Study on Internet of Things (IoT)

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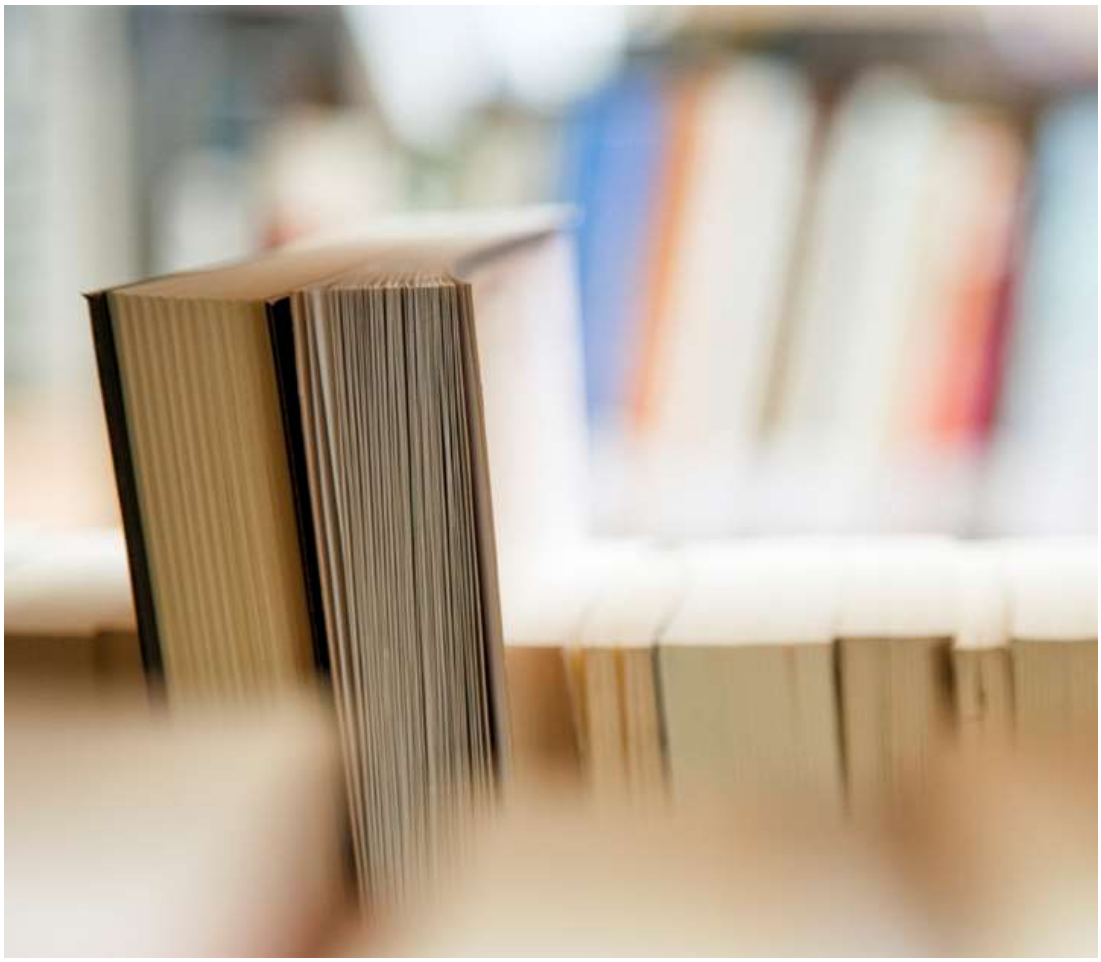

5th Generation Network(5G)

By:

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Abstract

The existing 4G networks have been widely used in the Internet of Things (IoT) and are continuously evolving to match the needs of the future Internet of Things (IoT) applications. The 5G networks are expected to massively expand today's IoT that can boost cellular operations, IoT security, and network challenges and drive the Internet future to the edge. The existing IoT solutions are facing a number of challenges such as a large number of connections of nodes, security, and new standards. This study reviews the general background of internet of things, technologies and features of 5th generation network, global regulatory practices and challenges for internet of things and Bhutan Power Corporation's digital strategy for smart grid system

1. Introduction

The evolving of fifth generation (5G) networks is becoming more readily available as a major driver of the growth of IoT applications. The Internet of Things (IoT) refers to a concept of connected objects and devices of all types over the Internet wired or wireless. The popularity of IoT or the Internet of Things has increased rapidly, as these technologies are used for various purposes, including communication, transportation, education, and business development.

