Intelligent Internet of Things for Energy Conservation Based on Routing Protocol

Khattab M. Ali Alheeti, *MIEEE*
School of Computer Sciences and Electronic Engineering
University of Essex
Colchester, United Kingdom
kmali@essex.ac.uk

Muzhir Shaban Al-Ani- MIEEE
Deparment of Computer Science
University of Human Development
Sulaimania, IRAQ
muzhir.al-ani@uhd.edu.iq

***Abstract*—The Intelligent Internet of Things (I^2oT) has become a significant technology in the recent research area. The application of internet of thing expands to the connectivity for anything, anytime and anyplace. It is expected that there will be 50 billion devices connected to the internet of things by 2020. This huge number of device that were connected together to establish internet of things. However, the proliferation of this technology will be accompanied by many problems, such as technique, the exploitation of energy resources. Performance enhancing of devices/nodes in internet of things is considered important matter in success this technology. Saving power is considered one of the important factors in performance enhancing. In this paper, new intelligent approach is proposed to save of consumer power of devices in internet of things. In other words, the proposed system has the ability to introduce the node/device in sleep mode based on features that have been extracted from trace file of network. Our proposal can prove its vital role in enhancing performance of nodes in internet of thing.**

***IndexTerms*—IoT;sensor wireless communication;battery power; energy efficient routing routing.**

I. INTRODUCTION

At the end of 1969, four host computers were connected together into the initial ARPANET, and the budding Internet was on the ground[1]. Since 1969, the Internet has developed step by step by adapting and introducing new and advanced technologies to meet the needs and demands of the human life[2]. Reliability, flexibility, availability and usability are considered main factors of the Internet growth. In addition easy connected and accessed from other devices such as mobile, iPad, …etc. Nowadays the Internet surround the world with very big networks that offers data and information any things, anywhere anytime to billions of people. The Internet is a world-wide broadcasting capability, a way for information dissemination, and a medium for collaboration and interaction between individuals and their computers without regard for geographic location[3].

One of the big challenge of Internet of things (IoT) is how to integrate all devices in Internet including tiny devices[4]. So the developed protocols for these devices must be changed and modified to adapt the new environment[5]. IoT deals with the cooperation and recognizing the individual components of the of all types of networks such as Local Area Network (LAN), Metropolitan Area Network (MAN), Wide Area Network (WAN), Personal Area Network (PAN), Campus Area Network (CAN), Radio Frequency IDentification (RFID and Cloud Network …etc.

The IoT is the huge wide extension of the Internet to be connected to the physical devices or objects this leads to the term things[6]. These things will be connected to the Internet through wired or wireless links with a global address to create a single world-wide network of electronic devices[7], [8].

The explosion growth of Internet penetration, Internet users, Internet connected devices and networks have led to big increased of IP addresses for each device[9]. Pv4 uses a 32-bit address scheme allowing for a total of 2^32 addresses (just over 4 billion addresses)[10]. This is what led to the full capacity of Internet protocol version 4 (IPv4). IPv6 (Internet Protocol Version 6) is also called Internet Protocol next generation and it is the newest version of the Internet Protocol (IP) reviewed in the IETF standards committees to replace the current version of IPv4 in order to solve all problems of the previous version. Pv6 uses a 128-bit address scheme allowing for a total of 2^128 addresses.

Merging of advanced technologies, modern devices, new standards and IPv6 lead to the capability to create the powerful IoT that can connect things and object all over the world with smart ways[11]. IoT-based communication rely on standard protocol solutions covering all the layers of the well-known Internet Protocol suite[12]. The standard has been released in its first version in the 2003 with the aim of enabling energy-efficiency communications in Low-Rate Wireless Personal Area Networks (LR-WPANs)[13].

The Internet of Things (IoT) is heterogeneous network of internet that was connected various objects to exchange and collect information/data[14].It is formed from a myriad of smart objects, sensors and actuators are connected together in that radio coverage area[15].These objects are equipped with various types of communication protocols, defender systems and microcontrollers to enable their tasks[15].The applications of IoT play a significant role in our daily life such as home appliances, surveillance and environment monitoring sensors. In addition, wireless sensor networks are considered one of the important applications in IoT[16], [17], [18]. An IoT network architecture is shown in figure 1.

