IOSR Journal of VLSI and Signal Processing (IOSR-JVSP)
Volume 10, Issue 2, Ser. I (Mar. - Apr. 2020), PP 35-38
e-ISSN: 2319 – 4200, p-ISSN No. : 2319 – 4197
www.iosrjournals.org

Noma for Massive Cellular Internet of Thing

Vismaya M Kumar[1], Shiras S N[2]
[1] *Department of ECE, Mar Baselios College of Engineering & Technology, Thiruvananthapuram, Kerala*
[2] *Department of ECE, Mar Baselios College of Engineering & Technology, Thiruvananthapuram, Kerala*

Abstract: *The Internet of Things (IoT), which represents the connectivity of everything everywhere, and promises the tremendous technology in the coming years. In 2020 about 20 billion devices will be connected to cellular networks which is beyond the number of devices. In order to support massive access of Internet of things (IoT) devices the upcoming fifth-generation wireless network need the development of the cellular Internet of Things (IoT) . There are several LPWAN(Low power wide area network)-technologies that can be used to connect the product to the internet, so it can communicate with other connected devices. The main types of LPWAN are NB-IoT, LTE, Lora, Sigfox and NOMA. As the number of connected objects is expected to increase over the coming years, in order to improve the overall capacity of the cell while providing similar level of power consumption at the IoT node, and the data rate new innovative technologies will be required with less congestion. Non orthogonal multiple access (NOMA), is a promising solution for addressing the challenges in 5G networks by accommodating several users within the same orthogonal resource block. NOMA offers high throughput efficiency with simple system structure, which is particularly beneficial for massive IoT applications with low-cost, low-power, and low-complexity devices, and can provide system scalability to support the massive number of devices involved in IoTcommunication.*

Background: *To support massive connection of IoT devices with limited radio spectrum, the massive multiple-input multiple-output (MIMO) and non-orthogonal multiple access (NOMA) combination is used in cellular IoT. NOMA is a low power wide area network. Due to the large spatial degree of freedom massive MIMO can connect large number of IoT devices. NOMA can also increase the number of admissible IoT devices by significantly decreasing the required number of radio frequency (RF) chains. So, a beam space based massive MIMO NOMA scheme is designed for the cellular IoT. Hence, the number of valid devices can be much larger than the number of BS antennas.*

Methods: *LPWAN technologies have emerged as an upcoming set of traditional wireless technologies such as 2G or 3G for many Internet of Things implementations. LPWAN is not a single technology, but is a group of various low- powers, wide area network that take many shapes and forms. There are several LPWAN-technologies that can be used to connect the product to the internet, so it can communicate with other connected devices. The main types of LPWAN are NB-IoT, LTE, LoRa and Sigfox. As the number of connected objects is expected to increase over the coming years, in order to to improve the overall capacity of the cell and the data rate while providing similar level of power consumption at the IoT node, new innovative technologies will be required with less congestion.Non orthogonal multiple access (NOMA), which has been recently proposed as a promising solution for addressing the challenges in 5G networks by accommodating several users within the same orthogonal resourceblock.*

Results: *Non orthogonal multiple access (NOMA), proposed as a promising solution for addressing the challenges in 5G networks. NOMA can accommodate several users within the same orthogonal resource block. This technology can be easily adopted by 3GPP technologies to further boost the system performance of current cellar solutions for IoT. NOMA with SIC is an optimal multiple access scheme in terms of the achievable multiuser capacity regions in both uplink and downlink.*

Conclusion: *Comparing with several LPWAN-technologies that can be used to connect the product to the internet, NOMA offers high efficiency that is beneficial for applications such as low cost, low power and low complexity.*

Key Word*: IoT; LPWAN; NOMA; 5G.*

Date of Submission: 16-07-2020 Date of Acceptance: 02-08-2020

I. Introduction

To provide different applications in medias such as industry, agriculture, medicine and environment, a multiple number of internet of things(IoT) devices are connected to various wireless networks. Inorder to support massive IoT 5G and beyond 5G networks are required. To support massive connection of IoT devices over limited radio spectrum, the massive multiple-input multiple- output (MIMO) and non-orthogonal multiple access (NOMA) combination is used in cellular IoT. The term massive IoT is an apt description of enormous number of IoT devices and sensors. Due to the large spatial degree of freedom massive MIMO can connect large number of IoT devices. NOMA can also increase the number of admissible IoT devices by significantly decreasing the required number of radiofrequency (RF) chains. So, a beam space based massive MIMO NOMA scheme is designed for the cellular IoT. Therefore, the number of valid devices can be much larger than the number of BS antennas. Massive IoT refers to the application that is less latency sensitive, low cost and low energy consumption. The key requirements of massive IoT includes long battery life, affordable device, strong coverage and low operation cost. Low cost networks can easily handle large number of devices. In conjunction with the rapid growth of IoT in market, low power wide area network have become a low rate long rate communication technology.

