

# IoT SOLUTIONS FOR SMART PARKING- SIGFOX TECHNOLOGY

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## **ABSTRACT**

*Sigfox technology has emerged as a competitive product in the communication service provider market for approximately a decade. Widely implemented for smart parking solutions across various European countries, it has now gained traction in Germany as well. The technology's successful track record and reputation in the market demonstrate its effectiveness and reliability in addressing the communication needs of IoT applications, particularly in the context of vehicle parking systems. This is noted in terms of a city like Berlin-Germany, for on which the study is conducted. The major challenge being on how to relate the parking techniques in a more user friendly, cost effective and less energy consumption mode where the questions had at the beginning of the paper, relatively at the end the answers are sought to it via Sigfox and its comparison with other related technologies like LoRA WAN and weightless. But more so future areas of research study is also pointed out on areas which are not clearly identified in this particular research area.*

*This paper entails the pros, cons adaptive, emerging and existing technology study in terms of cloud, big data, Data analytics are all discussed in tandem to Sigfox.*

## **KEYWORDS**

*Sigfox, LoRAWAN, Weightless, Big data, Data analytics, Cloud, Smart Parking, Existing and Emerging technology.*

## **1. INTRODUCTION**

In the beginning to start with an opening comment from [1] who says a man finds power in the contemplation of what he has absorbed, in the knowledge of which he finds safety and happiness. Hence to state a man's safety and happiness is attributed to the knowledge of things he possesses under the realm of the universe. Well to ironically correlate this psychological condition with my present topic of analyzing the Sigfox technology for Smart Parking in this smart world yes, it's quite challenging and interesting to collect, read, understand and present the personal interpretations for a better world.

When contemplating what areas of our daily lives needs better solutions for faster working pace of life, it's obvious to start with our on road solutions for in it we as human beings spend most of our time quantitatively without our willingness as wastage. This wastage when monetized for any city for that matter would run to few millions dollars depending on the country and the city's growth. Obviously this translates to the very intrinsic problem of traffic on roads but there is another aspect of on-road time wastage which city dwellers face these modern days. Its nothing but their time spent on search for parking of their two or four wheeled vehicles.

Now taking my current city of dwelling as an example I would like to state certain facts which might be alarming for search of better cost effective solution at the earliest to keep the problem within limits. The city is none other than Berlin, Germany. "INRIX published a major new study

that analyzed and ranked the economic costs of “parking pain”. The study found that German drivers spend an average of 41 hours a year searching for the elusive parking spot at a cost of €896 per driver in wasted time, fuel and emissions and the country as a whole €40.4 billion. The study combined data from the INRIX Parking database of 100,000 locations in 8,700 cities in more than 100 countries, with results from a survey of nearly 18,000 drivers in the US, UK and Germany, including almost 5,000 in 10 German cities. As per the Parking ranking Table below- Berlin is third (62 hours - €1.8bn), Düsseldorf in fourth (61 hours - €564m) with Cologne (60 hours - €861) rounding out the top five cities. Berlin has a much greater economic cost impact of searching for parking due to the city having a higher population and more cars and drivers.” [16]

Table 1: INRIX Parking Ranking (Germany) – Hours Spent Searching for Parking

Rank	German City	Average 2-Hour Parking Cost(within one mile of city centre)	On-Street Search Time(minutes per trip)	Off-Street Search Time(minutes per trip)	Annual Search Time(hours per driver per annum)	Annual Search Cost Per Driver	Annual Search Cost Per City
1	Frankfurt	€ 4	10	7	65	€ 1,410	€702m
2	Essen	€ 4	8	7	64	€ 1,390	€490m
3	Berlin	€ 4	9	6	62	€ 1,358	€1.8bn
4	Düsseldorf	€ 2	9	7	61	€ 1,337	€564m
5	Cologne	€ 2	9	6	60	€ 1,302	€861m
6	Dortmund	€ 4	8	6	57	€ 1,239	€484m
7	Hamburg	€ 5	9	6	52	€ 1,139	€1.5bn
8	Stuttgart	€ 5	8	5	52	€ 1,136	€437m
9	Munich	€ 6	9	6	50	€ 1,092	€1.1bn
10	Bremen	€ 3	7	5	49	€ 1,065	€393m
	Germany	€ 3	6	4	41	€ 896	€40.4bn

Source: Table1: INRIX Parking Ranking (Germany) –Hours Spent Searching for Parking [16]

Now that the problem and its quantum is now been brought out the ways of mitigating the problem is the most challenging part. But thanks to the advancement in the today’s technology which paves way for better solution, enhancement of existing solutions and more so provide options on these for cost effectiveness. On studying the available solutions for the problem one of the main technologies in place is Low Power Wide Area Network (LPWAN)-Sigfox.

