Narrowband IoT:
Principles, Potentials, and Applications

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ABSTRACT

Narrowband Internet of things (NBIoT) is a low energy and low resource consuming version of IoT. As its name suggests, it needs a narrow bandwidth for its operations. Its energy consumption is also very low, and thus it is suitable for low energy applications. It is compatible with all types of cellular communication infrastructure such as 2G, 3G, 4G and 5G. It is also possible to deploy NBIoT in the standalone mode where cellular networks are not available. It can cover a large area with a very small amount of power. So, it is a popular low power wide area (LPWA) technology. Due to its LPWA features, it is popular for the connected living applications at home and workplace surroundings. Its LPWA features make it a popular green technology for digital transformation. In this article, the authors provide the main characteristics of NBIoT, its standards, its potentials, and applications in different domains.

KEYWORDS

applications of NBIoT, characteristics of NBIoT, low power wide area technology, Narrowband IoT

INTRODUCTION

Internet of things (IoT) is now an integral part of the modern digital ecosystem. It has the ability to connect every object and living beings with the Internet. Therefore, it is one of the leading technologies in the current digital transformation across the world. Looking at the widespread deployment of the IoT components such as the sensors, actuators, servers, edge computing infrastructure, and other facilities; it is clear that the energy and other IoT resources will be needed in a large amount. In order to reduce the energy and other resource consumption there is a need of a leaner and thinner version of IoT. Narrowband IoT (NBIoT) is one such resource efficient version available now (3GPP, 2016). It was evolved from the need of large scale machine type communications over the LTE networks (GSMA, 2018). It is one of the most popular low power wide area (LPWA) technologies. It does not have adverse effects on the human and other living beings. That is why it is considered as a main technology for ambient living ecosystem (Routray, 2021). It is also preferred for the large scale

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deployments over a large coverage area. Cost wise, it is one of the economical forms of the available IoT (Chen et al., 2017). Its deployment is simpler when compared with other types of IoT (Routray, 2019). Its standardization has been completed and new provisions are added with the new application demands. It can be deployed over the cellular infrastructure as well as in the standalone mode (3GPP, 2016). It has enormous potential for low power applications. It is one of the most attractive LPWA technologies in a large number of technology and non-technology sectors in recent times. Therefore we find a lot of applications of NBIoT in the low power regime (Xu et al., 2017).

Large scale machine to machine communication is a primary requirement in the beyond 4G networks (Routray, 2019). In order to handle these connectivity issues several solutions have been proposed. In the mobile cellular framework, there are three different solutions viz. NBIoT, LTE-M, and EC-GSM. There are a few differences between these cellular IoT (CIoT) solutions. Though they are designed for the emerging demands of 5G and beyond 5G networks, they are also compatible with the legacy networks such as 2G, and 3G and 4G (Routray & Sharmila, 2017). NBIoT was proposed by the Third Generation Partnership Project (3GPP) for machine type communications in the LTE framework in Release 13 (3GPP, 2016). It was custom designed to be compatible with the LTE networks and their legacy systems. Its main goal was to compete with the existing low power non-cellular IoT technologies such as LoRa and SigFox. New physical layer signals and channels were designed to fulfil the demands of LPWA applications (GSMA, 2018). Its LTE features make it suitable for rural, urban and remote deployments over the mobile cellular infrastructure. Due to its low energy consumption characteristics it is regarded as a green technology (Routray & Sharmila, 2017). Due its LPWA characteristics it can be applied in a wide range of applications such as agriculture, healthcare, cattle tracking, localization in logistics, policing, utility management, traffic management, smart cities, smart grids, retail management, waste management, and smart homes (Routray & Hussein, 2019; Sharma et al., 2017; Routray et al., 2019; Routray et al. 2020). These applications of NBIoT indicate a lot about the popularity of NBIoT in the recent years. It is also a sustainable technology of the long term (Ramnath et al., 2017). Energy and bandwidth efficiency are essential for the global sustainability of the telecommunications industry (Mohanty & Moreira, 2014). NBIoT has both the attributes and it is essential for the global sustainability in the massive machine type communication (mMTC) sectors. Security and privacy aspects of NBIoT are essential for its sustained applications in the coming decades (Routray et al., 2017). In this regard, NBIoT is currently better placed than majority of the IoT in practice. NBIoT uses the security provisions of LTE and it has also its own initiatives at the upper layers (Yang et al., 2017). Several new initiatives have also been proposed for NBIoT which are certainly the game changers in the coming years (Routray et al., 2017). NBIoT is basically built for low data rates. However, in some of the applications higher data rates are needed. In such cases, NBIoT data has to be compressed using efficient techniques. IoT and other low bandwidth networks need support of the advanced compression techniques. These efficient compression techniques are essential for the overall success of NBIoT and other low bandwidth IoT networks (Routray et al., 2020b). It shows that effective compression techniques are essential to overcome several difficulties of low bandwidth networks. Resources for NBIoT such as the bandwidth for practical deployment are scarce. Bandwidth scarcity is a modern reality in the large cities and places with high density population. Several options for new bandwidths and management of existing bandwidths have been proposed for emerging services in the recent years[25]. NBIoT can be deployed over the cellular networks in different ways which we have discussed with more clarity in the deployment section of this paper. Due to the large size and large traffic, NBIoT needs some supporting technologies such as software defined networking (SDN) for proper control and management. Main issues related to the SDN approaches in IoT networks have been presented in some recent works (Muñoz et al., 2018; Ninikrishna et al., 2017). These works show that a dedicated slice for IoT based services is essential for the future demands. Various emerging issues of NBIoT such as the physical layer design, cloud implementation and future complexities are very relevant for its practical deployment (Kanj et al., 2020; Beyene at al., 2017; Routray & Mohanty, 2021). Centralized clouds are not suitable for NBIoT

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