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Research paper

Review about effects of IOT and Nano-technology techniques in the development of IONT in wireless systems

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Abstract

The growing and constantly emerging technology trends has increased the use of devices day by day and hence the efforts have been made to connect every device with each other through internet which is being called as Internet of Thing (IoT). Precisely, IoT is inter-networking of substantial tools, constructions and other items. Nanotechnology is the study and manufacture of extremely tiny machines or devices ranging from 1 to 100 nanometres. It has provided possible effectual solutions to numerous uses in biomedical, industrial, agricultural and military applications. On the other hand, nanosensors are any organic, biochemical, or clinical sensory points used to transfer information about nanoparticles to the macroscopic domain. The nano devices and nanosensors interconnection with Internet has pioneered the expansion of subsequent generation criterion derived from IoT known as "Internet of Nano Things" (IoNT). The foremost goal of this study is to give a comprehensive attitude of IoNT, its architecture, advantages, tryouts, application scopes and look out the prospects about how we can overcome the challenges and make the use of Internet of NanoThings in the field or wireless engineering. Additionally, IoT, Internet of Every-thing (IoE) and IoNT bases are discussed in this review.

Keywords: *IOT; Nanotechnology; Nano-Machines, Nano Sensors; Nano Communication; IONT; Wireless Networks.*

1. Introduction

Internet of Thing (IoT) is a new prototype shift in information technology world. It is created from the words of "Internet" and "Things". Internet is a worldwide structure of unified computer networks that apply the typical Internet Protocol suite (TCP/IP) to work for billions of customers in all over the world. It is a linkage of networks that has millions of reserved, shared, educational, commercial, and governmental connections, of limited to world-wide scopes, which are interconnected by a wide-ranging grouping of automated, wireless and optical networking tools [1-2]. Currently, many nations are interconnected into interactions of data, news bulletin and attitudes throughout Internet. In line with Internet World Indicators in 2011, there was an expected 2, 267, 233, 742 Internet customers in all over the world who accessed data from the Universal Resource Location. This implies 32.7% of the world's overall populace is consuming the Internet service. Uniform Internet is going into space throughout Cisco's Internet Routing program in the upcoming four years. However, based on IoT, Things can be any item or creature that can be apparent by the factual realm. In general, objects consist of not just electronic apparatuses, we come upon and practice regular and technically sophisticated items like device and widgets, but "things" that are routinely not about that things will be electronic for everything like clothes, materials, parts, furniture and utensils, products and specific objects; landmarks, testimonials and all the assortment of business, arts and classiness [3]. So, these things can be alive things such as person, animals, plants, and so on or lifeless things such as book, fridge, etc. and any home-based usages or manufacturing apparatus. Consequently, at this instant, things are items in this sensible realm [4].

The nanoscale devices development with customary wireless networks with speedy Internet pioneered newfangled development that is called "Internet of Nano-Things(IoNT)" [5-7]. Nanotechnology researches in the scope of Nano communication were also augmented progressively for the intention to construct innovative criterions for Nano devices to interconnect amid each other to be set up in miscellaneous applications. IoNT can involve tiny sensors attached to each other by means of Nano networks to acquire data from objects. Consequently, IoNT will initiate new studies in Nano communication, Nano Sensors and Nano Devices scopes.
According to the current statistical surveying testimonies by experts, IoNT marketplace is required to develop from $4.26 to $9.69 billion within 2016- 2020 year range, at an expected Compound Annual Development Rate (CAGR) of 22.81% from 2016 to 2020. A portion of the significant companies in the IoNT marketplace are Cisco Systems Inc., Intel Enterprise, Juniper Networks, Qualcomm Incorporated, and IBM Company in USA, in addition to Siemens AG in Germany [8].
The focal objective of this paper is to give an all-inclusive outlook of IoT, nano technology, IoE and their interrelation to IoNT outlines, benefits, and possibilities. Also, it viewpoints the visions about how can we overwhelm the challenges of IoNT in the field of wireless communication engineering.