### 1.1. LPWAN (Sigfox)- A Brief Introduction

Low Power Wide Area Network (LPWAN) is a technology which connects one machine to another with radio waves or wireless network technology. LPWAN is a renowned wireless communications technology for its battery life, scalability, coverage and security. It has also become a proven business model in various fields by supporting range of applications and deployments. As existing market technologies are very costly for IoT (Internet of Things) applications, hence service providers commenced with own unlicensed networks and deploying them. Through own deployment cost reduction or low cost operation was possible against the traditional network systems. Through this, LPWAN (outside the licensed spectrum) became an enabler for IoT devices. When in comparison to the existing cost effective communication technologies like Bluetooth, Zigbee, WiFi etc, which are short range in nature, LPWAN on the other end provides wide area coverage at a cost competitive model. Various are the types of

LPWAN communication technologies like Sigfox, Lora, NB-Iot, Weightless etc. For over a decade, Sigfox technology has been a leading player in the market, offering innovative solutions for a wide range of industries. Their smart parking solution, which has been successfully implemented in numerous European countries, has now gained traction in Germany as well. With its proven track record of reliability and efficiency, Sigfox technology has quickly become a go-to choose for businesses looking to optimize their parking systems. The seamless integration of Sigfox technology allows for real-time monitoring and management of parking spaces, providing a cost-effective and user-friendly solution for both operators and users. As more and more companies in Germany adopt this cutting-edge technology, Sigfox continues to solidify its position as a competitive and trusted provider in the market. These are to be discussed in details as below.

## **2. BASIS OF LITERATURE REVIEW ON SIGFOX**

According to [4] survey, a parking system is essential to translate an administrative model in a city to an operational model. To enable this sensor of different kinds can be used like camera, accelerator, magnetometer, optical, RFID, radar, ultrasonic etc. The major 2 dimensions of the survey were how the information was getting disseminated and what are the parking competitiveness in terms of human behavior. For our paper on concentrating on information dissemination- the sensors had to be installed in parking spaces so that sending messages through the Communication Technology (CT). This is either via short range like Bluetooth/Zigbee/Zwave or long range like Sigfox, LoRA, Weightless. The one advantage of long range CT is communication via radio access network can be done to any point at any interval with other infrastructures. On the paper cited above, the author finally suggests on a parking system deployment model consisting of stages of software system management, E parking monitoring, a software solution with a user interface and guidance.

In [5] it had been recently cited that Berlin official's along with the company Siemens implemented radar sensors on street lights ranging about 200m in certain sections of the Berlin city. Its noted that from the position of it being raised, the network sensor which was embedded in the street lights can scan an area of about 30m which equates to a position scanning of five to eighty parking lots/ spaces. From the scanned position the sensors keeps track of the free spaces and report back on the free spaces available to the space management software held for e-parking. The city traffic system which hold these kinds of information on the particular areas availability for parking, gets it forwarded from the information centre to the user's cell phone application via the data interface of the cell phone operator. This will enable the drivers to find the free parking spaces simply by the navigation device or using the smartphones or city parking guidance signs/ machines.

On understanding what the Sigfox technology basically mean is that SigFox is already it's a commercialized, proprietary owned product in smart parking markets and used in some cities, e.g., This technology is based on ultra narrow band intelligence which enable to send small size messages through the cellular link using a very small bandwidth. [10] "The major competitors to sigfox long range technology are LoRA and Weightless. LoRa has a longer transmission range than cellular networks and provides different energy classes for different applications' needs. Geneva has just launched a pilot project with 16 parking sensors equipped with LoRa in January 2015, in order to evaluate the possibility to deploy LoRa equipped sensors for the Smart Canton initiative. Likewise, thanks to Weightless is now deployed in London and Melbourne. In addition, Dinh et al. analyzed the on-street parking data in Melbourne to find out parking violations, that is, all the parking behaviors that do not comply with the parking rules." [11]

To make the undertaken study of sigfox to be in light with other competitive technologies, a comparative sheet of the three is now presented for broader view.