The Internet of Things (IoT) is a hugely important and rapidly growing market with the potential to transform the digital economy. Mobile services play an important role in the wide area IoT market and are rapidly evolving to meet a growing array of different requirements from smart meters to connected cars. As a result, cellular IoT is becoming increasingly well placed to compete effectively with other IoT solutions thus helping to drive innovation. However, the viability of cellular IoT is contingent on governments adopting a positive regulatory framework especially as it pertains to mobile spectrum.

2. General Background

The Internet of Things is a hugely important and rapidly growing market and mobile services play an important role in the wide area M2M (machine to machine) and IoT markets. Mobile technology is evolving to meet all the demands of wide area IoT services. The mobile industry already plays a significant role in the wide area M2M market today, most notably via GSM systems for low bandwidth applications, such as vending machines, and through 3G and 4G-LTE for high bandwidth applications such as streaming video. Given the requirements of wide-area IoT services vary much more widely than traditional mobile services, cellular technology standards have continuously evolved to support all use cases.

For connecting a large number of devices in an IoT a very good network connectivity which provides low latency and high data rate is a must, 5G is the 5th generation mobile network and a new global wireless standard after 1G, 2G, 3G, and 4G networks which will be able to fulfill this requirement. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects and devices.
5G is used across three main types of connected services, including enhanced mobile broadband, mission-critical communications, and the massive IoT.

3. 5G Features and Technology

According to Segan, 5G is based on OFDM (Orthogonal frequency division multiplexing), a method of modulating a digital signal across several different channels to reduce interference. 5G uses a new radio (NR) air interface along with OFDM principles. 5G also uses wider bandwidth technologies such as sub-6 GHz and high bands known as millimetres (mm) Wave. 5G speeds will range from 50 Mbps to over a Gbps and millimetres waves are the fastest 5G. 5G will bring wider bandwidths by expanding the usage of spectrum resources, from sub-3 GHz used in 4G to 100 GHz and beyond. 5G can operate in both lower bands (example sub-6 GHz) as well as millimetres waves (more than 24 GHz).

3.1. Features of 5G

• 5G is significantly faster than other networks (4G).
• 5G has more capacity.
• 5G has significantly lower latency.
• 5G is a unified platform that is more capable than other networks.
• 5G uses spectrum better than 4G.

3.1.1 5G is significantly faster than other network (4G)

5G can be significantly faster, delivering up to 20 Gigabits-per-second (Gbps) peak data rates and 100 plus Megabits-per-second (Mbps) average data rates.

3.1.2. 5G has more capacity

It is designed to support 100 times increase in traffic capacity and network efficiency *(Qualcomm, IMT 2020).*

3.1.3. 5G has significantly lower latency

5G has significantly lower latency to deliver more instantaneous, real-time access (10 times decrease in end-to-end latency down to 1ms) *(IMT 2020).*

3.1.4. 5G is a unified platform that is more capable than other networks.

While 4G LTE focused on delivering much faster mobile broadband services than 3G, 5G is designed to be a unified, more capable platform that not only elevates mobile broadband

experiences, but also supports new services such as mission-critical communications and the massive IoT. It can also natively support all spectrum types (licensed, shared, unlicensed) and bands (low, mid, high), a wide range of deployment models (from traditional macro-cells to hotspots), and new ways to interconnect (device-to-device and multi-hop mesh) *(Qualcomm)*.

3.1.5. 5G uses Spectrum better than 4G

It is designed to get the most out of every bit of spectrum across a wide array of available spectrum regulatory paradigms and bands, from low bands below 1 GHz, to mid bands (1 GHz to 6 GHz), to high bands known as millimetres waves *(Qualcomm).*

3.2. Difference between 5G and other Networks

The previous generations of mobile networks are 1G, 2G, 3G, and 4G.