II. Methods

LPWAN technologies have become an upcoming set of technologies such as 2G, 3G and for many Internet of Things. LPWAN technologies have advantages such as low-cost and power-efficient communication which is needed for many IoT devices. Licensed vs. license-free are the two classifications of low power wide area networks. All licensed low power wide area networks are derived from 3rd generation partnership project (3GPP) cellular standards, the license-free landscape is much diverse. Depending on theirunderlying technologies, license-free spectrum of LPWANs varies significantly in terms of network performance criteria. LPWANs have greater power efficiency and operate at lower cost than any other traditional mobile networks. They can connect large number of devices over huge area 10 to 1,000 bytes are the packet sizes that can be accommodated by the LPWAN with an uplink speeds of 200 Kbps and its range varies from 2 km to 1,000 km, depending on the technology. LPWAN is a group of various low-powers and is not a single technology, where the wide area network can take different shapes and forms. Smart metering, smart lighting, asset monitoring and tracking, smart cities, precision agriculture, livestock monitoring, energy management, manufacturing, and industrial IoT deployments are the different applications where low power wide area network technologies are used. There are several LPWAN-technologies that can be used to connect the product to the internet, so it can communicate with other connected devices. The main types of LPWAN are NB-IoT, LTE, LoRa and Sigfox. As we all know that the connected objects number increases in the coming years, therefore it is necessary to improve the overall capacity of the cell and the data rate to provide similar level of power consumption at the IoT node, by reducing the congestion. Therefore to face the challenges in 5G network and to connect multiple users the best solution is Non orthogonal multiple access(NOMA).

Sigfox: Based on the patented technology sigfox offers an end to end connectivity solution with a low power wide area network operator. The uplink communication that is the data from the base station to the end devices, the sigfox only supports uplink communication and not the downlink communication. Sigfox has an advantage where it experiences less noise levels and is an end to end network solution and technology player and it uses the frequency bandwidth efficiently which helps to reduce the power consumptions. Sigfox has the lowest cost radio modules. another advantage of sigfox is that it can cover a wide range of area where it is located. But it cannot be deployed everywhere, so it won't work for a large number of user cases. As sigfox only has a limited downlink possibility, it has a different link budget and is very restricted. Endpoint to the base station communication is better headed up in sigfox. Sigfox has bidirectional functionality, but the capacity from the base station back to the endpoint is overall controlled. Less power consumption is the main advantage of sigfox as less amount of data is send with less speed and it can cover a wide range of area where it is located, and the drawback is that it will not work for a large usecases.

Long range (LoRa): Long Range (LoRa) is a non-cellular modulation technology used for Long Range Wide Area Network (LoRaWAN). LoRa and LoRaWAN are two terms which are not interchangeable. LoRaWAN is mainly used for wide area network communications (WAN) whereas LoRa is used for long range communication. LoRa is a wireless platform which will provide low power and long range, that has become the technology for IoT. LoRa or Long range low power wireless standard is mainly used for providing low data rate communication network.LoRa can provide low data rate communication over threshold distances. The main advantages of LoRa is that it has good radio networks for IoT solutions and has better link budgets. Another advantage is that we are able to provide our own network and are able to manage our own network. LoRa devices has the ability to work well when they are in motion, which makes them useful for tracking assets. Energy management, natural resource reduction, pollution control, infrastructure efficiency, disaster prevention, which is the biggest problem faced by our planet can be solved by LoRa technologies. Longer battery life than narrow band IoT (NB-IoT) devices is the another main advantage of LoRa. The disadvantages of Lora includes lower data rates than NB-IoT, longer latency time and it requires a gateway towork.

Narrow band IoT (NB– IoT): For developing a wide range of new IoT devices and service a standard based new low power wide area network technology known as Narrow band IoT (NB-IoT) has developed, High system capacity, spectrum efficiency and high power consumption of user devices are the main advantages of narrow band IoT . Battery has a life expansion of more than 10 years. NB-IoT is the initiative project by the Third Generation Partnership project (3GPP), which is the organization for standardizing cellular systems, and addresses the needs of very low data rate devices that need to connect to mobile networks, often powered by batteries. To standardize the IoT device to make it more inter operable and more reliable is the main goal of NB- IoT. NB-IoT work well indoors and in dense urban areas as the devices rely on 4G coverage's and has better and faster response times than LoRa and has good quality of service are the main advantages of NB-IoT, the drawbacks includes its implementation difficulty and implementation cost. Sending large amount of data is the main design drawback of NB-IoT. NB-IoT is mainly used by meters and sensors since network and handoff is a problem inNB-IoT,

Long Term Evolution (LTE): LTE is also a project by third generation partnership project (3GPP) which is done in 2004 and LTE means Long Term Evolution. Among the cellular technologies such as 3G,4G, and 3GPP LTE is the current and promising technologies. LTE brings new standard for IoT networking. The main advantages of LTE that is long term evolution networks are low latency, packet optimized radio access technology supporting flexible bandwidth deployments and high data rate. The network design architecture of LTE is based on the goal to provide seamless mobility and quality of service to support packet switched data traffic. The main advantages include minimal infrastructure, robust reach over massive distances, low cost, low power and scalability, better battery life and better indoor penetration. The user needs to have mobile phones which support LTE functionality, which requires completely new network is the main drawback ofLTE.

