

# Fog Computing and NB-IOT towards 5G

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**ABSTRACT:** The mobile organization standard after fourth generation (4G) is Fifth generation (5G) which is likely to present internet associations a minimum of 40 times faster than fourth generation. Fourth generation cellular broadband is spreading all through but still we need fifth generation owing to its advantages. TillFifth generation of organization, each generation is the spontaneity of previous generation of network. Each generation has its own advantages and disadvantages. To conquer the disadvantages of fourth generation of network, the fifth generation came up with advantages to gather all networks on one platform. Massive connection, ultra-reliable and delay are limitations of fourth generation networks. These limitations are taken as demanding situations by the fifth generation network and can present many services like smart retail, smart parking and smart waste management based on fog and NB-IOT (Narrow Band-IOT). These services have good solutions presented by technologies like fog computing and NB-IOT.

**KEYWORDS:** 4G, 5G, Fog computing, NB-IOT (Narrow Band IOT).

## I. INTRODUCTION

The 5G communication era is approaching and the first service is expected to rollout by 2020. 5G provides uniform, un-interrupted and consistent connectivity across the world. Though, 4G communication grows up promisingly, there are still many limitations which has to be taken care. The major limitations of 4G communications is the operating area, rural area and many locations in metropolitan cities are not well served by the current networks. The wireless technology has evolved in 1980's with 1G and today we are in the era of 5G with people talking about it and its upcoming success. The 5G will be a combination of many existing wireless technologies like GSM, Wi-fi, LTE etc. The limitations of the 4G communication will become the advantages and plus points of 5G communication. The 5G communication is mostly expected to increase the data rates per second and provided increased broadband density to the users. It presents systematic, uninterruptable and consistent connectivity across the world. This extension of fourth generation with more advanced data rates better supports internet of things, focusing on an example where customer can download 600 MB/Sec or even more advanced on fifth generation comparatively than downloading 15MB/Sec on fourth generation. The latency and the amount of battery consumption will be less. It will also create a big impact to the era of smart cars and smart homes. Massive connection, ultra-reliable and delay are limitations of fourth generation networks and solution to this are provided in 5G using Fog computing and NB-IOT.

## II. RELATED WORK

Currently Internet being an important aspect of human life, where for every source human being are dependent on internet. Present generation is moving very fast, so everything in the present world are expected to be fast and secure. So the services and resources of estimation, communication, storage and control which are related to user is distributed by Fog which contributes an outline of research opportunities [1]. The evolution of RAN (Radio Access Network) technology showed up in meeting all possible ways in minimizing the efforts of additional man power [2]. Fog node is managed in shared environment to increase the confidentiality and protection than the social cloud server [3]. Using fog and NB-IOT technologies, garbage management can be made resourceful for smart cities [4]. The use of internet of Things (IOT), Artificial Intelligence, Virtual reality, Tactile Internet and 5G applications helps in transforming present modernization to the digital modernization, in the field of work, communication, shopping and sports [5]. Fog computing also plays a necessary appearance in Internet of things [6]. Confidentiality and protection are significant attributes of Fog computing. The resource of the new enforced or distributed computing permits demand to run as close

as possible to sensed, serviceable and huge data, originating at of mankind action and object. The fog node managed in such a scheme can provide better confidentiality and protection compared to cloud server.

### III. CLOUD COMPUTING

Using cloud service provider the computing that relies on internet to accumulate, handle and process data, instead of a local server or personal computer is called cloud computing. The primary benefits of cloud computing are competence, accessibility, opportunities, innovation, adjustability and saving. With all these benefits cloud computing also have some limitations such as delay, bandwidth, data security and internet connectivity because of which the fog computing came into existence. Fig 3 shows the cloud computing module.