Comparison	2G	3G	4G	5G
Introduce in year	1993 Introduced digital voice	2001 Brought mobile data.	2009 Ushered in the era of mobile broadband.	2018 All the previous networks led to 5G, to provide more connectivity than was available before.
Technology	GSM (Global system for mobile)	GSM (Global system for mobile)	LTE (Long Term Evolution) WiMAX (Worldwide Interoperability for microwave Access)	MIMO (multiple input multiple output) Millimeter waves (mm waves)
Access System	CDMA (Code division multiple access) TDMA (time division	CDMA	OFDMA (Orthogonal frequency division multiple access) CDMA	OFDMA SCMA (Sparse code multiple access, combination of OFDMA and CDMA)

	multiple access)			BDMA (Band division multiple access)
Switching System	Circuit Switching for voice and packet switching for data	Packet switching except for air interference	Packet switching	Packet switching
Internet Services	Narrow band	Broadband	Ultra broadband	wireless world wide web
Bandwidth	25 MHz	25MHz	100MHz	(30-300) GHz
Data Speed	Slower data rate (64Kbps)	(2-8) Mbps	50 Mbps	10 Gbps
Advantages	Multimedia (SMS, MMS), international access and SIM introduced	High security, international roaming	speed, high speed handoffs, global mobility	Extremely high speed, low latency
Application	voice calls, short messages	video conferencing, mobile Tv and Gps	High speed application, mobile Tv and wearable devices	High resolution video streaming, remote control of vehicles, robots and medical procedures

3.3. Spectrum and Bandwidth Requirement

The 5G spectrum is a range of radio frequencies in the sub-6 GHz range and the millimetres-wave (mm Wave) frequency range that is 24.25 GHz and above *(Craven 2020).* LTE networks also use frequencies in the sub-6 GHz range and will be sharing the space with 5G traffic.

To utilize the mm Wave spectrum, 5G networks will have to use the 5G New Radio technology being standardized by the 3GPP. The frequency bands for 5G networks are in two sets. Frequency range 1 (FR1) is from 450 MHz to 6 GHz, which includes the LTE frequency range. Frequency range 2 (FR2) is from 24.25 GHz to 52.6 GHz. The sub-6 GHz range is the name for FR1 and the mm Wave spectrum is the name for FR2 (Craven 2020). 5G networks share LTE's frequencies because 5G is not wholly and immediately replacing LTE.
Regulators have assigned 5G spectrum in three broad ranges to deliver widespread coverage and support a wide range of use cases: high bands (mm Wave) which support the fastest 5G speeds, mid bands (1-10 GHz) which offer a good mixture of coverage and capacity and low bands (below 1 GHz) which help provide strong wide area, in-building coverage and will be used in less densely populated area. Most focus has been on the 3.5 GHz range (i.e. 3.3-3.8 GHz) to support initial 5G launches, followed by mm Wave awards in the 26 GHz and 28 GHz bands *(GSMA 5G spectrum, 2021)*.

Increased low-band (less than 1 GHz) capacity will be required to create greater equality between urban and rural broadband connectivity thus reducing the digital divide. It will also improve in building 5G services everywhere and help support the growth of IoT. Mid bands typically offer a good mixture of coverage and capacity benefits for 5G services. High bands are needed for 5G services such as ultra-high speed mobile broadband. 5G will not be able to deliver the fastest data speeds without these bands. The 26 GHz and 28 GHz bands have especially strong momentum and, as they are adjacent and well harmonised, can be supported quickly by a wide range of affordable devices with reduced complexity.

4. Global Regulatory Practices and Challenges for IoT

IoT is in its evolving stage in the world with certain countries having implemented it in a modest way. The revolutionary technology can have benefits in the way we live and its cross sector impact has been well understood by international organizations, telecom sectors and regulators, that is why it is vital to have a policy framework in place, to foster the IoT so that complete benefits of this innovation can be passed on to the citizens.

The policy and regulatory challenges are enormous and involve reshaping regulations and opening up avenues for imaginative new policies. Internet Service Providers (ISP's), as connectivity providers, are familiar in dealing with telecom regulators. But when it comes to

IoT they are out of their comfort zone, as there are multiple regulators and data authorities for health, energy, road & transportation services and many more.