2. Internet of thing

The conception of IoT involves the linking of daily objects and devices to entirely varieties of networks as in corporation intranets, peer-to-peer nettings and also the worldwide web [9-11]. Thus, its development is of unlimited importance to the wireless communication industry. It will encounter all obtainable structures within

recognized corporations, and develop the root for completely innovative prospects and business models. IoTs form the new accomplishment of mobile and internet networks by intensifying the world's linkage of networks. It has the application of strategic high-tech enablers. These enablers can be classified as radio-frequency identification (RFID), wireless sensor machineries and nanotechnology. The developed version of internet can sense and screen changes in the physical status of associated things (through sensors and RFID) in real-time. Expansions in smallness process can further enable industrial ubiquity. Interconnected networks and the things are also progressively being smart, through expansions in "smart technologies". Though IoT is a somewhat new idea, its supporting tools have been from one place to another for some time, established in comparative remoteness from each other. RFID had been invented in the mid of the previous century and the materials using nanotechnology were available in the marketplace for over a decade. The influence of a grouping of such skills cannot be undervalued. Accordingly, it is important to observe the contemporary telecommunication background to measure the future potential applicability of IoTs to the commerce all together. Enabling objects to identify and check their environment through sensors will empower the network to detect and respond to peripheral incentives. Inserted intelligence at the network edges will further expand the network's capability to react. Indeed, IoT spreading out has a number of vital considered consequences for industries and regimes. Determining a user-approachable and cost-effectively market will be on the minds of researchers as they uncheck their imaginings and inventiveness on the future.

IoT concept was proposed by Ashton [5] in 1999.Rapid developments and intense researches are going under the process in fields of e-health, e-industry, e-agriculture, smart cities , etc by using the wireless communications. IoT has started making a significant changes in everyone's life by connecting their devices which they use in day to day life such as washing machines, tv's , watches , etc . It has a lot of data that processed and stored through virtual storages such as Cloud computing platform which helps in storing, analyzing, monitoring and communicating the data among various devices [1]. In fact, the number of devices connecting with internet was overcome the number of people in the earth during 2008 as shown in Figure 1. However, IoT can be classified as Internet of Underwater things as in Figure 2, where the ships are connected by the acoustic links in the ocean floor and satellite with onshore sink or Internet of Underground Things as in Figure 3 which are related to connecting of trucks, Internet of Battlefield Things as in Figure 4 which includes the monitoring and the communications between the military sectors through video camera, infrared camera and, microphone. The last field may be for Internet of Space Things which are related to space issues such as satellites as in Figure 5.

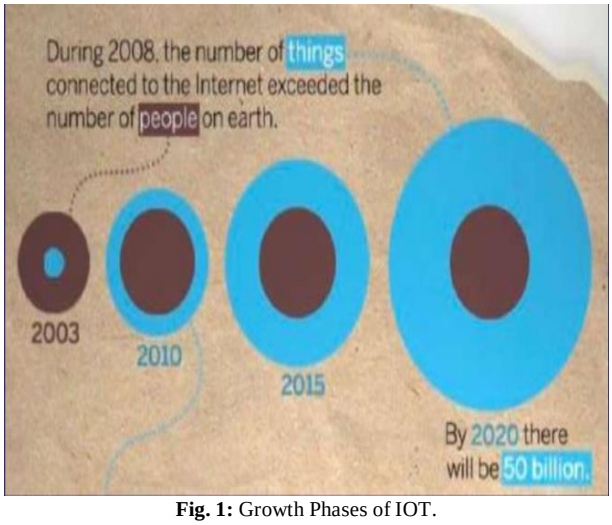

Fig. 1: Growth Phases of IOT.

