0.83	0.33	0.27	0.21	0.29	0.37	0.06	3.96

Years / Segment	Utilities	Government	Building Automation	Physical Security	Manufacturing & Natural Resources	Automotive	Healthcare Providers	Retail & Wholesale Trade	Information	Transportation	Total
2019	1.17	0.53	0.31	0.95	0.4	0.36	0.28	0.36	0.37	0.07	4.81
2020	1.37	0.7	0.44	1.09	0.49	0.47	0.36	0.44	0.37	0.08	5.81

[6][49]

everyday objects to

according to [50][51].

RFID has the potential to transform dump devices into objects that are comparatively intelligent [6]. According to [52], the retail segment of the RFID market will have grown from $2.7 billion in 2018 to $5.4 billion by 2021, representing a compound annual growth rate of 38.9 percent over the forecast period.

RFID has dominated the marketing strategy since its inception, owing to its low cost and small size, as well as its widespread use [51]. Economic fluctuation is another significant challenge impeding the more active development of the RFID market, particularly in market areas such as smart healthcare, smart cities, and smart transportation [52]. RFID can be used in manufacturing for a variety of purposes, including supply chain management, production planning, and more [53]

The IIoT is mostly used in manufacturing environments where automation plays an important role in success, but the technology is rapidly expanding in both capabilities and application cases [41].

For industrial operations, the IIoT market alone is developing at a fast rate despite being just one aspect of the overall IoT industry. According to [54], with a market size of roughly $216.13 billion in 2020, the worldwide IIoT market will reach about $1.1 trillion by 2028 [41].

The IoT is widely recognized as a cutting-edge technology that has the potential to transform the industrial sector [53]. By using advanced technology for knowledge and production, intelligent manufacturing can create manufacturing processes that are scalable, efficient, and easily reconfigurable to meet the demands of a globally competitive market [17][55]. Technology such as the IoT can enable manufacturing, as demonstrated by the German Industry 4.0 initiative, which has been influenced by the global economic environment in general.

As with a developing marketplace, IoT technologies have expanded to become a global market for the acquisition of illustrious products such as Google glasses and GPS shoes. A wireless sensor network, on the other hand, makes it possible for purchasers to access an electronic market from any location at any time. This is made possible by the facility of the electronic market. The field of wireless communications has seen significant advancements recently, particularly in the area of remote sensor networks, which have developed quickly and have been successfully implemented in the buyer electronics market [56], once again, this has become a global market, particularly in light of the ability of IoT technologies to be deployed in the marketplace.

According to IDC, the IoT solutions are at the heart of the third platform's vision. In recent years, the IoT solution has been introduced into the marketplace through a variety of techniques; as a result, these solutions can be implemented both economically and creatively, thus introducing the concept of the third platform. **Figure 4** describes innovative industry solutions and the IoT driving value throughout the third platform [57].

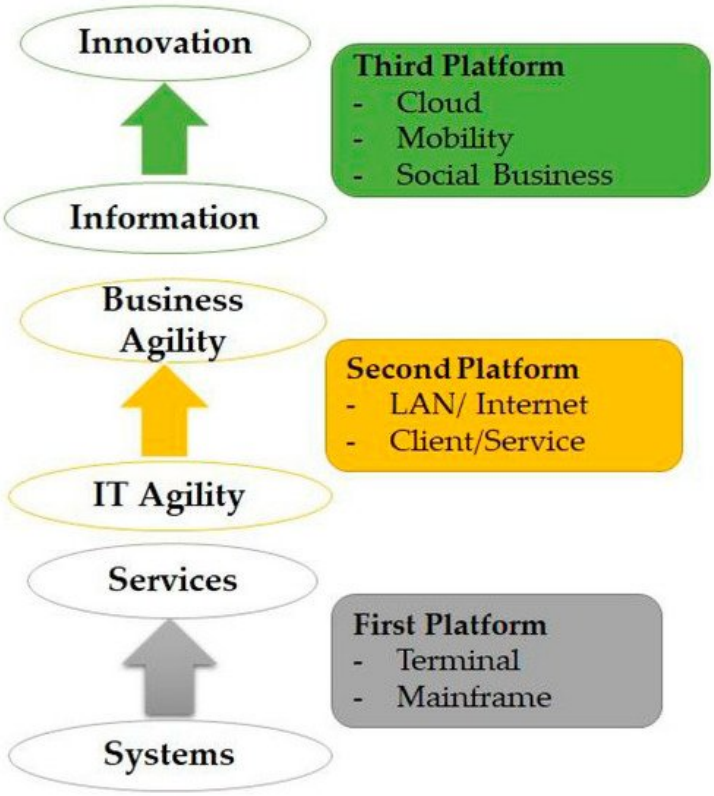

Figure 4. IoT: Driving value throughout the third platform.