In long run, globally, following issues have to be dealt by regulators:

- Regulatory framework
- Numbering plan
- Permanent roaming
- Quality of service
- Spectrum licensing and management
- Security, Privacy and Data protection

4.1. Regulatory Framework

Regulatory frameworks for IoT or M2M services are in their early stages worldwide, with very few countries formalizing any specific roadmap. Regulators in many countries are increasingly focusing on this as a key priority and looking at it in a comprehensive way. As the scope of IoT is diverse and involves different sectors, multitude of players and wide-ranging technologies, challenges arise in terms of identifying the feasibility of the framework. The primary objective of any framework should be to safeguard the interests of consumers and end users. A brief overview of Regulatory Practices followed by different countries and Regulatory bodies are as follows:

4.1.1. Regulatory Practices for Singapore

Operators are required to have a license to offer services under the framework of the regulator, Info-communications Media Development Authority (IMDA). Licensees have to ensure that SIM cards used for these services are only used for automated communication. Licensees shall list out the following:

- The range of International Mobile Subscriber Identity (IMSI) numbers and Mobile Station International Subscriber Directory Number (MSISDN) to be used.
- Working with any local operator partner in relation to the provision of services.
- Identification of equipment importer.
- Registration of all SIM cards used to provide services in Singapore.

- The records to be maintained in Singapore for a minimum of 12 months from the date of termination of the service.

4.1.2. Regulatory practices for USA

In January 2017, the US Department of Commerce published guiding principles and outlined an approach to support the advancement of M2M or IoT services. The key highlights are as follows:

- Enabling infrastructure availability and access: Physical and spectrum related assets; IPv6 adoption.
- Crafting balanced policy and building coalitions: Cyber security, privacy, intellectual property and free flow of cross-border data.
- Promoting standards and technology advancement.
- Encouraging markets: Public private partnerships, Government procurement and workforce issues (education, training and civil liberties).

4.2. Numbering And Addressing

The experts have already estimated that the number of IoT connected devices worldwide is set to rise dramatically. The need for IoT devices to be identifiable in the network will persist, as it does today for traditional voice and data devices, however IoT devices are fundamentally different from traditional devices.

Many of the requirements associated with the use of the traditional telephone numbers, ranges are inappropriate for the large majority of IoT connected services. For example a smart meter or an asset tracking tool, the requirements connected with current numbering regulation such as number portability are not relevant, as their service does not involve directly an individual and the connectivity element is just an enabler of the entire service wrap.

4.3. Permanent Roaming

Permanent roaming gives devices the ability to use data internationally without restriction. However, due to a lack of clarity and regulations regarding IoT connectivity, there are still significant limitations to most connectivity solutions.

The ideal choice for most global IoT projects is to choose a global connectivity provider, one that offers permanent roaming with a business model that is linked to the value generation of the IoT solution. Keeping the devices connected across the world is a top priority for many IoT systems.

Despite a lack of standardized regulation for IoT roaming, global providers are working to offer a solution that bridges the gap between traditional connectivity and the needs of IoT projects.

4.4. Quality of Services

Sending data quickly and efficiently adds a critical competitive IoT edge. With effective QoS management in place, the IoT system has a much better chance of receiving warnings or other high priority messages in near real time. Along with important messages that will be prioritized via a reliable QoS, the IoT client can also see cost efficiencies from being able to connect more nodes to the network. With advanced QoS solutions, the needs of the IoT device are met while considerations of the other IoT devices sharing a gateway are also effectively addressed in a reliable and secure way. Optimize operations and reduce infrastructure costs with QoS accelerating provisioning and protecting high value traffic. It can be one of the parameters that will help to select a suitable IoT service as per the requirement among the various available services showing similar capabilities.

Services being provided using the licensed spectrum band are already being regulated by the telecom regulators. Mandating any uniform QoS for IoT is not recommended. QoS is best left to a mutual agreement between stakeholders.