Name of Standard	SigFox	LoRaWAN	Weightless		
			-W	-N	-P
Frequency Band	868 MHz/902 MHz ISM	433/868/780/915 MHz ISM	TV whitespace(400-800 MHz)	Sub-GHZ ISM	Sub-GHZ ISM
Channel Width	Ultra narrow band	EU: 8x125kHz, US:64x125kHz/8x125kHz Modulation: Chirp Spread Spectrum	5MHz	Ultra narrow band (200Hz)	12.5 kHz
Range	30-50km (rural), 3-10km (urban), 1000km LoS	2-5k (urban), 15k (rural)	5km (urban)	3km (urban)	2km (urban)
End Node Transmit Power	-20 dBm to 20 dBm	EU:<+14dBm US: <+27dBm	17 dBm	17 dBm	17 dBm
Packet Size	12 bytes	Defined by User	10 byte min.	Up to 20 bytes	10 byte min
Uplink Data Rate	100 bps to 140 messages/day	EU: 300 bps to 50 kbps US:900-100kbps	1 kbps to 10 Mbps	100bps	200 bps to 100 kbps
Downlink Data Rate	to 4 messages of 8 bytes/day	EU: 300 bps to 50 kbps US:900-100kbps	same	No downlink	same
Devices per Access Point	1M	Uplink:>1M Downlink: <100k	Unlimited	Unlimited	Unlimited
Topology	Star	Star on Star	Star	Star	Star
End node roaming allowed	Yes	Yes	Yes	Yes	Yes
Governing Body	SigFox (proprietary)	LoRa Alliance	Weightless SIG		
Status	In deployment	Spec released June 2015 in deployment	Limited deployment awaiting spectrum availability	Deployment beginning	Standard in development. Scheduled release 4Q 2015

Figure1: LPWAN technologies comparison  
Source: The Keleno [11]

As understood from the table above it is clear that sigfox bandwidth is competitively higher in comparison with its competitors and a wide range of coverage is also provided both in terms of rural and urban context. Sigfox also enables small messaging services at defined packet sizes to eliminate the underlying communication problem of locating the available resource to the need at the right time. Not only so but the said technology in terms of cost is also much competitive (as projected in picture below) on studying the proprietary (sigfox) products along with the competitive products in the market. This is shown in the picture below.

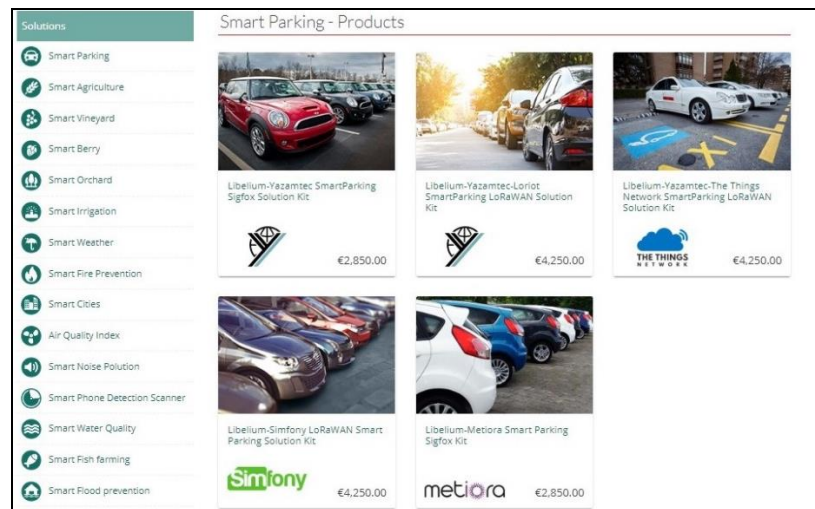


Figure 2: Smart parking products in market  
Source: IoT Marketplace [9]

Not only so but to understand the architecture behind sigfox working it is better to get a grasp of its network description, to show how sigfox is a simple, excellent choice of design for applications without much frequent burst out of data because of its small packet transmissions and incessant supply of data without any formal hiccups. Its simple network is now as shown in Figure 3 below.