978-1-5386-2955-0/17/$31.00 ©2017 IEEE

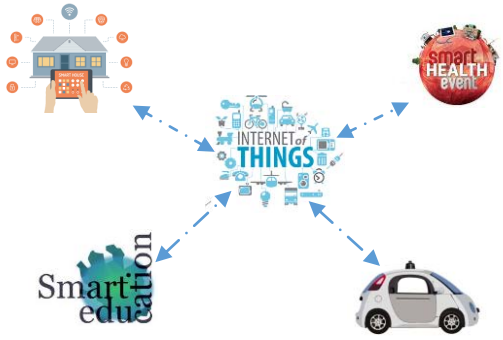

Fig 1.An Internet of Things (IoT) network architecture.

Wireless Sensor Network (WSN) makes up a class of ad-hoc network in which the nodes are having basically low-cost, limited computing power which operates with the use of batteries[19]. They are used in a very huge numbers in order to collect data about the surroundings or any physical event such as aggregate information, and as well communicate areas of interest to monitor nodes either on demand or as required. A great scenario of interest include seismic monitoring, power plant or nuclear reactor, close-circuit camera in retail, traffic management, military usage to sense the territory of the enemy[20].The researchers consider power consumption one of the common problem in WSN [21].

In order to reduce long range message transfer, the nodes are organized into hierarchical cluster and messages are kept short and bursty in nature as well as spaced apart in order to optimize power consumption. A good sensing coverage and connectivity at the same time can be provided in dense sensor nodes simply by maintaining the necessary set of sensor nodes active in order to increase lifetime of a network. The scheme tries to not adversely affect the sensing coverage and connectivity while keeping other nodes in sleeping modes.

In this paper, an intelligent sleping mode and energy detection system are proposed to detect energy level of nodes that were connected to a common IoT. It is designed to increasing network lifetime and enhancing the efficiency performance of WSN. The system has the ability to introduce node in sleep mode at suitable time without delay. It based on features that have been extracted from trace file of routing protocol. In other words, the proposed sleeping mode is based on throughput features that was calculated from trace file.

The nodes which are having the lower remaining energy level are given higher priority for each period which is done for some selected sleep mode. The loads are more eventually distributed in order to prolong the lifetime of the sensor nodes. At the end of data transfer, we discovered that the energy level of nodes is distributed in randomly fashion because there is no single point of failure which eliminates exhaust condition from network.The work makes contributions, which are:

- Designing intelligent sleep mode to enhancing the performance of WSN.
- Increasing network lifetimeof IoT through introduce nodes in sleep mode at suitable time without delay.

The application of intelligent sleep mode in IoTenables to add a new dimension in the current WSN, thus increasing the robustness of the WSN in IoT.

The remaining of theresearch is organized in the following way: Section II explores literature survey in the domain ofWSNs. Section III explains the methodology and section IV describes the simulation results. Section V analysis the results and discuss the outcomes of the scheme. Section VI is a conclusion and future works.

II. LITERATURE REVIEWS

In this paper, our focus is on one of the most common problem in WSNs which is energy power of nodes in IoT. Centralized and distributed are common algorithms that were employed in saving energy for nodes in IoT [22].

The most recent energy saving techniques are described and compared in [22], [23]. The role of centralized and distributed algorithms is explained to analysis advantages and disadvantages for each algorithm. In addition, centralized saving algorithm has the ability to provide more precise about which nodes /devices must be sleeping mode at t time. However, this algorithm suffers from high traffic messages or overhead. In other words, it made extra burden on network as well as it had problem with quick adapt with changing conditions. Whereas, distributed algorithms for saving power had less cost of traffic messages, can easily adapt with dynamic conditions and more scalable. Therefore, it is facing problem with optimal decision about sleep mode.

Li et al. proposed an Intra-Cluster CoMP based Sleep-Mode Scheme (ICCSS) to enahmces the efficiency of energy in Dense Heterogeneous Network[24]. They divided small cells of dense into different clusters. After that, a greedy algorithm is utilised to optimize the original problem. Then, ICCSS can enhance efficiency of energy by 24.5%.

In [25], sleep mode is proposed for base station to decline the energy consumption of cellular networks. When the packet traffic is low and mobile users can connect to nighbour cells, the proposed system has the ability to introduce the BS in sleeping mode. The proposed saving algorithm can extermally decline the total energy consumption of cellular networks.

