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Evolution of Internet of Nano Things (IoNT)

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ABSTRACT- *Nanotechnologyis the next big thing the field of networks and resource sharing. As electronics industry progresses to manufacture nano devices and nano machines, it finds many applications in diverse fields like biomedical, healthcare, agriculture and defence projects. The interconnection of nano sensors and nanodevices with the existing communication networks via internet provides a new frontier in communications which is termed as "Internet of Nano Things"(IoNT). The main objective of this paper is to explore the major challenges in Internet of Nano Things (IoNT). A basic architecture of IoNT has been described and solutions are proposed to overcome the challenges.*
KEYWORDS:Graphene, Internet of Nano Things (IoNT),Nano sensors, Nano technology, Terahertz band.

I. INTRODUCTION AND BACKGROUND

Nanotechnology deals with the devices in size of nanometers ranging from 1 to 100 nanometers. Nanotechnology has applications in many fields like military, healthcare, environment protection etc.A nanomachine is defined as the most basic functional unit of a nano network [1] which is able to perform simple tasks such as sensing or actuation. In Internet ofNano Things (IoNT), a large number of nano machines, like sensors, are interconnected via communication networks over the Internet. The IoNT has a number of applications. For example, sensor implanted in a patient's heart, calls the doctor when the organ shows signs of failing; the sensor deployed in the door opens the door automatically when it identifies that owner of the house has arrived in. In contrast to Internet of Things (IoT)[2, 3], more number of sensors are deployed in IoNT because the size of the sensors is considerably reduced to nano scale. Hence, IoNT will give more precise and detailed information about a particular object.In the future, we would find ourselves surrounded by billions of nano sensors providing us useful information.

In IoNT, thenano devices can communicate with each other via Internet by following two techniques:
(a) Molecular Communication
(b) Nano-Electromagnetic Communication.

(a) Molecular Communication- In this type of communication, messages are transmitted in the form of encoded molecules from transmitter to the receiver [4].Here, water is used as a medium.

(b) Nano-ElectromagneticCommunication-In this type of communication, the transmission and reception of the messages takes place using electromagnetic radiations[5,6]. Here, air is used as a medium.

We begin our discussions by introducing a basic architecture for Internet of Nano Things in Section II. We describe the major communication challenges in nano networks in Section III. Conclusions and future directions are given in Section IV.

II. ARCHITECTURE OF IoNT

The architecture ofIoNT consists of four components as described below:

i. **Nano nodes**-Nano nodes are the nano devices like sensors or actuators which can be deployed in the human body or in any physical space. They form the smallest units of the nano network. They perform simple tasks. These nodes have limited memory and can transmit data over very short distances. They can be integrated in pens, books, doors, paper folders, keys etc. For example: sensors fitted in the body are nanonodes.

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ii. **Nano routers-** Nano routers are comparatively larger than the nano nodes. They are placed between the nano nodes. They aggregate the information coming from different nano nodes. They also control nano nodes by using some simple commands like on/off, read value, sleep etc.

iii. **Nano-micro interface devices-** These devices collect and process the information coming from different nano routers to carry it to the microscale and vice versa. So, they are known as hybrid devices. They can communicate both in nano scale as well as micro scale.

iv. **Gateway-** It acts as a medium which carries the information from the nano micro interface to the provider over the internet. For example: An advanced cell phone acts as a gateway between nano micro interface device placed in our body and the healthcare service provider.