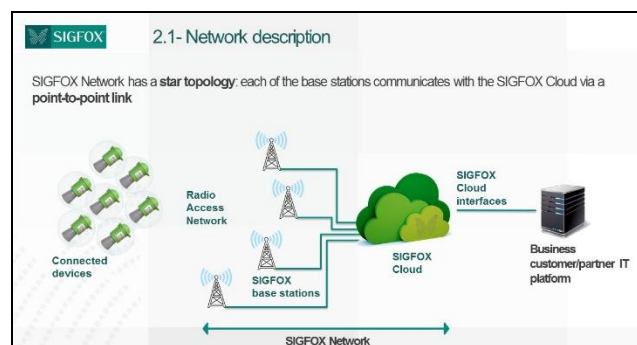


Figure 3: Sigfox Network  
Source: IoTforall [9]

Sigfox being a proprietary technology product founded in 2009, is a French company based in Labège, France. Having significant traction in the LPWAN and backing by its wide successful campaigns on marketing across Europe- it was able to cover a large volume of ecosystem vendors and recently, SigFox had made more intentions of tapping the European market as in line with the consideration of US focused adopters. SigFox uses proprietary technology, an example of using a slow modulation rate to achieve a more extended range. Due to this design choice, SigFox is an excellent option for applications where the system only needs to send small, infrequent bursts of data. [7]

### **3. CRITICAL REVIEW OF SIGFOX TECHNOLOGY**

The deployment of Sigfox technology in the realm of communication and IoT applications has brought about both advantages and challenges. This innovative proprietary technology operates on Ultra-Narrow Bandwidth (UNB) frequencies, allowing for long-range communication with low power consumption. While Sigfox offers unique features such as Geo-location and a cooperative model for radio transmissions, there are also limitations to consider, such as potential delays in message delivery and packet losses. Understanding the pros and cons of Sigfox technology is essential for stakeholders looking to leverage its capabilities effectively in various applications, including smart parking and navigation systems.

#### **3.1. Independent Opinion based on Qualitative Comparison and Argument**

In the following [8]

1. Sigfox is a proprietary technology which operates on 868 MHz in Europe and on 902 MHz. Because it uses an Ultra-Narrow Bandwidth (UNB) large quantity of devices can communicate up to 10-50kms radius on a low power consumption. As independently argued based on an independent opinion this modulation technique which do have some gaps noted. Because of the narrow bandwidth of the network thorough throughput cannot be achieved at 100%, meaning the deliver of messages via the interface might take much longer time as the equals only twelve bytes each in a device for daily limit.
2. Sigfox advises to use Sigfox Geo-location as a complementary method to other positioning systems such as WiFi localization or GPS Based on the qualitative aspects Sigfox uses Ultra-Narrow Bandwidth (UNB) variation, because of this for localization timing methods may not be an appropriate option. Hence other many localization methods have been researched. It is seen by some that Sigfox Geolocation is built on probabilistic distance calculation. Because of this if a device receives is supposed to receive a message then it could be of a possibility of transmission from three or for base stations via triangulation in which the accuracy of the location information processed is below 500 meters.

#### **3.2. Sigfox Triangulation Highlights**

Some of the architectural and the technical triangulation which makes the product or the long range technology to stand out in terms of its competitors and their characteristics are as jotted below for Sigfox. [12]

- Central LPWAN Gateway through which provides long range access with same accuracy and reach of a short range CT.
- It also enables or imbibe cloud based service centre to enable the reach and scalability of the services.
- With a cooperative model, the radio gateways or the base stations form the stronghold for the sigfox transmissions
- This CT can be easily tapped via public cellular networks which enable easiness in operation
- It enables central and global authentication whereby there would be no requirements on roaming
- The transparency of the network is enabled by the user friendly end device application

### **3.3. Evidence of the Sigfox implementation**

The implementation of Sigfox Technology in software and hardware applications for solving parking problems in Berlin involves comprehensive and experimental architecture. The software aspect includes developing algorithms for data analysis, prediction of parking availability, and user interface design for real-time information dissemination to drivers. Hardware components such as Sigfox-enabled sensors and gateways are deployed throughout the city to collect and transmit data regarding parking space occupancy and availability. This data is then processed and analyzed using Big Data analytics within a cloud-based architecture to optimize parking management strategies and enhance user experience. Experimental tests and simulations are conducted to assess the effectiveness and reliability of the system in addressing parking challenges in Berlin, with a focus on improving efficiency, reducing traffic congestion, and enhancing overall urban planning. Through this integrated approach, Sigfox Technology demonstrates its potential to revolutionize smart parking solutions and contribute to the development of smarter and more sustainable cities.