Ebrahim et al. investigated the energy consumption metrics of cell networks which are worked with sleep mode functionally[26]. The proposed method has the ability to determine the potential sleep mode without the require for an exchausive search. The authors assessed an compared the

Energy ConservationAlgorithm

begin
//Create Molility and traffic model for nodes in IoT.
For n (nodes) Do
Calculating energy rate with position for each node in IoT.
//finding the energy power with position for IoT nodes.
While each of node has low energy rate will introduce in sleep mod.
End While.
End for.
End.

performance of the proposed method with optimal benchmark. According the results, the saving energy can reduce computational burden on network.

Praseebaa et al. foused on reducing energy of WSNs that was based on routing of packets. Hence, rouing protocol should not use all nodes in the network to increase the lifetime of nodes in WSNs. In other words, the routing protocol utilise the minimum number of nodes. As a result, the authors can improve lifetime of nodes in network by reducing energy consumption.

The motivation of our research, is to design an intelligent energy saving based on routing protocol features. This will help providing long network lifetime for WSNs in IoT. Here a novel sleeping mode in WSNs is presented that was different from the previous systems by which it has ability to increasing network lifetime. In addition, the proposed algorithm is based on one feature that have been extracted from the trace file. In this case, the saving algorithm can overcome the common problems of saving methods.

III. METHODOLOGY

In this paper, an intelligent sleeping mode is proposed to increasing network lifetimeof devices in IoT. The system has the ability to identify and introduce nodes in sleep mode at suitable time.

An n number of nodes with m number of devices connected to a common road side units (RSUs); these devices communicate with each other in that radio coverage area. Devices in this proposed system can be represented by the symbol D_i where $i = 1, 2, 3, 4, \dots\dots j$. The duration of time is utilised for measure node activity in IoT. In other words, some performance metrics are employed in our system to select sleep- mode- node such as Packet Delivary Rate (PDR) and throughput rate. These metrics will apply on each nodes in IoT to measure overall performance. However, these metrics usage could lead to right descision of select nodes. Hence, the number of nodes should be decline when the overall performance is reducing at time t. Reducing the number of IoT devices as procedure to re-increase the system performance.

There are six stages of the sleep mode approach for nodes in IoT.

1. The first stage (configuration real-world) –The traffic and mobility models are utilised in this stage to configuration real world communication for nodes in IoT as shown in figure 2.

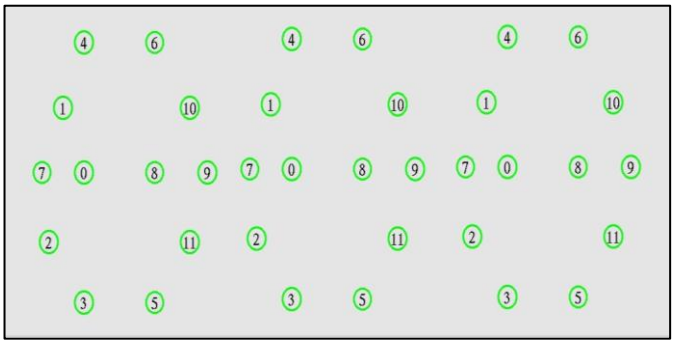

Fig. 2: WSNs Topology

2. The second stage (ns-2) – The simulator network is employed in this stage to simulate the IoT nodes with Bus station.
3. The third stage (Pre-processing data set): The extracted features were pre-processed to transfer some symbols to numbers.
4. The fourth stage: (Significant communication feature):Here, throughput rate is calculated from the trace file. The proposed saving power for nodes in IoT is heavily based on trace file features. In more details, the Alfred Aho, Peter Weinberger, and Brian Kernighan (AWK) language is used in analysis the trace file of ns-2.
5. The fifth stage: (energy rate): The energy rate is measured of each node in IoT. These values play important role in select the node that is introduce in sleeping mode. The architecture of the proposed system illustrated in figure 3.
6. The sixth stage: (Energy Conservation): In this stage, sleeping mode will apply on nodes that have low active rate or low throughput rate. The algorithm of the energy conservation as shown blow:

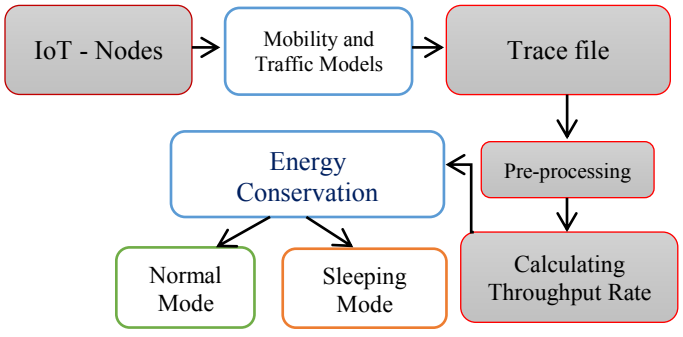

Fig. 3:Energy Conservation Architecture

The system first installation traffic and mobility modes for nodes in IoT. They arethen generated the trace file of ns-2 that was created from source node to destination node. The extracted features/ throughput rate from the trace file that is need to pre-processing phase. The energy conservation system will apply on node that has low energy rate than others.

IV. Simulation Results

The network simulatorversion ns-2 are utilised in order to stimulate the real moving behaviours of the nodes in a mobile ad hoc network. We conducted evaluations making use of 100 nodes which are randomly scattered in a region of 1000Mx1000m. These factors are used as the critical scenario. The model of the energy includes the radio range of 250m, 2Mbps of data rate; the initial energy supplied to each node is random. The power that was utilised during transmission and reception are 1.5W and 1.0W respectively. Additionally, CBR (Constant Bit Rate) traffic model was used with packet size of 512 bytes, rates 50 packets/s and simulation time of 100s. The ns-2 is carried to generated engergy.tcl.

A small WSNs network is designed using Network Simulation ns-2. The proposed saving power system begins with a nodes of IoT that random propagate signal to road side units and collect data and save it in a trace file. Python language is used in preprocesing the trace file that have been extracted from ns-2. The performance information of IoT nodes is calculated that was reflect nodes activity over time. After detectionnode activity of the WSN nodes, anenergy conservationsystem is utilised to identify the nodes according to activity value, repetition process in the WSN, and energy level of each node. In table 1, activity value per node over the time is measure from the ns-2 trace file. Then these values will pass into an energy conservation to decision making algorithm.

TABLE 1 NODES ACTIVITY PER TIME MATRIX

	N1	**N2**	**N3**	**….**	**Nj**
$Time_1$	Non-Active	Active	Active		Active
$Time_2$	Active	Active	Active	Active	Active
$Time_3$	Active	Active	Non-Active		Active
…					
$Time_n$	Non-Active	Non-Active	Active		Active

The IoT nodes with high activity status over the time allowed to remain connected to the WSN. an energy conservation is applied to the non-activity nodes as swhoen in table 2. It contains the nodes identification (ID) and energy levels is passed to the propose sleeping mode to create a decision to decline connection from WSN of nodes that are low energy level.

TABLE 2 ENERGY LEVEL OF NODES

	N_1	N_2	N_3	….	N_j
$Time_1$	85%	25%	100%		0%
$Time_2$	90%	15%	75%		0%
$Time_3$	78%	21%	89%		0%
…	71%	38%	72%		0%
$Time_n$	65%	20%	55%		0%

According to table 2, the propose system will decline node N_2that low activityrate from other over time. In this case, the network lifetime will increase for other node in that radio coverage area. The energy conservation will support all IoT application that had suffer from power consumption such as WSNs.

In ns-2, the communication parameters are one of the important issues in simulation due to they have anvital role in determining the communication performance and behaviour of IoT nodes. Some parameters used as shown in table 3 which are: Constant Bit Rate (CBR) application which sends constant packets through a transport protocol, and Random Propagation Model [27].

TABLE 3SIMULATOR ENVIRONMENTAL AND PARAMETERS

Parameter	**Value**
Simulator	ns-2.35
Simulation time	700*s*
Number of nodes	50nodes
Type of Traffic	Constant Bit Rate (CBR)
Topology	1000 x 1000 (*m*)
Transport Protocol	UDP
Packet Size	512
Routing Protocol	DSR
Channel type	Wireless
Queue Length	50 packets
Radio Propagation Model	Random
MAC protocol	IEEE 802.11
Interface queue type	Priority Queue
Network Interface type	Physical Wireless

The efficiency role of the proposed system easily observed in figure 3. The energy conservation system plays important role increasing the throughput rate of nodes in WSNs. Hence, it has direct and positive reflect on performance of IoT nodes.

