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Challenges and Issues in Network Traffic in IoNT

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Abstract

The next generation networks will be based on the "Internet of Nano Things (IoNT)". A large number of effective nano devices like sensors and actuators are being manufactured by various companies. These nano devices have become an integral part of our daily life in terms of gadgets and equipments that we use on day to day basis. As the field of nanotechnology continues to progress and find solutions to diverse problems ranging in computer science, bio-technology, agriculture and defense industry, the adaptation of existing distributed computer networks to process large volumes of data generated by nano devices has become a critical issue. The main aim of this paper is to study the challenges in overcoming the network traffic problems in IoNT. The authors attempt to present a network architecture of IoNT and the associated novel routing protocol comprising of nano routers and nano interface devices which shape network traffic to achieve optimized network performance parameters such as time delay and throughput.

Keywords: *Graphene, Nano sensors, Nano technology, Terahertz band.*

INTRODUCTION

Nanotechnology deals with the devices in size of nanometers ranging from 1 to 100 nanometers. In modern world, nanotechnology has several important applications. For example, the implanted sensor 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. All such nano devices like sensors or actuators may be connected to the Internet to form Internet of Nano Things (IoNT).

Devices in IoNT interact with each other via nano network over the Internet to fetch the information about a particular object. This new model will have impact on every field of the society like health, home security, environment protectionbecause nano sensors, mini power supplies and nanoantennas are economical as well as considerably efficient. The nano network has many extraordinary capabilities.

Internet of Things (IoT) [1,2] has been a much researched field in the recent past, however in case of IoNT the size of connected devices has gone down to the order of nanometers enabling the deployment of large number of devices in any given area. Hence, IoNT will give us more detailed and precise information about the object of interest.In future, we will see billions of nano sensors all around us transmitting real time information for different purposes.The nano devices communicate over the Internet by two approaches (a) molecular communication and (b) Nano-electromagnetic communication.

(a) Molecular communication- In this type of communication, messages are transmitted in the form of molecules from transmitter to the receiver [3,4].Here, water is used as a medium.The transceivers react to the specific molecules and to release others as a response to an internal command.

(b) Nano-electromagnetic communication- 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 novel architecture for Internet of Nano Things in SectionII. We describe the communication challenges in nano networks in Section III. In Section IV, a novel routing protocol for IoNT is proposed. The Case study based on the proposed protocol is illustrated in sectionV.Conclusions and future directions are given in SectionVI.

II. ARCHITECTURE OF INTERNET OF NANO THINGS

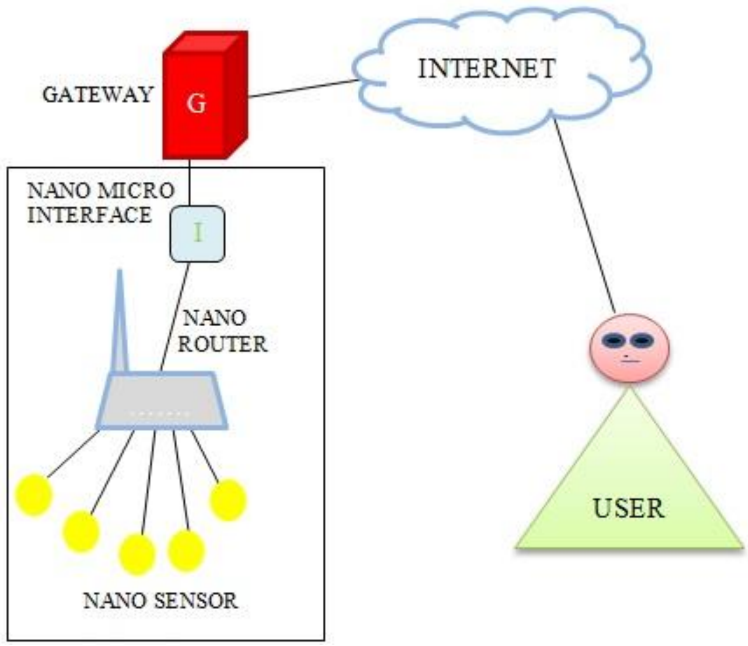

Figure 1:Architecture for Internet of Nano Things

The architecture of IoNT is a sparsely researched area. Literature study suggests that there are four components in the architecture of IoNT[7] as shown in figure 1. Each of these components are described as under-

Nano nodes-Nano nodes are the Nano devices like sensors or actuators which can be deployed in the human body or in office. They are 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 Nano nodes.

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.
Nano micro interface devices-These devices aggregate 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.

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 provider.

III. CHALLENGES OR ISSUES IN INTERNET OF NANO THINGS

The underlying architecture described in previous section has 5 major challenges-

i. Interaction:In the Internet of Nano Things, huge amount of data is to be transmitted,for this data has to be compressed. Hence, data compression techniques are required. This can be also achieved by changing the underlying architecture of nano networks. Moreover, terahertz band is proposed by the researchers for the internet of nano things. Terahertz band offers huge amount of bandwidths and very high data transmission rates [8]. Also, for terahertz band, researchers have proposed the graphene based nanoantennas[9], which helps in transmission and reception of signals in terahertz band frequency.

ii. Modulation and encoding: The present wireless sensor networks do not use terahertz band communications. So, for the internet of nano things, which works in terahertz band frequency, both these schemes have to be changed. For this purpose, carbon Nano tubes based emitter and decoder has been proposed [10].

iii. Addressing: Since, huge amount of nano devices are to be given addresses, this is not a simple task.

iv. Routing: In the terahertz communications, the data is transmitted at very high rates, therefore the existing routing protocols used in wireless sensors networks cannot be used for nano machines. So, new novel routing protocols has to be proposed.