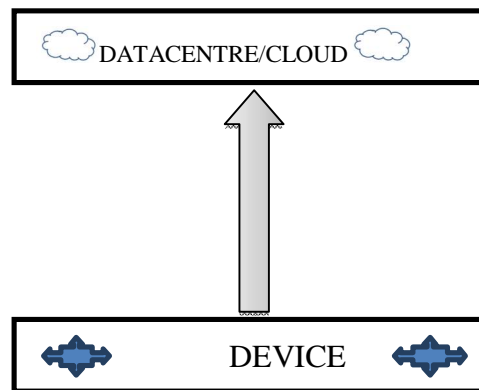


Fig 3: Cloud Computing Model

### IV. FOG COMPUTING

Fog computing is the term which was originally introduced by CISCO. At first, it seemed like a exotic idea of a company that was in constant search of new product applications, but the term has become a basic for network solutions including IOT. Fog computing can be used for storage, communication and for distributed application server. It is closer to edge devices by which it can be called as cloud computing. The fog computing model consists of the cloud network or sensor which are attached to the internet. Fig 4.1 describes the fog computing model. In this model we have fog network in middle it acts as an intermediate layer which brings IOT to life by delivering distributed edge computing

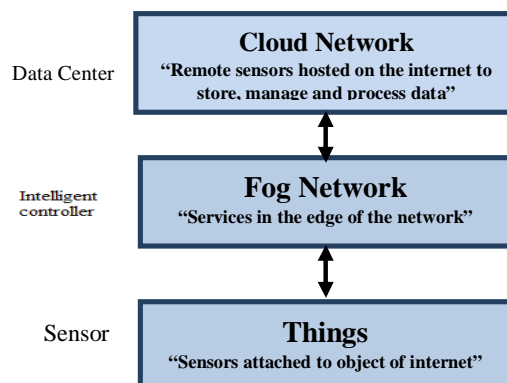


Fig 4.1: Fog Computing Model

The fog network layer is the intermediate layer. It supports many number of applications. The concept of fog requires support of mobility and deploys in distributed manner with the location notification and also provides a lower support clarity. A fog node is a lesser version of a cloud server but uses the same components like network and storage. The fog nodes operates faster and is more reactive to the location application. The idea of Fog computing architecture is to distribute data processing and operation procedure over various devices that are connected through internet to the cloud. The unique feature of fog computing are security and privacy. The other feature of fog computing is distributed computing, which allows various applications to run as sensed. The fog node which operates in these kind of environment is a better option than a public cloud server. The architecture of a fog computing is as shown in Fig 4.2 which the cloud and the things are connected through the middle layer fog.