### **3.4. Sigfox-Pros & Cons**

Advantages are:

1. Outdoor navigation system is implemented
2. Mobility of usage for drivers and agents through mobile devices
3. Usage of powerful sensors makes communication easy
4. This system is also valid for indoor parking techniques and strategies
5. Geo-location positioning system of Sigfox in competitiveness to GPS (Global positioning System)
6. Cost competitiveness is a huge up play for the CT as a product
7. Space management of spaces can be done in an effective way
8. Being a hybrid trending system with a wireless sensor
9. Enables mass parking via integration to cluster architecture
10. Star topology enables greater latency in connection and support the interactive applications in the horizon

Disadvantages are:

1. Long range communication may have low data range which may slow down the data flow rate
2. Because of presence of other signalling overheads there could be presence of other short range multi pop ups packets which can hamper the flow of long range throughput transmissions
3. LPWAN and its related technologies and its variants are known for the packet losses
4. Major smart cities and corresponding IoT devices face sporadic and intermittent transmissions of data because of which continuous monitoring and metering of applications could be a challenge.

## **4. EMERGING TECHNOLOGY TRENDS & ITS CHALLENGES**

The emerging trend of our current problem which is in the question of smart parking solutions we have dealt and discussed much on the availability and the characteristics and pros and cons of the employing a long term technology in place to fix and find solutions to the impending parking problems of the city. No time wasted in parking is time gained on constructive work by the

drivers / users of the vehicle. The administration and the operation of the local municipality also fixes and considered various options along the expanded time lines of past with the ever increasing demands and coping with the trends of technology on a day to day basis. On these lines if we see on how we can employ smart parking to the city like Berlin which has been truly international in its operations and infrastructure. The puzzle to solve is quite tricky to the authorities.

On contemplating large scale development the major city level implementation problems are mobile sensing via short range communication or fixed site sensing for long range communication. In long range communication for fixed parking sensors it requires sensors to be fixed physically in each parking space. To top it to enable sensors communicative technology properly it should be harnessed with good connectivity, great infrastructures, internet gateways, routers, repeaters etc. Operating conditions being so, the following are the cities around the world which are in presence of Sigfox. Sigfox LPWAN is fully deployed and functional in the European countries like France, Spain, Portugal, Netherlands, Luxemburg and Ireland. Its been currently rolled out and tested in countries like Japan, Belgium, UK, Germany, Denmark, Czech, Mauritius Island, Australia, New Zealand, Oman, Brazil, Italy, Malta, Singapore, Mexico and not the least USA. The coverage of the technology has been so huge that it had catered to population so far like 340 million people across the globe covering 1.3 million square kms. When seeing for the maximum cell size, each is around like 50kms.

To make the parking mechanism easy it is required that parking prediction system should be proper. There had been theories coined on this by some of the authors before. The demand of a particular vehicle type in relation to the parking spots/ places and the corresponding time study is what coined as parking prediction system. Through this the seeker of information makes sure he/she gets the results of what type or space is required for small/ medium/ large sized cars or vehicles in a particular locality of the city at a particular point of time in a peak working day. There have been studies recoded on this to analyse the data flow and its requirements and match it with the current availability or resource sourcing in other major cities of the world. This brings out the parking stress or parking pain of a particular city/ location. Through these data and its exploitation the data analytics plays a major role in the form of the big data gathered during the flow of the day. The big data architecture and its built up module on monitoring helps to unveil the on street parking masks for a particular location and time within seconds/ minutes. The mere play around data and its manipulation and extraction techniques have been an emerging scope for analytics and decision making specially amongst the governing municipal bodies of the government. They get to know where the real issues are faced and at what time intervals. So this helps them to manage human and land resources via space planning, infrastructure provision, allocation of budgets, time space for completion and provision of temporary alternatives till then.

#### **4.1. Challenges**

According to [14] the propensity of the problem of the algorithms used in the management of parking spaces plays an important and crucial role for the overall design management and development of a effective fool proof and robust smart parking system. The large number of algorithms used in their study were not too complex, but they were mostly of the sort of which are easily executable and sortable at the server end of the operations of the system. This paves a way for easy traffic loads among the interfaces and minimises the exhaustion of the sensors involved in the work and do not cause overload to them. This also entails they not much or large amount of energy is consumed so as to make sure the lifetime of the batteries are also with adequacy in duration for long period of time [13].