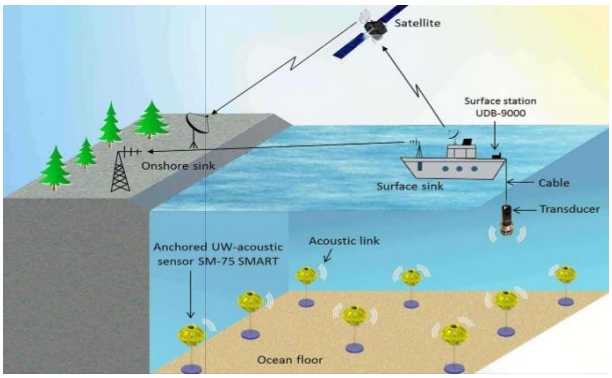

Fig. 2: Internet of Underwater Things Example.

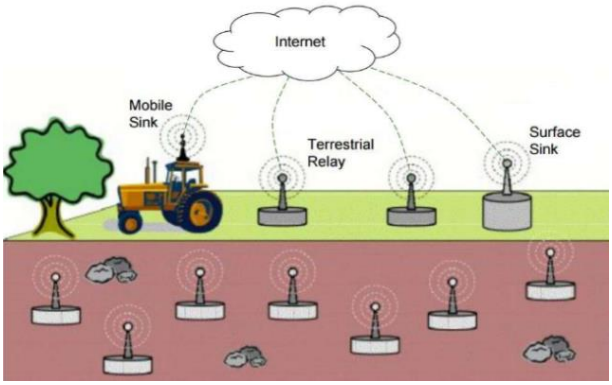

Fig. 3: Internet of Underground Things Example.

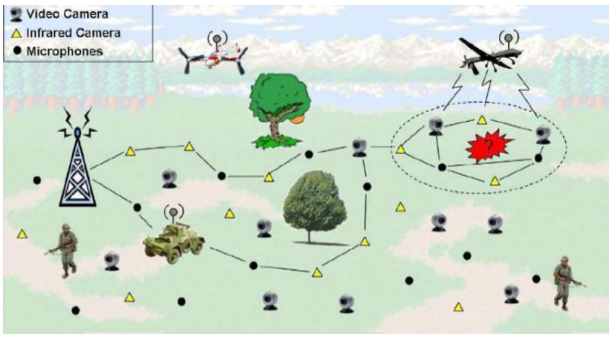

Fig. 4: Internet of Battlefield Things.

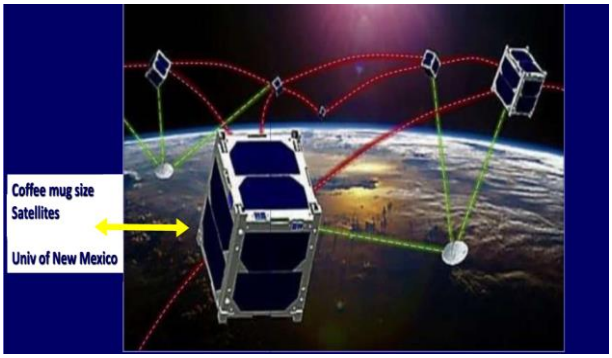

Fig. 5: For Internet of Space Things

3. Nanotechnology and internet of nano-thing

Nanotechnology notion has been specified by "Richard Feynman", a Physicist Nobel Laureate in 1965 in his well-known speech entitled "There's Plenty of Room at the Bottom" in 1959 [10]. The key indication in this speech was to highpoint the compactness and upcoming of producing influential and smaller devices. The perception of "Nanotechnology" was primarily reported as it principally includes handling of, separating, merging, and twist of materials by a solitary atom or molecule [11]. The elementary ideas behind expansion and practice of Nanotechnology is to manufacture of miniature devices

of 1 to 100 nano meters in scale. Mihail Roco [12] was well-defined two main generations of nanotechnology progress. The first step was from 2001-2010, where the nanoscale research had been considered, and the roadmap for the nanotechnology had been defined. The determining of new features, aspects, and services in the field of nanoscale was the major targets. Also, this generation developed a high level quality of tools, combined many instruments to create a standard blocks for future usages, and enhanced the current devices by including the nanoscale ingredients. However, Nano1 may be assigned to this stage.