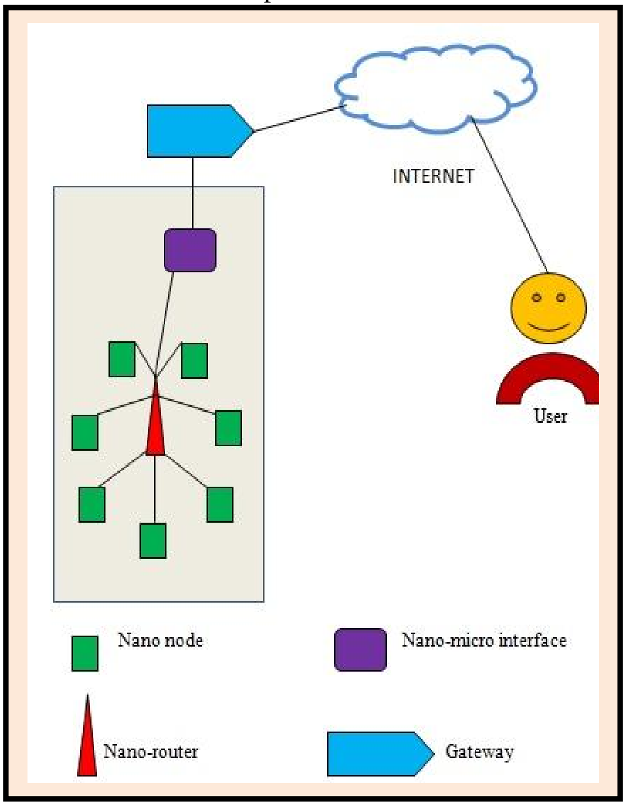

Figure1:Architecture for Internet of Nano Things.

III. MAJOR CHALLENGES IN IoNT

1) **Frequency band requirement for nano devices**:

The performance of the nano networks strongly depends on the appropriate selection of the frequency of operation of the nano antennas. For Internet of Nano things, terahertz [7] frequency bandof electromagnetic spectrum is preferred. Currently, nano antennas made up of graphene[8, 9] are proposed. Graphene allows the propagation of the Surface Plasmon Polariton (SPP) waves in the terahertz frequency band (0.1 - 10 THz).This means the wave involves the electric charge motion oscillations at the interface between graphene and the dielectric material. These nano antennas are comparatively smaller than the classical antennas. Graphene is the thinnest and lightest material in the world. The electrons mobility in graphene is very high than the silicon. In graphene based nano antennas [10], two types of nano materials are used:

i. Carbon nano tube (CNT)

ii. Graphene nano ribbons (GNR)

In the beginning, megahertz frequency is preferred, because at lower frequencies the trans- receivers can communicate over longer distances. But the energy efficiency of the nano machines is quite low and a very high power pump source is required to excite the CNT[10]. Hence, now the terahertz band is preferred. But the main problem is that the terahertz frequency region is least explored. This region lies between microwave and infrared regions, which are most investigated. So, the first challenge for the researchers in the field of electromagnetic nano networks is the development of new channel models for the terahertz frequency band.

2) **Privacy and Security**

IoNT is expected to be one of the pillars of our modern-day digital industrial economy. Every physical device from our phones and household appliances, to sensors and vehicles, to large scale infrastructure systems including nuclear plants, already have their control and monitoring procedures digitized, and connected to the internet. There are major issues of privacy and security for Internet of Nano Things. Our digital terrain is increasingly under attack. The Critical data can be easily hacked by the hacker because now the ton of information is available via internet. This would cause damage to the victims ranging from the theft, spying and manipulation of their data. The governments of different countries are trying their best to counter these attacks but even afterwards, many PCs have been subjected to the threats again and again. The cyber-attacks are highly asymmetric where the hacker could sit in any location across the world, and target digital systems. The confidential data should be protected from illegal usage and fake acts for personal benefits. Campaigns should be started to spread awareness about cyber-attacks, along with regular updates and installations of security solutions, would make these threats less severe.

3) **Channel modelling**

Since, for terahertz frequency band, the technology generation and its manipulation are in its early stage, so, new channel models are to be proposed. Here, we have discussed various parameters of channel model like path loss, noise, bandwidth and channel capacity for the terahertz band.

a) **Path loss-** The total path loss for the wave is the contribution of the spreading loss and the molecular absorption loss. The spreading loss is the attenuation caused due to the expansion of the wave as it propagates through the medium. It depends on the frequency of the signal and the transmission distance. The absorption loss is the attenuation that the wave suffers due to its absorption by the surrounding molecules. This phenomenon depends on the total concentration of the molecules and particular type of mixture of the molecules along the path. Also, other phenomenon like scattering effect due to the nano particles and the multipath propagation affects the strength of signal at the receiver end.

b) **Noise-** The noise is due to the presence of molecules in the surroundings of the nano devices. The molecular absorption does not only cause attenuation in the signal but also adds the noise. The overall noise depends on the total number of molecules and the type of mixture of molecules present along the path from transmitter to receiver. It also depends on the transmission distance. Terahertz channel strongly depends on the transmission distance and the medium molecular composition.