IoT Development Market: Exports of Connected Devices

As indicated by [58], the growth of the IoT marketplace has been driven by communication among devices. Consistent with [59], the IoT development market has seen growth in different periods from 2015, and that it is expected to continue up to 2030, while two points have been discussed concerning commercial and industrial electronics and consumers as well.

According to [59], in general, the description of the IoT marketplace has been highlighted as below:

- Commercial & Industrial Electronics
  - Good growth is projected for sales: 2013–2030 compound annual growth rate (CAGR) = 20%.
  - The next decade (2021–2030) adds the highest amount of devices deployed.
- Consumers
  - In the long term, revenue would see moderated growth: 2013–2030 = 13.8% (CAGR).
  - The user base increased from 2015 to 2020 for connectable devices.
  - New shipping for total compatibility will rise by 12.5% from 2013–2030.

The primary scheme of an IoT business opportunity is to allow the owners of sensors and actuators to charge IoT application designers for the use of sensor-generated data and access to actuator capabilities. This type of commerce goes beyond the immediate needs of device owners and application engineers, allowing for the development of a new class of data-driven service contributors, where data processing and analysis can be provided to vendors and purchasers of IoT data by dealers, rather than the immediate needs of device owners and application engineers.

According to [59], an intelligent IoT integrator (I3) must incorporate the following components to be a practical and successful commercial center:

- The dealers post their accessible sensor-flowing information and actuators admit items alongside some hint of their worth and states of utilization.
- Application designers and data/actuators admit purchasers to peruse or be suggested pertinent sensor data streams/device proprietors just as data intermediaries to interface with. This can be an index or potentially an endorsement instrument.
- Motivating mechanisms for vendors to afford valuable data and actuators, for example, adaptation per unit amount of data for the actuator to acquire.
- Directing ongoing data from sensor data sources to all purchasers that are approved dependent on the established understandings (counting installments, procedure arrangements).
- Steering continuous activation and control signals from approved clients (purchasers) to actuators. Assurance and prestige evaluating and determining components for clients to rate each other. Metering and charging instruments to uphold advertising agreements being steered through the commerce.
- APIs and SDKs for methodical admittance to different functionalities of the platform data naming and organizing capacities, just as security instruments to channel data.

The IoT marketplace consequently presents: proficient sharing/exchanging of data, advantageous arrangement and exchanges of data and access cost and utilization strategy models, and dataflow control to actualize the business perception [59].

The research of [60] has explained some examples of IoT marketplaces, including:

- For the Internet of Vehicles (IoVs) to function, monetary transactions must be made between vehicle-to-vehicle networks, vehicle-to-roadside networks, and vehicle-to-infrastructure and pedestrian networks.
- Smart Agriculture—Real-time crop information is available to farmers and other agricultural supply chain participants using this technology.
- Smart Health—Data monetization is possible thanks to the wearable IoT (WIoT) devices used by patients, medical imaging, test results, social media, and external patient data that are collected by healthcare systems and patients alike.

References

1. Tan, L.; Wang, N. Future Internet: The Internet of Things. In Proceedings of the 3rd International Conference on Advanced Computer Theory and Engineering, ICACTE 2010, Chengdu, China, 20–22 August 2010; pp. V5-376–V5-380.
2. Ashton, K. Internet of Things. Page 1—RFID Journal. Available online: https://www.rfidjournal.com/articles/view?4986 (accessed on 2 March 2020).
3. Magurano, D. Development of a Scalable Architecture for Industrial Internet of Things. Available online: https://pdfs.semanticscholar.org/9ff6/7ba53c0fbaee90d5d27e43d5958b0ff4872f.pdf (accessed on 30 August 2020).
4. Miorandi, D.; Sicari, S.; De Pellegrini, F.; Chlamtac, I. Internet of things: Vision, applications and research challenges. Ad Hoc Netw. 2012, 10, 1497–1516.
5. Lampropoulos, G.; Siakas, K.; Anastasiadis, T. Internet of Things in the Context of Industry 4.0: An Overview. Int. J. Entrep. Knowl. 2019, 7, 4–19.
6. Perera, C.; Liu, C.H.; Jayawardena, S.; Chen, A.M. A Survey on Internet of Things from Industrial Market Perspective. IEEE Access 2014, 2, 1660–1679.