Energy efficiency is the greatest considerations in the self organised algorithms of the Sigfox technology by the solid creation of a consistent topology to increase the longevity of the network and energy consumption. This is ensured between different sensor nodes for increase in network longevity. Sometimes the self-algorithms used in the sensors of the company (Sigfox) than the one which are available in the existing ones of the market do not have much of a competitive edge than compared to the existing market ones [15]. This does not allow the creation of a chain topology for linear parking areas and a cluster topology for mass parking areas. It cannot be structured according to the needs. Furtherance to the need to balance the load between the different sensors and minimize the energy consumption during the transmission of data to obtain a better energy efficiency management and increased the lifetime of the nodes is a primary requirement which not all time provided by the customised products.

In order for a complex city operations, parking system or rather smart parking system should be enabled or created with flexibility in topology networking with the existing system types based on the services and needs of convenience of the drivers is a want of the hour. Though Sigfox guarantees as an emerging technology to cater to the demands in terms of load balancing etc but the self-algorithmic operations if not designed to meet the demands of the hour and architecture of the city the product may have glitches to face to have and taste a win-win situation. Hence for this systems technology with an adaptable wireless sensor network architecture provides a flexibility and a suppleness in the deployment of smart parking systems that will be monotonous in the design and implementation, and will also be standardized in the development of applications and services for the different types and structures of existing car parks, bearing in mind that this solution creates a solid basis for the development and improvement of these systems in the future, as required [10].

## **5. IMPACT ANALYSIS AND FUTURE TRENDS**

In the realm of smart parking solutions, the integration of existing technology like Big Data analytics with emerging technologies such as Cloud Architecture has the potential to revolutionize the efficiency and effectiveness of operations. Big Data analytics enable the collection, segmentation, analysis, and interpretation of vast amounts of data related to parking spaces, allowing for accurate predictions of parking availability and optimization of urban development factors. On the other hand, Cloud Architecture provides a scalable and flexible solution for storing and managing large volumes of data in a centralized manner, offering benefits such as enhanced collaboration, mobility, data security, and cost efficiency. The impact of integrating Cloud Architecture with Big Data analytics within the framework of Sigfox communication technology holds the promise of not only enhancing smart parking solutions but also streamlining storage and dissemination of valuable information for users. This synergy between existing and emerging technologies presents new possibilities for improved functionality and user experience in the realm of smart parking systems.

### **A) Existing Technology of SigFox Communication Technology- Data analysis/ Big Data:**

“Since cities own parking spaces’ spatiotemporal information, studying data characteristics is essential to improve system efficiency and parking policy.” [1]

The very first purpose of any parking mechanisms solution finding is a vacancy prediction in the space available. This can be jotted or toiled from the data collected so that it simplifies the life of the drivers and make them information available and understandable. Not only availability of data through data analytics is made but service/ data dissemination to various parking lots and its drivers is spread out. Generally parking is related to that problem where matching of the land use, traffic of motors/cars, city revenues and the population flow are

done in tandem. The statistics on parking data will be able to indicate key factors for urban development from technical, economical and environmental perspectives.

Through the data gathered and analytics done with each locality and its traffic for given different times of the data, the quantum and volume of data gathered by the civic authorities is a quite a Big Data-Existing Technology. The Big Data gives a hotbed for parking meter suppliers and data scientists to predict parking availability without installing physical sensors. Some machine learning algorithms have aimed at improving matching time and accuracy. However, we do not have an idea yet which algorithm is the best for geo-localized data and service. [3]

#### **B) Emerging Technology of Sigfox Communication Technology- Cloud Architecture**

In today's world the internet plays a key role in all aspects of life operations. Hence not to leave the space of parking for which we are searching for free spaces solutions. Internet does have a solution for this here too. With the constant large volumes of data pooling in every day, jam of data, collection, segregation and storage could be the greatest problem. The cloud software which today integrates with anything and everything also can access the smartphone apps, e-commerce data, massive traffic signals and social media too. Concerning smart parking, networks are full of data, interests, and e-parkings. These different kinds of data are called data packets in and though which both parking and the interest of the individual/driver on the specified requested area of parking is made known. Some frameworks or architectures for the integration of different technologies and software packages are much available with the service providers of cloud architecture to enable smooth flow of operations and data. Most of them are cloudifying the system for the future Internet of everything. Such kind of network shall be capable of matching different interests to the most appropriate data, that is, the future data network. [6]

This being implemented in the current market scenario is noted in well-known apps like Uber, Airbnb. They guide the users according to the interest and requested information and satisfy their need. Smart parking integration and regulation with data matching, individual interest adoption and app operations with information storage still in development than in pro stage of operation. This is studied based on the inputs gathered from the various sources.