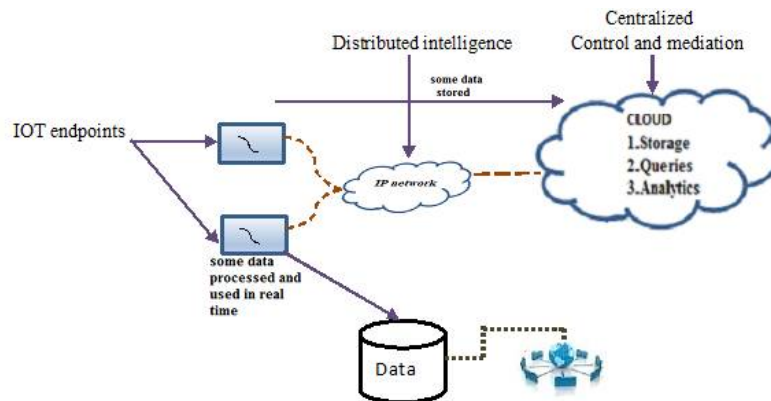


Fig 4.2: Fog Computing Architecture

## V. NARROW BAND-IOT

NB-IOT (Narrow Band-IOT) is also called as a network designed for “simple” things. It is a low power wide area network (LPWAN) radio technology standard that has been developed to enable a wide range of devices and services to be associated using cellular telecommunication bands. NB-IOT is also defined as a signal over narrow range of frequencies to relate IOT devices and it is a narrow band radio technology designed for internet of things that has been developed to enable a wide range of devices and services to be connected using cellular telecommunications bands. NB-IOT focuses on long battery life, low cost and allows large number of devices to get associated together. The main advantages of NB-IOT are security, public network, scalable, deployable and support of massive and currently present environment system. Fig 5 shows some of the vital components of NB-IOT they are device, module, and chip. The key components are attached to NB-IOT devices to access with one another. These components are used in the primitive setup of NB-IOT which has two podium and they are the service podium and the access podium. All NB-IOT devices drive on the access podium and device application drive on the service podium. The meaningful reason is to manage improved technology exploration and improvement in the zone of swiftly accelerating or encouraging marketplace category and then to relocate the developed Internet custom mechanization. One of the present inspection problem in the smart network system is to cultivate the NB-IOT minor cell protocol for wide spread of Internet of things around the world. We acquired the thought of Fog computing in the sustain NB-IOT architecture. NB-IOT application system uses fog node and main feature of fog using in these application is elucidated as diffused or Virtual server incorporated from cloud center and to the mobile devices, sensor networks, or IOT devices its geo-location is near.



Fig 5: NB-IOT Components

### VI. BASIC SETUP OF NB-IOT

Fog computing and NB-IOT is considered to be a good solution to the challenges of 5G. NB-IOT is a new way of communicating with things that require small amount of data over long period of time in places which are hard to reach. It is low power WAN radio technology standard which has been developed to enable a wide range of devices and services. The NB-IOT device, NB-IOT RAN, cloud, customer application and device application all together constitutes the NB-IOT basic setup. This device is connected to the cloud with the help of a RAN. There are two layers in the setup, namely the access layer and the service layer as shown in fig 6. The NB-IOT device will access the cloud through fog in the access layer and the service to the user is provided in service layer as an application.

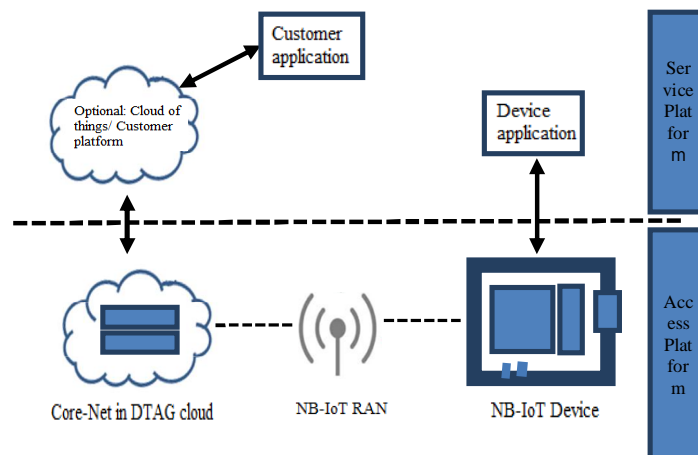


Fig 6: Basic setup of NB-IOT

There are many applications which can be extracted from this setup. Examples of radio access network types are: (i) GRAN: GSM radio access network.(ii) GERAN: essentially the same as GRAN but specifying the inclusion of EDGE packet radio services. (iii) UTRAN: UMTS radio access network. (iv) E- UTRAN: The Long Term Evolution (LTE) high speed and low latency radio access network. (v) NB-IOT RAN: Narrow band IOT radio access networks.

### VII. APPLICATIONS OF FOG NODE WITH NB-IOT ASSOCIATION

There are many industry applications on Fog node software system. They may include (i) Transport and Logistics – Successful moving and cargo space of commodities like possessions tracking. (ii) Public Sector - The slice of budget that is controlled by state like smart lane lighting, smart parking, and smart barren management. (iii) Smart Buildings –Intention of using automated action to instinctively direct the behavior in the building like lighting system, buzzer systems, access controls, and other systems proposal. (iv) Industrial Automation - Use of management systems, such as computers, robots or in rank technologies for handling discrete process and engineering apparatus like vending machines and mechanized apparatus management in an industry to replace a human being. (v) Consumer Electronics - Electronic or digital tools proposed for everyday bring into play like wearable, consumables refill for appliances typically in home. (v) Utilities - Services consumed by public like Electricity, Gas, and Water.