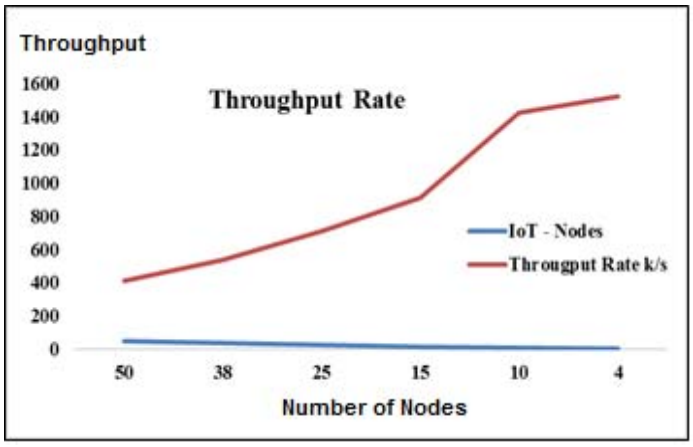

Fig. 3: Efficiency of IoT Nodes

V. DISCUSSION

According to wide boom of Internet networks, devices and tiny sensors all over the world, so these huge number of things connected to the Internet need to be controlled and organized under certain standard protocols which is a big challenges of the IoT. Power consumption is a big problem for these billions of devices connected to the Internet via IoT. The intelligent of power saving of this environment is an important issue because of big traffic of wireless devices connected to IoT environment.

The performance information of IoT nodes is calculated when WSN node activity is detection. An intelligent energy conservation approach is applied according to activity value, process repetition, and energy level of each node. The implemented approach depends on the intelligent sleep mode of nodes in WSN so the energy is stored and network connectivity is kept. The obtained simulated results of this approach are implemented using ns2 simulator in which indicated a good performance in WSNs of IoT.

VI. CONCLUSION AND FUTURE WORKS

In this paper, we proposed a novel strategy in order to manage the sleep of the nodes in the wireless sensor networks so that energy can be stored and network connectivity can be kept. The novelty of the strategy is its extreme simplicity. This method is a convenient and effective approach and has been applied to several areas of the networking successfully. In our proposed work, we will develop a sleep management protocol and network reliability for wireless sensor networks. We will also extend the protocol to the synchronous network, in which nodes manage their own mode (sleep or awake mode) independently. The experiment demonstrates that intelligent sleep mode has shown good performance in WSNs of IoT.

REFERENCES

[1] L.G.R. Thomas Marill, TOWARD A COOPERATIVE NETWORK OF TIME-SHARED COMPUTERS, (1966). http://www.packet.cc/files/toward-coop-net.html (accessed February 16, 2017).

[2] L.G. Roberts, Multiple computer networks and intercomputer communication, Proc. First ACM Symp. Oper. (1967) 1–6. doi:10.1145/800001.811680.

[3] V.G. Cerf, R.E. Kahn, A Protocol for Packet Network Intercommunication, IEEE Trans Comms. 22 (1974).

[4] A. Dunkels, B. Grönvall, T. Voigt, Contiki -a Lightweight and Flexible Operating System for Tiny Networked Sensors, (n.d.).

[5] C. Gomez, J. Paradells, Wireless home automation networks: A survey of architectures and technologies, IEEE Commun. Mag. 48 (2010) 92–101. doi:10.1109/MCOM.2010.5473869.

[6] D. Guinard, V. Trifa, E. Wilde, A Resource Oriented Architecture for the Web of Things, (n.d.).

[7] G. Kortuem, F. Kawsar, V. Sundramoorthy, D. Fitton, Smart objects as building blocks for the Internet of things, IEEE Internet Comput. 14 (2010) 44–51. doi:10.1109/MIC.2009.143.

[8] M. Petracca, S. Bocchino, A. Azzarà, R. Pelliccia, M. Ghibaudi, P. Pagano, WSN and RFID Integration in the IoT scenario: an Advanced Safety System for Industrial Plants, (n.d.).

[9] S. Jiang, B. Carpenter, Transmission and Processing of IPv6 Extension Headers, (n.d.).

[10] S. Chakrabarti, Z. Shelby, E. Nordmark, Neighbor Discovery Optimization for IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs), (n.d.).

[11] E. Baccelli, M. Philipp, M. Goyal, The P2P-RPL Routing Protocol for IPv6 Sensor Networks: Testbed Experiments, (2011) 1–6. https://hal.archives-ouvertes.fr/hal-00651603 (accessed February 16, 2017).