The second essential generation from 2011 to 2020 will concentrate in finalizing of nanoscale science and engineering. Actually, this phase will evolve a new equipment, calculations with precise timing, and widely deployment of nanotechnology. Finally, the concentration on the research and development and the applications is expected to be more complicated nanotechnology systems. This generation may be referred as Nano2 as it is depicted in Figure 6.

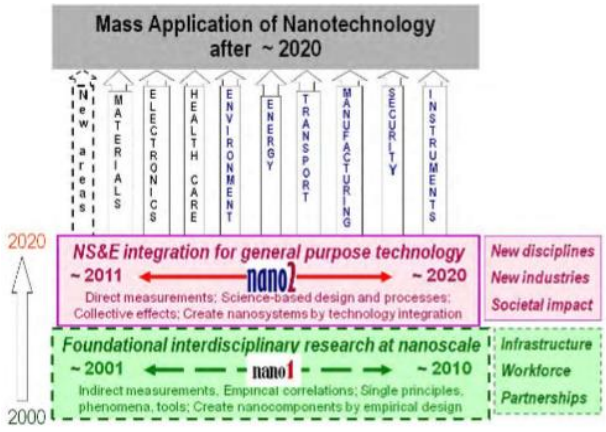

Fig. 6: Nanotechnology Primary Phases.

Nanotechnology is facilitating the devices development in a small number of hundred nanometers [8, 14]. A nanomachine stands for the elementary serviceable unit, incorporated by nano-machineries and capable of implementing uncomplicated assignments like actuation or sensing. Organization and information distribution amid numerous nanomachines will magnify the prospective usages of discrete devices in terms of complication and operation range. Objects like tablets, smartphones, NFC (Near Field Communication) , RFID (Radio Frequency Identification) , actuators , sensors, etc. have a dynamic task in interrelating and interconnecting with each other to accomplish required tasks. A new technology named as Internet of Everything has emerged by combining various domains such as Wireless Body Area Networks (WBAN) and Internet of NanoThings (IoNT). IoNT has the feasibility of involving compact sensors linked to each other by means of Nano networks to acquire data from substances. Consequently, Internet of Nano Things will expose innovative studies in Nano communication, Nano Sensors and Nano Devices. The conception of IoNT has been suggested by Ian Akyildiz and Josep Jornet [4] in "The Internet of Nano-Things" published study. He has given key study encounters regarding of channel modelling, information encoding and practices for nano networks and IoNT.

According to the various researches going on, it has been envisaged that there are dual foremost possibilities for nanoscale communication as in molecular and nano- electromagnetic communications. Molecular communication represents the sending and receiving of coded information in molecules. In this concern, Nano machineries of sender encode information into information molecules as in proteins, DNA and peptides. Information can be transferred within a DNA constituent. The capabilities of producing communication structures and networks using organic constituents and processes are existing in natural surroundings. Steering the micro entryway in molecular Nano setups is query based. Nano-electromagnetic communication stands for the sending and receiving of electromagnetic (EM) radiation from constituents based on innovative nanomaterials. The distinctive features perceived in these materials are attributed on the explicit emission bandwidth of EM radiation, the emission time lag, or the magnitude of the produced power for a specified input energy.

4. Nano-machine structural design

Nano-machine includes at least one segment coordinated with each other in fluctuated levels of many sided qualities and run from straightforward scaling down machine to top of the line and advanced nano-mechanical technology. The subsequent elements are the components that structure Nano-Machine [8, 14-15]:

Control Unit: It stands for the central point and focal sensory structure for nano-machine and does the assignment for implementing every one of the guidelines to play out the wanted errand. It as well limits all other parts of nano-machine and furthermore goes about capacity unit for sparing every one of the information from nano-machine to be utilized by clients.