IV. PROPOSED ACTIVE SOURCE ROUTING PROTOCOL FOR INTERNET OF NANO THINGS

For the internet of nano things, the routing protocol should handle very high data rates; this means that routing protocol should have high throughput. Also, the routing protocol should deliver data packets with least delay. Since, the Nano machines are simple devices with limited processing capabilities, the protocol should not be complex. It shoud be simple.

Keeping all these things in mind, active source routing protocol(ASR) is proposed. In this protocol, a source node which is ready to send the data packet to the destinationnano routerdo not have any idea of the route to the destination. Hence, the source node floods the path request packet in the network.The path request packet consists of four fields as follows:

1) **ID:** The identification number generated by the source node
2) **PA:** The path transverse by the path request packet is filled.
3) **SN:** The source node.
4) **DNR:** The destination Nano router.

ID	PA	SN	DNR

Figure2: Path request packet header

Each node after receiving a path request packet forwards the packet to its neighbor.A node after receiving the request packet checks the identification number on the packet before forwarding it. The packet is forwarded only if it is not a duplicate path request. The identification number on the packet is used to prevent loop formation and to avoid multiple transmissions of the same request packet by the nodes.TheNano router after receiving the request packet replies to the source node through the reverse path with the help of PA fieldof the request packet header.

V. CASE STUDY

Consider a nanonetwork of 5 nodes in which in which node 1 is the source node and node 5 is the Nano router. Nano router is the destination. This network is shown in figure 3.When node 1 is ready to send the data packet to the Nano router,itwill initiates 'path request packet'. This packet is flooded throughout the network.The proposed routing protocol for the nano network is shown in figure 3:

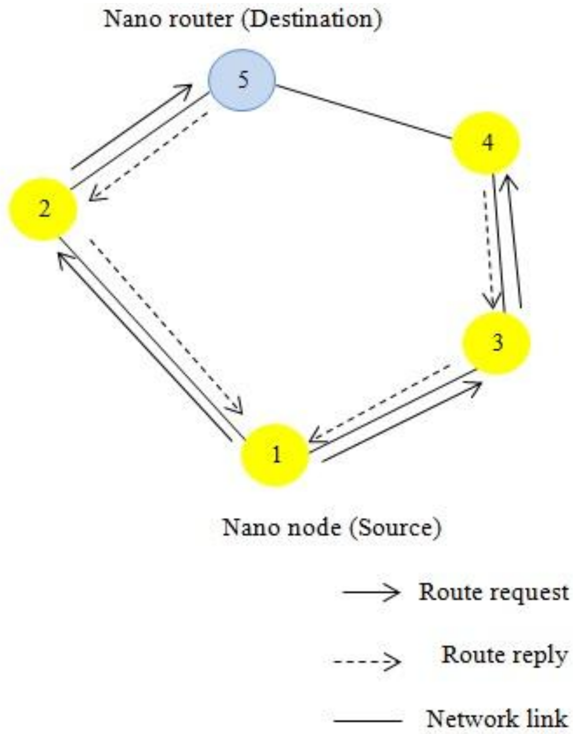

Figure 3: Proposed Active Routing Protocol for IoNT

ID		1	5

Figure 4: Request packet from node 1

ID	2	1	5

Figure 5: Request packet from node 2

ID	3	1	5

Figure 6: Request packet from node 3

ID	3,4	1	5

Figure 7: Request packet from node 4

For Path request packets from node 1, 2, 3 and 4 refer to figures 4, 5, 6 and 7 respectively. The source node 1 has node 2 and node 3 as its neighbors. So, nodes 2 and 3 will receive the path request packet from node 1. After receiving these packet nodes 2 and 3 finds that this packet is meant for Nano router from source node 1. Hence nodes 2 and 3, forwards this packet to their neighbors node 5 and node 4 respectively.

As soon as the packet reaches Nano router, its checks that this packet is belongs to it from node 1. On the other side, node 4 will further forwards the packet to its neighbor. Now the Nano router will immediately sends back the acknowledgement to the source node 1 via intermediate node 2 with the help of PA field. This technique of sending back acknowledgement by destination to the source will increase the reliability of the nano network. Also the shortest path is established via route 1-2-5 from source node 1 to the destination Nano router. This will decrease the time delay of the data transmission and reception.

The throughput of this process is very high. This protocol is energy efficient. Also, this protocol is simple to implement. This will decrease the complexity of the hardware.

CONCLUSION

In this paper a novel routing protocol is proposed. In this protocol, the best shortest and desired path in a defined order is established. This reduces the time delay between the transmission and reception of the data packet. Therefore, the data rate is very high which makes throughput considerably high in this protocol. Also, the chances of collisions are very less, as this protocol is best suitable for static environments. This protocol is very easy to implement. This protocol is quite energy efficient. In future the proposed routing protocol will be implemented over a nano network to gather the information about the object for which they are deployed.

REFERENCES

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

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

III. 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.

IV. T. Suda et al., "Exploratory Research on Molecular Communicationbetween Nano machines," Genetic and EvolutionaryComputation Conf. (GECCO), Late BreakingPapers, June 2005.

V. 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.

VI. C. Rutherglen and P. Burke, "Nano electromagnetics: Circuitand Electromagnetic Properties of Carbon Nanotubes,"Small, vol. 5, no. 8, Apr. 2009, pp. 884–906.

VII. Josep Miquel Jornet, Ian F. Akyildiz, "The Internet of Multimedia Nano-Things", Nano Communication Networks 3 (2012) 242–251.

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

IX. 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.

X. 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.