#### A. Smart Parking Application Based on Fog and NB-IOT:

Implementing Fog and NB-IOT technology, parking can be made smarter. Fig 7.1 illustrates the operation procedures of smart parking using Fog and NB-IOT. In this proposed system NB-IOT sensor with unique parking ID is assigned to each parking channel. But each vehicle has to be implemented with a NB-IOT sensor which must be issued by the parking service providers to access these proposed system is one of the main criteria to be considered. IOT communication providers has the role to deploy the NB-IOT minor cells and FOG nodes. Smart parking system is operated in the following way. Initially parking slot and vehicles are to be integrated with the NB-IOT small cell sensors, then at the time of parking the vehicle, whether the parking space is occupied or vacant is detected by the NB-IOT sensors and data obtained by detecting is sent to the central server. If user is required a parking space then, smart phone app “requests” a parking space and guides drivers to the free space. Important aspect of using these technology in this application is that, the parking fee is paid directly through the app. Due to development of 5th generation Technologies, NB-IOT sensors and fog node is expected to take place in further more applications. The main benefits of smart parking are Low data rates, Low power consumption and Low hardware cost.

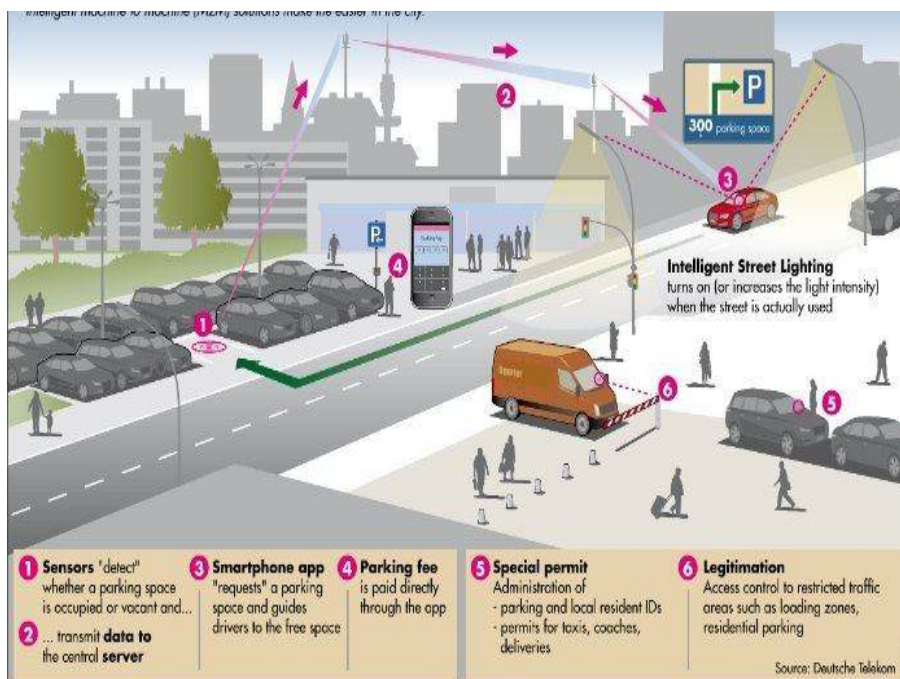


Fig.7.1 Smart Parking Based on Fog and NB-IOT.



**B. Smart Waste Management Based on Fog and NB-IOT:**

Currently disposal of garbage is an hectic task to the government and managing those activities is one of the main problems in the current situation. To reduce these problems, smart waste management based on Fog and NB-IOT smart sensors can be designed as shown in the fig 7.2. In this implementation, the NB-IOT sensor is the main component where, it functions as a tracking device which is attached to each garbage trucks, garbage cans, streets and the main authorities of the city. This garbage management should be taken into progression, in such a way that people should not face any type of environmental issues and the proposed system provides a great solution to this problem. In this proposed system the sensors attached on the garbage cans senses the presence of garbage and sends the sensed signals to the cloud server which support sensing as a service and through these signals the garbage trucks track the route and collect the garbage smartly.