#### **C) Efficient Measurement Parameters for Experimental Analysis of Sigfox**

Efficient measurement parameters play a crucial role in the experimental analysis of Sigfox technology, especially in applications such as stocking movement approaches in smart parking systems. Some key measurement parameters that can be utilized for experimental analysis include signal strength, data transmission latency, packet loss rate, and energy consumption of Sigfox-enabled devices. These parameters help in assessing the performance, reliability, and efficiency of the Sigfox communication network in real-world scenarios.

For example, in a stocking movement approach for smart parking, the signal strength parameter can help determine the coverage and reach of the Sigfox network within a specific parking area. Data transmission latency measurements can provide insights into the speed at which parking availability information is communicated to drivers, enabling them to make informed decisions quickly. Monitoring packet loss rates can indicate the network's stability and reliability in transmitting data without errors or interruptions. Additionally, assessing the energy consumption of Sigfox devices is essential for optimizing battery life and ensuring continuous operation. [8]

To illustrate, sample datasets of records in the Sigfox application for car parking experimental analysis may include timestamps of parking space occupancy status, vehicle ID information, and location coordinates. These datasets can be collected from Sigfox-enabled sensors installed in parking lots, recording when a vehicle enters or exits a parking space. By

analyzing these datasets, researchers can evaluate the effectiveness of the approach in much better way.

#### **D) Impact of Emerging Technology (Cloud) on the Existing Technology (Big Data) in terms of Sigfox operations**

In order to answer this question we would have to see what means big data in terms of smart parking. It means data pooling, data segregation, data analysing and data sorting. Any data gathered is just a dump until it gets sorted to form as an information. Without the above procedures being followed data gathered is not an information. Once the information is processed the next of usage by the nodes and transmitters of the Sigfox system for enablement of usage of information by the users. Once the users get hold of the required information the balance used, processed and in usage information should simultaneously get stored somewhere for references and go back mechanisms on requirement. With the density of the city and the volume of operations and information no city can provide heavy manual servers to store the information. Hence comes in handy the high tech today's solution-the cloud architecture. Some of the benefits of using cloud are:

- Control over users and permission can be centralised
- High tech collaboration can be done
- Enhance your team's mobility
- Back up and recover lost/stolen files with ease
- Directory integration between systems
- Free up costs and save storage space
- Cost efficacy like pay per use
- Ensure data security with ease and escrow contracts
- Protect the content of your files with end-to-end encryption
- Boost your compliance

So by engaging the emerging technology into the existing technology for Sigfox communication technology the purpose of finding solutions of not only in terms of smart parking is met but also in terms of smart storage and dissemination of information is served.

## **6. CONCLUSION**

In this paper we have known through our comparative study of LPWAN technologies and its advancement in various types through the options of Sigfox, LoRAWAN, Weightless. These were the highly popular long range communication techniques in market of this Sigfox was selected as an option to find answers to the Berlin city parking problems. The challenges of the city parking in terms of space allocation, cost variance and implementation techniques with the required infrastructure were studied in detail in the previous sections.

On studying the Sigfox application as a smart parking solution the main approach behind this was to enable cost effective long range unhampered method of communication. Sigfox being a competitive product in the market now for about a decade and had been successfully implemented in various European countries as the same smart parking solution, had now gathered momentum in Germany too.

Not only so in terms of efficacy of its operations and pros and cons of the system were discussed but It also got mapped along with the emerging technology like Cloud with the existing technology like Big data analytics and see where Sigfox as a communication technology stand in

this whole realm. So on studying the technology in detail the following are given as recommendation for the paper concluding.

The insights gathered by this study can help in seriously considering Sigfox as an option for implementation for the main reasons like simplicity, cost, long range coverage and low power consumption than in comparison with the other competitive technologies. But it doesn't absolve that there is no gaps, yes there are gaps like on how to manage the packet filtration traffics without hampering short range transmissions and how the geo locationing be made in par with the current GPS techniques and all at a least competitive model are the areas of further research in this topic.

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