Non – Orthogonal Multiple Access (NOMA): Orthogonal and non-orthogonal approaches are the two types of multiple access techniques. Orthogonal multiple access (OMA), includes time division multiple access (TDMA), frequency division multiple access (FDMA), and orthogonal FDMA (OFDMA), where there is no overlapping of each other. A non-orthogonal scheme allows overlapping among the signals in time or frequency by exploiting power domain, code domain. NOMA is one of the most promising radio access technique in next generation wireless network. Compared to OFDMA, which is the current standard technique, NOMA offers a set of desirable potential benefits such as enhanced spectrum efficiency, reduced latency with high reliability and massive connectivity. NOMA techniques can broadly classified into two major categories, i.e., power-domain NOMA and code-domain NOMA. In Power domain NOMA multiplexing is fully based on different power levels and in Code domain NOMA multiplexing is fully based on different codes. NOMA uses superposition coding at the transmitter end. NOMA uses SIC (Successive interference cancellation) technique to retrieve data of both the users. The Key ideas of NOMA is that all the users are served at the same time, frequency and code, Users with better channel conditions get less power and Successive interference cancellation is used at the receivers. The baseline idea of NOMA is to serve multiple users using the same resources in terms of frequency, time and space.

III. Result

Non orthogonal multiple access (NOMA), has been recently proposed as one of the most promising solution in radio access network. The main advantage of NOMA is that simple system structure having high throughput efficiency, that is beneficial for massive IoT applications, with low-cost, low power, and complexity devices, NOMA provide scalability to system which support massive connection of devices involved in IoT communication. For improving system performance NOMA can be combined with multi antenna and beamforming technique.Massive NOMA offers high throughput efficiency with simple system structure, which are beneficial for massive IoT applications with low cost, power and complexity devices, and can provide system scalability to support massive number ofdevices.

IV. Conclusion

Comparing with several LPWAN-technologies that can be used to connect the product to the internet, NOMA has many benefits such as high throughput efficiency, low cost, power and complexity.

References

[1]. Guanghua Yu, Xiaoming Chen, and Derrick Wing Kwan Ng, " Low cost design of massive access of cellular Internet of things," IEEE Trans. Commun., vol. 67, no. 3, pp. 2930-3208, Mar.2019

[2]. M. Shirvanimoghaddam, M. Dohler, and S. J. Johnson, "Massive nonorthogonal multiple access for cellular IoT: Potentials and limitations,"IEEECommun.Mag.,vol.55,no.9,pp.55-61, Sep.2017.

[3]. Y. Liu, Z. Qin, M. Elkashlan, Z. Ding, A. Nallanathan, and L. Hanzo, "Nonorthogonal multiple access for 5G and beyond," Proc. IEEE, vol. 105, no. 12, pp. 2347-2381, Dec.2017.

[4]. X. Chen, Z. Zhang, C. Zhong, and D. W. K. Ng, "Exploiting multiple antenna techniques for non-orthogonal multiple access," IEEE J. Sel. Areas Commun., vol. 35, no. 10, pp. 2207-2220, Oct.2017.

[5]. X. Shao, X. Chen, C. Zhong, J. Zhao, and Z. Zhang, "A unified design of massive access for cellular internet of things," IEEE Internet of Things J., vol. 6. no. 2, pp. 3934-3947, Apr.2019.

[6]. Z. Ding and H. V. Poor, "Design of massive-MIMO-NOMA with limited feedback," IEEE Signal Process. Lett., vol. 23, no. 5, pp. 629-633, May2016.

[7]. X. Chen, R. Jia, and D. W. K. Ng, "On the design of massive nonorthogonal multiple access with imperfect successive interference

cancellation," IEEE Trans. Commun., vol. 67, no. 3, pp. 2539-2551, Mar.2019.
[8]. J. Zhang, X. Xue, E. Bj¨ornson, B. Ai, and S. Jin, "Spectral efficiency of multipair massive MIMO two-way relaying with hardware impairments," IEEE Wireless Commun. Lett., vol. 7, no. 1, pp. 14-17, Feb.2018.
[9]. S. M. R. Islam, N. Avazov, O. A. Dobre, and K-S. Kwak, "Powerdomain non-orthogonal multiple access (NOMA) in 5G: potentials and challenges," IEEE Commun. Surv. Tuts., vol. 19, no. 2, pp. 721-742,Jun.2017.
[10]. X. Chen, Z. Zhang,C. Zhong,D. W. K. Ng, and R. Jia, "Exploiting interuser interference for secure massive non-orthogonal multiple access," IEEE J. Sel. Areas Commun., vol. 36, no. 4, pp. 788-801, Apr.2018.