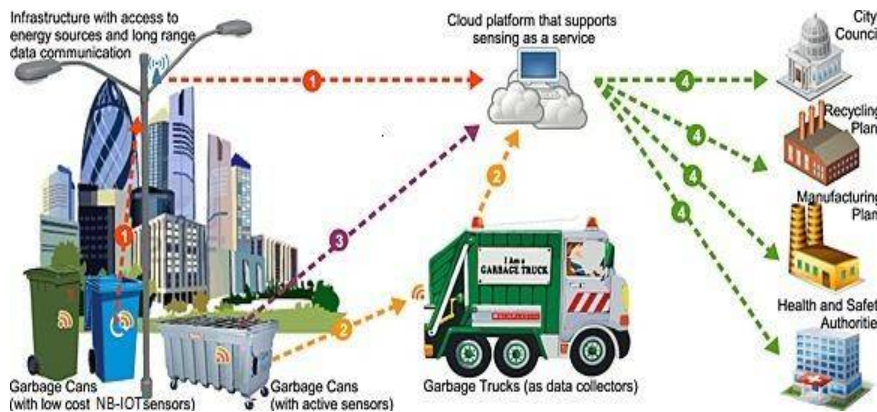


Fig.7.2 Smart Waste Management Based on NB-IOT.

**C. Smart Retail Application Based on Fog and NB-IOT:**

In this application, the NB-IOT sensor acts as a tracking badge which is provided to each retail item. Initially items are arranged on the shelves which are monitored by NB-IOT sensors. When the purchaser picks item from shelves the sensor sends signal of stock reduction to the dealer application platform, Which intern sends low stock alert signal to the shelf refill management department .When the new customer wants to pick the same kind of item which is not available on the shelves, an automatic alert service can be initiated by the NB-IOT sensors associated with the Fog computing. Fig 7.3shows the Illustration of smart retail application based on Fog and NB-IOT.

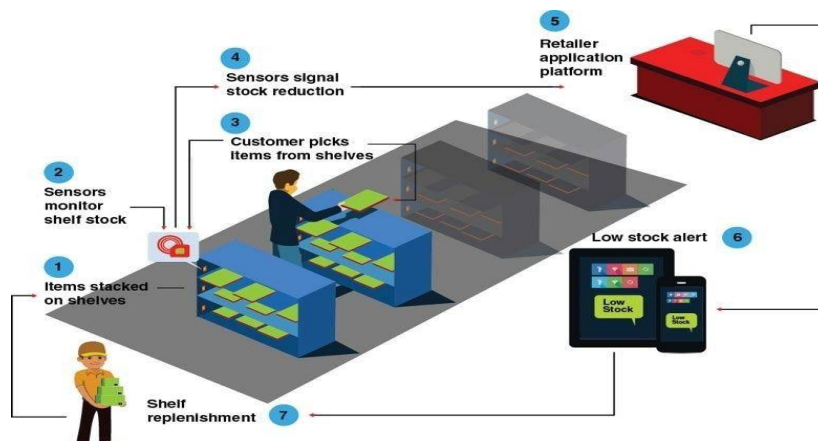


Fig.7.3 Smart Retail Based on NB-IOT

## IX. CONCLUSION

Proposed system describes how the technology development from Fourth Generation network to the Fifth Generation have challenges like low delay, massive connections, and ultra- reliability that can overcome from fog computing and NB-IOT technology. In this point of view the technologies like cloud computing, Fog computing and the NB-IOT technology are discussed. There are many applications of NB-IOT cells integrated with Fog computing technology, as of now the three applications like smart supermarket, smart parking and smart waste management based on Fog and NB-IOT are discussed. All the three applications are those which give solutions to the major problems faced by the public. So these particular innovative applications are the one which triumph over the challenges of Fifth Generation by fog computing and NB-IOT technology.

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