Communication Unit: It prepares the errand of transmitting and accepting data at nano-level.

Reproduction Unit: It executes creation of every segment of nano-machine utilizing outside components and amass them adequately to structure the nano-machine.

Control Unit: It organizes the assignment of controlling all the parts of nano-machine. It gathers vitality from different exterior sources as in light, temperature and so forth for next errand of utilization and dispersion.

5. IONT network configuration

IoNT is picking up the step in swift scopes. Irrespective of the relevance scopes, the subsequent constituents stand for the decider part of IoNT architecture as depicted by Figure 7[15]:

1) Nano-Nodes: They are considered as the tiniest uncomplicated nano machines that accomplish numerous errands as in transmission and computation if the data are over small distances and have a smaller amount of memory storage. As for Body Sensor Networks (BSNs), organic sensors fixed in Human Body represent Nano-Nodes.
2) Nano-Routers: They possess huger computational power than nano nodes and they represent aggregators of coming information from nano-nodes. They as well have decisive task in adjusting nano-nodes by controlling instructions interchange.
3) Nano-Micro interface gadgets: These gadgets have the responsibility of data accumulation initiating from nano-switches and send it to the microscale machines. They approach as cross breed gadgets to take in nanoscale using Nano correspondence systems and likewise with conventional correspondence systems with established system conventions.
4) Gateway: It facilitates the regulation of all-inclusive nano things network over the Internet.

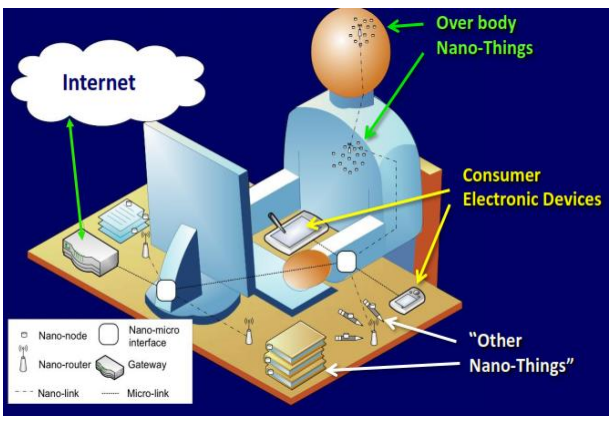

Fig. 7: Network Architecture Example of IONT.

6. IONT applications

The most refined and propelled techniques are utilized by IoNT for information accumulation that empowers IoNT to broaden its base from current appliances to widespread variety of innovative and propelled appliances when contrasted with IoT. Regular Architecture and Common Components make IoNT considerably underlined. Medicinal services Monitoring/Nano-Sensor Based Body Sensor are instances for IoNT application as depicted in Figure 8 [15-16].

The 1st and the premier notable IoNT relevance nowadays as certifiable thing is BSN containing in-body nano sensors assuming a critical part in gathering and observing patient's organic movement and different points of interest. Nano sensors are being utilized in BSN to give ongoing information on a wearable gadget utilized by the specialist for getting convenient data with respect to patient's wellbeing. Innovative health care techniques can be developed by means of molecular communication network for monitoring calcium level within short ranges or bacteria within medium ranges and hormones within long range. With the utilization of nano sensors in Environmental observing by means of sending out in the open areas as in Bus Stops, Airports, Railway Stations, Hotels as well as other Public spots, live and constant checking of Traffic, Air Pollution, Temperature Checking can be accomplished all productively. On the other hand, the utilization of IoNT in farming will prompt improvement of a few accuracy cultivating appliances and with the quick execution of Nano-Sensors based Nano gadgets will prompt effective condition checking, tillage development and even checking. With the improvement of Wireless Nano Sensor, different farming exercises are feasibly performed as in Grass 24-hour care, Animal Healthiness and Feed Managing, Cultivation Field Condition 24-hour care and Compelling checking of utilization of Insecticides in the Agriculture field. Additional Potential Usages in Real Domain: Making an allowance for IoNT points of interest, sooner rather than later IoNT can likewise be connected for Battleground Supervising, Nano-Cybernetics, Nano-Drones Development , Space Based Applications and may be Nano Insect Robotics for Intelligence Purposes [17-19].