7. Wang, S.; Wan, J.; Li, D.; Zhang, C. Implementing Smart Factory of Industrie 4.0: An Outlook. Int. J. Distrib. Sens. Netw. 2016, 12, 3159805.
8. Lin, K.; Wang, W.; Bi, Y.; Qiu, M.; Hassan, M.M. Human localization based on inertial sensors and fingerprints in the Industrial Internet of Things. Comput. Netw. 2016, 101, 113–126.
9. Jing, Q.; Vasilakos, A.V.; Wan, J.; Lu, J.; Qiu, D. Security of the Internet of Things: Perspectives and challenges. Wirel. Netw. 2014, 20, 2481–2501.
10. Blanchet, M.; Rinn, T.; Thaden, G.; Thieulloy, G. Industry 4.0. The New Industrial Revolution. How Europe Will Succeed. Hg V Roland Berg. Strategy Consult; GmbH Münch. Abgerufen Am 1105 2014 Unter: Munich, Germany, 2014.
11. Aazam, M.; Zeadally, S.; Harras, K.A. Deploying Fog Computing in Industrial Internet of Things and Industry 4.0. IEEE Trans. Ind. Inform. 2018, 14, 4674–4682.
12. Wollschlaeger, M.; Sauter, T.; Jasperneite, J. The Future of Industrial Communication: Automation Networks in the Era of the Internet of Things and Industry 4.0. IEEE Ind. Electron. Mag. 2017, 11, 17–27.
13. Mahmoodpour, M.; Lobov, A.; Lanz, M.; Makela, P.; Rundas, N. Role-based visualization of industrial IoT-based systems. In Proceedings of the 14th IEEE/ASME International Conference on Mechatronic and Embedded Systems and Applications, MESA 2018, Oulu, Finland, 2–4 July 2018.
14. SlideModel. Industry 4.0 PowerPoint Template. Available online: https://slidemodel.com/templates/industry-4-0-powerpoint-template/ (accessed on 16 March 2020).
15. Lee, J.; Bagheri, B.; Kao, H.A. A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems. Manuf. Lett. 2015, 3, 18–23.
16. Lasi, H.; Fettke, P.; Kemper, H.G.; Feld, T.; Hoffmann, M. Industry 4.0. Bus. Inf. Syst. Eng. 2014, 4, 239–242. Available online: https://link.springer.com/article/10.1007/s12599-014-0334-4#auth-1 (accessed on 1 May 2020).
17. Zhong, R.Y.; Xu, X.; Klotz, E.; Newman, S.T. Intelligent Manufacturing in the Context of Industry 4.0: A Review. Engineering 2017, 3, 616–630.
18. Batista, N.C.; Melício, R.; Mendes, V.M.F. Services enabler architecture for smart grid and smart living services providers under industry 4.0. Energy Build. 2017, 141, 16–27.
19. Zhao, F.; Sun, Z.; Jin, H. Topic-centric and semantic-aware retrieval system for internet of things. Inf. Fusion 2015, 23, 33–42.
20. Liu, J.; Yan, Z.; Yang, L.T. Fusion–An aide to data mining in Internet of Things. Inf. Fusion 2015, 23, 1–2.
21. Kalsoom, T.; Ahmed, S.; Rafi-ul-Shan, P.M.; Azmat, M.; Akhtar, P.; Pervez, Z.; Imran, M.A.; Ur-Rehman, M. Impact of IOT on Manufacturing Industry 4.0: A new triangular systematic review. Sustainability 2021, 13, 12506.
22. Sanchez, L.M.; Nagi, R. A review of agile manufacturing systems. Int. J. Prod. Res. 2001, 39, 3561–3600.
23. Dallasega, P.; Rauch, E.; Linder, C. Industry 4.0 as an enabler of proximity for construction supply chains: A systematic literature review. Comput. Ind. 2018, 99, 205–225.
24. Kamble, S.S.; Gunasekaran, A.; Sharma, R. Analysis of the driving and dependence power of barriers to adopt Industry 4.0 in Indian manufacturing industry. Comput. Ind. 2018, 101, 107–119.
25. Gottge, S.; Menzel, T.; Forslund, H. Industry 4.0 technologies in the purchasing process. Ind. Manag. Data Syst. 2020, 120, 730–748.
26. Rahim, M.A.; Rahman, M.A.; Rahman, M.M.; Asyhari, A.T.; Bhuiyan, M.Z.; Ramasamy, D. Evolution of IOT-enabled connectivity and applications in Automotive Industry: A Review. Veh. Commun. 2021, 27, 100285.
27. Javaid, S.; Sufian, A.; Pervaiz, S.; Tanveer, M. Smart Traffic Management System using internet of things. In Proceedings of the 20th International Conference on Advanced Communication Technology, ICACT 2018, Chuncheon, Korea, 11–14 February 2018.