[12] S. Bocchino, M. Petracca, P. Pagano, M. Ghibaudi, F. Lertora, SPEED routing protocol in 6LoWPAN networks, in: ETFA2011, IEEE, 2011: pp. 1–9. doi:10.1109/ETFA.2011.6058995.

[13] Jian-Ming Chang, Ting-Yun Chi, Hsin-Yun Yang, Han-Chieh Chao, The 6LoWPAN ad-hoc on demand distance vector routing with multi-path scheme, in: IET Int. Conf. Front. Comput. Theory, Technol. Appl., IET, 2010: pp. 204–209. doi:10.1049/cp.2010.0562.

[14] Y. Xu, B. Agyemang, S. Wu, M. Liu, Procedure Graph Model For Automatic RFID Data Processing Service Management, IEEE Internet Things J. (2017) 1–1. doi:10.1109/JIOT.2017.2661326.

[15] Z. Abbas, W. Yoon, A survey on energy conserving mechanisms for the internet of things: Wireless networking aspects, Sensors (Switzerland). 15 (2015) 24818–24847. doi:10.3390/s151024818.

[16] A. Zanella, N. Bui, A. Castellani, L. Vangelista, M. Zorzi, Internet of Things for Smart Cities, IEEE Internet Things J. 1 (2014) 22–32. doi:10.1109/JIOT.2014.2306328.

[17] J. Jin, J. Gubbi, S. Marusic, M. Palaniswami, An Information Framework for Creating a Smart City Through Internet of Things, IEEE Internet Things J. 1 (2014) 112–121. doi:10.1109/JIOT.2013.2296516.

[18] J.A. Stankovic, Research Directions for the Internet of Things, IEEE Internet Things J. 1 (2014) 3–9. doi:10.1109/JIOT.2014.2312291.

[19] M. Kassim, R. Ab. Rahman, R. Mustapha, Mobile ad hoc network (MANET) routing protocols comparison for wireless sensor network, in: 2011 IEEE Int. Conf. Syst. Eng. Technol., IEEE, 2011: pp. 148–152. doi:10.1109/ICSEngT.2011.5993439.

[20] L. Li, H. Xiaoguang, C. Ke, H. Ketai, The applications of WiFi-based Wireless Sensor Network in Internet of Things and Smart Grid, in: 2011 6th IEEE Conf. Ind. Electron. Appl., IEEE, 2011: pp. 789–793. doi:10.1109/ICIEA.2011.5975693.

[21] Z. Koybasi, I. Kaya, Security and power consumption comparisons of wireless sensor networks, in: 2013 21st Signal Process. Commun. Appl. Conf., IEEE, 2013: pp. 1–4. doi:10.1109/SIU.2013.6531452.

[22] M. Cardei, J. Wu, Energy-efficient coverage problems in wireless ad-hoc sensor networks, Comput. Commun. 29 (2006) 413–420. doi:10.1016/j.comcom.2004.12.025.

[23] S. Slijepcevic, M. Potkonjak, Power efficient organization of wireless

sensor networks, in: ICC 2001. IEEE Int. Conf. Commun. Conf. Rec. (Cat. No.01CH37240), IEEE, n.d.: pp. 472–476. doi:10.1109/ICC.2001.936985.

[24] D. Li, W. Zhou, X. Yang, H. Du, An Intra-Cluster CoMP Based Sleep-Mode Scheme in Dense Heterogeneous Network, in: 2016 10th Int. Conf. Innov. Mob. Internet Serv. Ubiquitous Comput., IEEE, 2016: pp. 245–249. doi:10.1109/IMIS.2016.57.

[25] Y. Kang, S. Dong, J. Zhang, An energy-efficient user offloading algorithm for cellular network in base station sleep mode, in: 2016 8th Int. Conf. Wirel. Commun. Signal Process., IEEE, 2016: pp. 1–4. doi:10.1109/WCSP.2016.7752448.

[26] A. Ebrahim, E. Alsusa, Interference and Resource Management Through Sleep Mode Selection in Heterogeneous Networks, IEEE Trans. Commun. (2016) 1–1. doi:10.1109/TCOMM.2016.2623614.

[27] E.H.T. Issariyakul, Introduction to Network Simulator NS2, Springer, 2011. https://bayanbox.ir/view/3697480237749666667/Introduction-to-Network-Simulator-NS2-2012.pdf (accessed June 11, 2016).