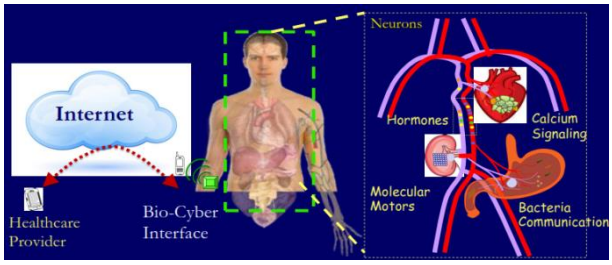

Fig. 8: Network Architecture Example of IONT for Biomedical Applications.

7. IOT, IoE and IONT differences

Technically talking, there is just one Internet: Internet of Everything (IoE). It has three theoretical subsystems: Internet of Digital (IoD), Internet of Things(IoT), and Internet of Humans (IoH) as depicted in Figure 9 [20].

IoD stands for digital-first domain which represents "customary" Internet, where digital data points are readily available. IoT as explained before is regarding involving physical-first domain that does not create digital data unless augmented or manipulated. Machine-to-Machine (M2M) stands for IoT subsystem, but not the other way round. The main variance is that in M2M; the physical-first products can be associated with point-to-point case, but in IoT this occurs on multipoint cases. IoH refers to communications amid persons and other two subsystems. This possibly includes direct user input as in control over a digitally connected product or indirect human tracking as in Quantified Self application. IoT and IoE have been wrongly considered to be identical by numerous analysts. IoE notion was being expanded to its completest by IoNT application. It can be accomplished by integrating nano-sensors in miscellaneous objects by means of nano-networks. Model of IoNT as medical application has illustrated in Figure 10. It offers access to data from the locations formerly unreachable to be sensed by definite devices that had been intolerable to use as a result of their previous huge sensor size. This will allow innovative environmental and medical data to be accumulated, possibly enabling the enhancement of current information, pioneering innovations and superior medicinal diagnostics. This technique has been designated by Akyıldız and Jornet, using graphene based nano-antennas in service at Terahertz frequencies. They as well deliberate the difficulties of dangerous attenuation at these networking and frequencies at this nano-level. Every serviceable assignment like sensing or actuation, in IoNT is implemented by a "nano-machine" whose sizes range from 1 to 100 nm as we stated before.

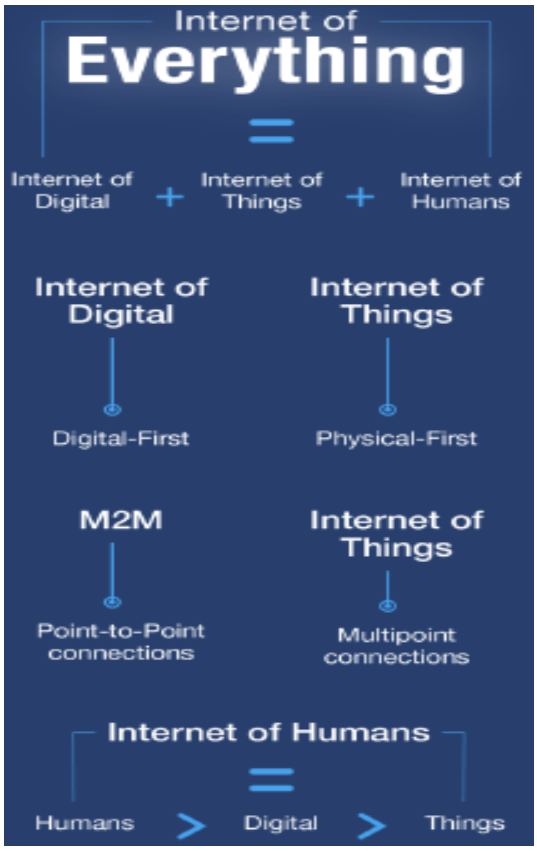

Fig. 9: IOE Based on [20].