28. Sumia, L.; Ranga, V. Intelligent traffic management system for prioritizing emergency vehicles in a smart city. Int. J. Eng. 2018, 31, 278–283.
29. Pyykonen, P.; Laitinen, J.; Viitanen, J.; Eloranta, P.; Korhonen, T. IOT for intelligent traffic system. In Proceedings of the IEEE 9th International Conference on Intelligent Computer Communication and Processing, ICCP 2013, Cluj-Napoca, Romania, 5–7 September 2013.
30. Muthuramalingam, S.; Bharathi, A.; Kumar, S.R.; Gayathri, N.; Sathiyaraj, R.; Balamurugan, B. Iot based intelligent transportation system (iot-its) for global perspective: A case study. In Intelligent Systems Reference Library; Springer Science and Business Media LLC: Berlin/Heidelberg, Germany, 2019; Volume 154.
31. Afzal, B.; Umair, M.; Asadullah Shah, G.; Ahmed, E. Enabling IOT platforms for social IOT applications: Vision, feature mapping, and challenges. Future Gener. Comput. Syst. 2019, 92, 718–731.
32. Nasr, E.; Kfoury, E.; Khoury, D. An IOT approach to vehicle accident detection, reporting, and Navigation. In Proceedings of the IEEE International Multidisciplinary Conference on Engineering Technology, IMCET 2016, Beirut, Lebanon, 2–4 November 2016.
33. Raj, J.T.; Sankar, J. IOT based Smart School Bus Monitoring and Notification System. In Proceedings of the IEEE Region 10 Humanitarian Technology Conference, R10-HTC 2017, Dhaka, Bangladesh, 21–23 December 2017.
34. Drath, R.; Horch, A. Industrie 4.0: Hit or Hype? . IEEE Ind. Electron. Mag. 2014, 8, 56–58.
35. Mondal, D. The Internet of Thing (IoT) and Industrial Automation: A future perspective. World J. Model. Simul. 2019, 15, 140–149.
36. Sreenivasulu, R.; Chalamalasetti, S.R. Applicability of Industrial Internet of Things (IIoT) in Lean Manufacturing: A brief Study. Prod. Sched. 2019, 10, 22–26. Available online: https://www.researchgate.net/publication/337286599_Applicability_of_Industrial_Internet_of_Things_IIoT_in_Lean_Manufacturing (accessed on 16 December 2021).
37. Harrell, C. The Internet of Things and Control System Architecture. Available online: http://blog.aac.advantech.com/the-internet-of-things-and-control-system-architecture/ (accessed on 1 July 2020).
38. Xu, L.D.; He, W.; Li, S. Internet of Things in Industries: A Survey. IEEE Trans. Ind. Inform. 2014, 10, 2233–2243.
39. Capello, F.; Toja, M.; Trapani, N. A Real-Time Monitoring Service based on Industrial Internet of Things to manage agrifood logistics. In Proceedings of the 6th International Conference on Information Systems, Logistics and Supply Chain ILS Conference, Bordeaux, France, 1–4 June 2016.
40. Caesarendra, W.; Pappachan, B.; Wijaya, T.; Lee, D.; Tjahjowidodo, T.; Then, D.; Manyar, O. An AWS Machine Learning-Based Indirect Monitoring Method for Deburring in Aerospace Industries towards Industry 4.0. Appl. Sci. 2018, 8, 2165.
41. Hiter, S. Industrial Internet of Things (IIoT) Market Size & Forecast. 2022. Available online: https://www.datamation.com/trends/industrial-internet-of-things-iiot-market/ (accessed on 16 December 2021).
42. Evans, D. The Internet of Things How the Next Evolution of the Internet Is Changing Everything. Cisco Internet Bus. Solut. Group (IBSG) 2011, 1, 1–11. Available online: https://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf (accessed on 10 February 2021).
43. Afshar, V. HuffPost Is Now a Part of Verizon Media. Available online: https://www.huffpost.com/entry/cisco-enterprises-are-leading-the-internet-of-things_b_59a41fcee4b0a62d0987b0c6 (accessed on 14 June 2020).
44. Statista Research Department. IoT: Number of Connected Devices Worldwide 2012–2025. Available online: https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/ (accessed on 10

February 2020).