4) **Bandwidth Constraints and Channel Capacity**

The network traffic problems in Internet of Nano Things consist of bandwidth issues. Day by day, as the need for more data requirement grows, more bandwidth will be needed. But the band width available to us is very limited. This issue can be solved by switching to the unexploited electromagnetic spectrum band. This unused frequency band is known as the terahertz band. Terahertz band provides very huge amount of bandwidth for very short ranges (>1m).Hence, very large amount of channel capacity seems to be available for nano networks. About 100 tera bits per second rates are possible. However, the nano machines are simple devices having very limited capabilities. So, practically utilizing the entire channel efficiently by these nano machines is not a simple task.

5) **New Modulation Techniques**

Graphene based antennas radiate very short pulses of femtoseconds. These pulses are discrete in nature rather than continuous. This relaxes the requirements for power unit for the nano machines. For pulse based communication, a new modulation technique is employed. This is known as time spread on/off keying mechanism. nano machines transmit a pulse to represent logic 1 and remains silent to represent logic 0.The channel capacity can be maximized when more number of 0's are transmitted than 1's.Moreover, by being silent, absorption losses and interference are reduced. To detect a very low energy pulse, very accurate sampling and synchronization is required. This issue can be solved by transmitting several pulses in burst rather than a single pulse. Parameters such as energy per pulse, number of pulses in a burst, time between consecutive pulses are to be planned.

6) **Protocols for nano machines**

Nano machines send the information from source to the destination by using very short pulses. The medium access protocols (MAC) protocols used for carrier sensing based communication cannot be used for nano networks because there is no carrier signal is used for sensing. Hence, new MAC protocols should be discovered for pulse based transmissions for nano networks. Nano machines are simple devices with limited capabilities so, the fresh protocols discovered should not be very complicated. Since, the information is transmitted using very short pulses so; chances of collisions among different nano nodes trying to access the channel at the same time are very less. The new MAC protocols should be designed to give maximum scalability, throughput and fairness. The time between the pulses should be greater than the pulse duration. This is necessary as the power options are limited in nano machines. Even if collisions takes place among various nano nodes, MAC protocols with collision avoidance techniques should be formulated.

Any nano sensor deployed in the human body may be toxic. This will emit harmful radiations within the body and would be very dangerous. So, initially the experiments should be performed on the plants and some other less risky organisms. Integration of many components on a single nano chip is a big deal. Nano networks will yield huge amount of data. Handling this large data is not an easy task. Data compression is required. For this, data compression algorithms are to be discovered.

CONCLUSION

Literature study reveals that IoNT will dominate and entirely change the way in which devices are connected together. Although the opportunities lying in IoNT are innumerable, there is a need to integrate hardware and software solutions to the existing setup in a seamless manner. As a future work, each of the challenges discussed above will be investigated in detail.

REFERENCES

[1] F. Akyildiz, F. Brunetti, and C. Blazquez,“Nano networks: A New Communication Paradigm,” ComputerNetworks (Elsevier) J., vol. 52, no. 12, Aug. 2008, pp.2260–79.

[2] Xia, F.,Yang, L. T., Wang, L., &Vinel, A. (2012). Internet of things. International Journal of Communication Systems, 25(9), 1101.

[3] Atzori, L.,Iera, A., &Morabito, G. (2010). The internet of things: A survey. Computer networks, 54(15), 2787-2805.

[4] T. Suda et al., “Exploratory Research on Molecular Communicationbetween Nano machines,” *Genetic and EvolutionaryComputation Conf. (GECCO),* Late BreakingPapers, June 2005.

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

[6] C. Rutherglen and P. Burke, “Nano electromagnetics: Circuitand Electromagnetic Properties of Carbon Nanotubes,”*Small*, vol. 5, no. 8, Apr. 2009, pp. 884–906.

[7] K.-C. Huang, Z. Wang, Terahertz terabit wireless communication,IEEE Microw. Mag. 12 (4) (2011) 108–116.

[8] J. M. Jornet and I. F. Akyildiz, “Graphene-Based Nano- Antennas for Electromagnetic Nano communications in the Terahertz Band,” Proc. 4th European Conf. Antennas and Propagation, EUCAP, Apr. 2010, pp. 1–5.

[9] M. Rosenau da Costa, O. V. Kibis, and M. E. Portnoi, “Carbon Nanotubes as A Basis for Terahertz Emitters and Detectors”, Microelectronics J., vol. 40, no. 4–5, Apr. 2009, pp. 776–78.

[10] Y. M. Lin et al., “100-GHz Transistors from Wafer-ScaleEpitaxial Graphene,” Science, vol. 327, no. 5966, Feb.2010, p. 662.