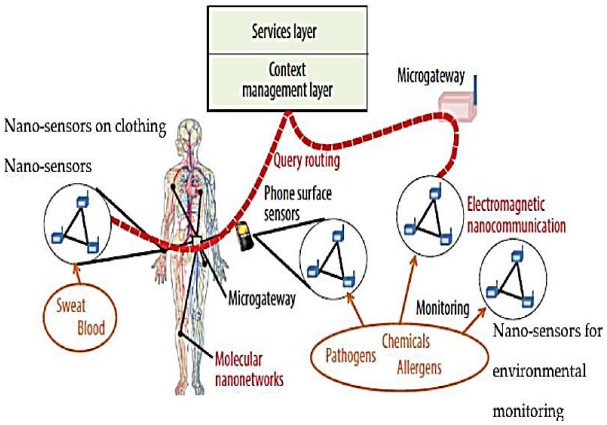

Fig. 10: IONT Based on [21].

8. Conclusion

Specialists are presently working on developing nano machines based on IoNT for live organization in differed territories in not so distant future. In this paper, IoNT is viewed as subsequent developmental stride in universe of nanotechnology. Nonetheless, nano machines, relevance and research scopes are along with IoT development. The improvement of nanomachines with correspondence capacities and their connection with smaller scale and large scale gadgets will empower the IoNT. This innovative systems administration worldview can have an extraordinary effect in nearly each theme of general goals, running from End-to-End unwavering quality in nanonetworks and the IoNT needs to be ensured for the going messages from a remote room to the nano-hubs based on electromagnetic nanonetworks. Numerous specialists are right now occupied with building up the equipment unseen for future nanomachines. The novel features of the nanoscale and the nature of nanonetworks involve novel arrangements for correspondences that must be given by the data and correspondence society. Among others, novel nano- recieving wire outlines, nanoscale channel models, data encoding as well as tweaks for nanoscale systems, and conventions for nanonetworks are commitments anticipated from the IoT field. The majority of studies about IoNT are related to biomedical applications. However, one day, research can be performed on emerging individual IoNT based Nano Sensor Network for Productiveness, Cultivation, Battleground and other future monitoring undertakings. IoNT stands for full expansion of IoE application and in addition to IoD and IoH, IoT represents essential part of IoE.

IoNT is viewed as the most scaled down nano sensor systems having the capacity to be thusly useable in constant appliances in differing fields. However, despite huge amounts of cutting edge focal points, IoNT additionally endures with a few issues and difficulties which should be tended to so that it can end up plainly some key portions of humankind in close future with no hiccup. Specialists must address the issues regarding setting administration, security and protection, benefit of organization and disclosure. Aside from taking a shot at looking into on different application ranges and improvement of Nanotechnology based IoNT gadgets, new security and protection instruments should be tended with respect to the information being gathered by nano sensors. Administrations ought to likewise be upgraded and new benefit situated designs should be projected to create nano sensors and nano systems perfect to hold huge amounts of extensive assortments of information.

References

[1] G. Jayavardhana, B. Rajkumar, S. Marusic, and M. Palaniswami, “Internet of Things: A Vision, Architectural Elements, and Future Directions,” Future Generation, 2013.

[2] L. Atzori, A. Iera, and G. Morabito, “The internet of things: A survey. Computer networks,” vol. 54, no. 15, pp. 2787-2805, 2010. https://doi.org/10.1016/j.comnet.2010.05.010.