45. Patil, P.; Tawade, P.; Samudre, S.; Mali, S.; Pardeshi, S. Survey on Internet of Things (IoT): Tools and Technologies. Int. J. Sci. Res. Comput. Sci. Eng. Inf. Technol. (IJSRCSEIT) 2018, 3, 1108–1112. Available online: http://ijsrcseit.com/CSEIT1833352 (accessed on 3 April 2021).
46. Heutger, M. A Shared Journey: Customer-Centric Innovation-Huawei Case Studies. Huawei Enterprise. Available online: https://e.huawei.com/en/case-studies/global/2017/201709070922 (accessed on 16 December 2021).
47. Cisco. Solutions-Cisco IOT Helps Nissan Transform Car Production Operations. Cisco. Available online: https://www.cisco.com/c/en/us/solutions/collateral/internet-of-things/nissan-motors-case-study.html (accessed on 16 December 2021).
48. Gartner Gartner Says 5.8 Billion Enterprise and Automotive IoT Endpoints Will Be in Use in 2020. Available online: https://www.gartner.com/en/newsroom/press-releases/2019-08-29-gartner-says-5-8-billion-enterprise-and-automotive-io (accessed on 3 April 2020).
49. Welbourne, E.; Battle, L.; Cole, G.; Gould, K.; Rector, K.; Raymer, S.; Balazinska, M.; Borriello, G. Building the Internet of Things Using RFID: The RFID Ecosystem Experience. IEEE Internet Comput. 2009, 13, 48–55.
50. Presser, M.; Gluhak, A. The Internet of things: Connecting the real world with the digital world. Eurescom Message—The Magazine for Telecom Insiders. 2009, Volume 2. Available online: http://www.eurescom.eu/message (accessed on 1 January 2021).
51. Ray, P.P. A survey on Internet of Things architectures. J. King Saud Univ.-Comput. Inf. Sci. 2018, 30, 291–319.
52. Frost & Sullivan Best Practices Award. Radio-Frequency Identification for Retail Self Checkouts—Europe. 2019, pp. 1–19. Available online: https://www.nordicid.com/wp-content/uploads/Frost-Sullivan-Nordic-ID-New-Product-Innovation-2019-report.pdf (accessed on 10 December 2021).
53. Yang, C.; Shen, W.; Wang, X. Applications of Internet of Things in manufacturing. In Proceedings of the IEEE 20th International Conference on Computer Supported Cooperative Work in Design, CSCWD 2016, Nanchang, China, 4–6 May 2016.
54. Industrial Internet of Things Market Size Report. 2021–2028. Available online: https://www.grandviewresearch.com/industry-analysis/industrial-internet-of-things-iiot-market (accessed on 16 December 2021).
55. Shen, W.; Norrie, D.H. Agent-Based Systems for Intelligent Manufacturing: A State-of-the-Art Survey. Knowl. Inf. Syst. 1999, 1, 129–156.
56. Li, X.; Li, D.; Wan, J.; Vasilakos, A.V.; Lai, C.-F.; Wang, S. A review of industrial wireless networks in the context of Industry 4.0. Wirel. Netw. 2015, 23, 23–41.
57. Lund, D.; Carrie, C.; Turner, V.; Morales, M. Worldwide and Regional Internet of Things (IoT) 2014–2020 Forecast: A Virtuous Circle of Proven Value and Demand. IDC Analyze the Future, 1–27. Available online: http://branden.biz/wp-content/uploads/2017/06/IoT-worldwide_regional_2014-2020-forecast.pdf (accessed on 10 January 2020).
58. Morelli, B. IoT Market Overview. 2018. Available online: https://www.gsaglobal.org/wp-content/uploads/2019/05/Bill-Morelli-GSA-Silicon-Summit-IoT-Market-Overview-IHS-Markit-4.9.18.pdf (accessed on 17 September 2021).
59. Krishnamachari, B.; Power, J.; Shahabi, C.; Kim, S.H. IoT Marketplace: A Data and API Market for IoT Devices; University of Southern California: Los Angeles, CA, USA, 2017.
60. Saputhanthri, A.; Alwis, C.D.; Liyanage, M. Emergence of Blockchain Based IOT Marketplaces. Available online: https://www.researchgate.net/profile/Madhusanka-Liyanage/publication/350835689_Emergence_of_Blockchain_based_IoT_Marketplaces/links/6080a4c8907dcf667bb5ae4f/Emerg of-Blockchain-based-IoT-Marketplaces.pdf (accessed on 19 December 2021).