[3] M. IGigli, and S. Koo, “Internet of Things, Services and Applications Categorization,” *Advances in Internet of Things*, no.**1**, pp. 27-31, 2011. http://dx.doi.org/10.4236/ait.2011.12004.

[4] F. Akyildiz, and J. M. Jornet, “The internet of nano- things,” IEEE Wireless Communications, vol. 17, no.6, pp. 58-63, 2010. https://doi.org/10.1109/MWC.2010.5675779.

[5] K. Ashton, “That 'Internet of Things' thing”, RFID Journal ,2009.

[6] S. Balasubramaniam, and J. Kangasharju, “Realizing the internet of nano things: challenges, solutions, and applications Computer,” 46(2), pp. 62-68, 2013. https://doi.org/10.1109/MC.2012.389

[7] F. Akyildiz, F. Brunetti, and C. Blazquez, “Nanonetworks: A New Communication Paradigm,” Computer Networks (Elsevier) J., vol. 52, no. 12, pp. 2260–79, August 2008.

[8] K. Dabhi , and A. Maheta, “Internet of Nano Things-The Next Big Thing,” International Journal of Engineering Science and Computing, vol.7, no. 4, 2017.

[9] Nayyar, and V. Puri, “Data Glove: Internet of Things (IoT) Based Smart Wearable Gadget.” British Journal of Mathematics & Computer Science, vol. 15, no. 5, 2016.

[10] R. P. Feynman, “There’s plenty of room at the bottom. Miniaturization"(HD Gilbert, ed.) Reinhold, New York, 1961.

[11] F. Xia, L. T. Yang, L. Wang, and A. Vinel, “Internet of things,” International Journal of Communication Systems, 25(9), 2012. https://doi.org/10.1002/dac.2417.

[12] C. Roco Mihail, A. Mirkin Chad, and C. Hersam Mark, “Nanotechnology Research Directions for Societal Needs in 2020’’, Springer, 2010.

[13] N. Taniguchi, On the basic concept of nano-technology, in: Proceeding of the International Conference on Production Engineering, 1974.

[14] C. Rutherglen and P. Burke, “Nanoelectromagnetics: Circuit and Electromagnetic Properties of Carbon Nanotubes,” Small, vol. 5, no. 8, pp. 884–906,April 2009. https://doi.org/10.1002/smll.200800527.

[15] Nayyar, V. Puri, y D.-N. Le, “Internet of Nano Things (IoNT): Next Evolutionary Step in Nanotechnology,” Nanosci. Nanotechnol, vol. 7, no. 1, pp. 4-8, 2017.

[16] M. H. Miraz, et al., "Review on Internet of Things (loT), Internet of Everything (IoE) and Internet ofNano Things (IoNT)", ITA 2015, Wrexham, 8-11 Sept. 2015, 219 - 224.

[17] F. Akyildiz and J. M. Jornet, “Electromagnetic Wireless Nanosensor Networks,” Nano Communication Networks (Elsevier) J., vol. 1, no. 1, pp. 3–19, Mars 2010.

[18] C. Rutherglen and P. Burke, “Nanoelectromagnetics: Circuit and Electromagnetic Properties of Carbon Nanotubes,” Small, vol. 5, no. 8, pp. 884–906, April 2009. https://doi.org/10.1002/smll.200800527.

[19] J. Jarmakiewicz, and K. Parobczak, (2016, May). On the Internet of Nano Things in healthcare network. In Military Communications and Information Systems (ICMCIS), 2016, pp. 1-6. https://doi.org/10.1109/ICMCIS.2016.7496572.

[20] Internet of Things vs. Internet of Everything: What's the Diffrence, API Research 2014. Accessed 28.010.2018. https://digitalstrategy.nl/files/Internet-of-Things-vs-Internet-of-everything-by-ABI-June-2014.pdf.

[21] Mahdi H. Miraz, Maaruf Ali, Peter S. Excell and Richard Picking, Internet of Nano-Things, Things and Everything: Future Growth Trends, Future Internet, 2018.