4.4.1. Licensed spectrum is vital to deliver the most reliable, high quality IoT services

Licensed spectrum will be able to provide high quality of service over wide areas, as operators are not at risk of interference and can control usage levels. As a result, licensed cellular IoT may be the only choice for services which require concrete assurance levels such as for security and medical application. As licensed spectrum assures access and quality levels it encourages sustainable, long-term investment in networks. Contrastingly, unlicensed spectrum is intrinsically less suited to wide-area IoT applications, especially those requiring higher quality of service levels. This is generally due to low permitted power levels and interference risks over long distances are high- especially as the number of service providers and usage levels scale up.

4.5. Security Privacy and data protection

Privacy and security are among the significant challenges of the Internet of Things (IoT). Improper device updates, lack of efficient and robust security protocols, user unawareness, and famous active device monitoring are among the challenges that IoT is facing.

The unconscious use, not changing passwords, and the lack of device updates have increased cybersecurity risks and access to malicious applications to the IoT system's sensitive data. Such inappropriate security practices increase the chances of a data breach and other threats. Most of the security professionals consider IoT as the vulnerable point for cyber-attacks due to weak security protocols and policies. Even though several security mechanisms were developed to protect IoT devices from cyber-attacks, security guidelines are not appropriately documented.

4.6. IoT in 5G spectrum planning (Future of IoT)

5G is expected to play an important role in the evolution of cellular IoT and therefore suitable provisions need to be made in future band planning. 5G should support the growing number of forecasted end points along with efficient signalling and addressing, while also delivering even lower device costs and making more efficient use of spectrum. 5G IoT capability is likely to be made available across all existing and emerging 3GPP bands.

It is important that governments and the mobile industry ensure the needs of IoT applications are incorporated into 5G spectrum planning. 5G will increase the data rate, reduce the end to end latency, improve coverage and provide higher quality of service or even guaranteed service. These properties are particularly important for many applications related to IoT. An example like emerging autonomous cars, intelligent transportation and interactive mobile games, to which small latency is essential and are really bandwidth hungry, which cannot be supported with current 4G networks. So 5G will play an important role in IoT.

According to GSMA, 5G brings a range of benefits to the IoT which are not available with 4G or other technologies. These include 5G's ability to support a massive number of statics and mobile IoT devices. Which have a diverse range of speed, bandwidth and quality of service requirements.

The previous 1G to 4G network system relies on orthogonal multiple access where different time slots are being allocated to each user and one user cannot access a channel allocated to others. Such multiple access will be difficult to support future IoT applications. There will be lots of devices and would have to allocate time slots dedicated to each of them. where we don't

have the luxury for affording, since the number of available time slots and bandwidth resources will be insufficient. So, orthogonal multiple access won't work for 5G.

Currently there is a lot of research exploring how to develop non orthogonal multiple access by putting a number of users into the limited bandwidth channels. This will lead to interference which causes low data rates but there are many devices in IoT which would be served timely with low data rates like wireless healthcare, where wearable devices (heart monitors, biosensors) need to send patient data timely to hospital severs, but the data rates used by these devices are not likely high.

A lot of IoT users or devices with different quality of service requirements can be squeezed into the same time slot or frequency channels by using non orthogonal multiple access. Another benefit to breaking the orthogonality of multiple access is to have cognitive radio technologies *(Ding 2015).* Currently single bandwidth or channel is allocated to a user and they are not able to reuse the channel. With cognitive radio communication, new users can be admitted into this channel. And if this user has a good connection to the base stations large data rates can be realized.

Now the question is how 5G is going to deal with the spectrum crunch, to solve spectrum crunch a combination of a lot of technologies is needed. One way is to improve the efficiency for using the existing available bandwidth and for this non orthogonal multiple access, massive MIMO, cloud radio access networks, full duplexing can be used. Another way is going for shorter, millimetres wavelengths (60-90) GHz, where more spectrum bandwidth is available for telecommunications *(Ding 2015).* There are some challenges with regards to this, like the higher the frequency, more attenuation by atmosphere, which rules out long distance transmission. Moreover, there is a shadowing problem but this problem can be solved with the help of multiple antennas.

5. Regulatory Framework for SATRC members

SATRC consists of nine South Asian Countries, Afghanistan, Bangladesh, Bhutan, India, Islamic Republic of Iran, Maldives, Nepal, Pakistan and Sri Lanka. Based on the questionnaire circulated to the experts in the SATRC working group to ascertain the status of the regulatory framework, the following responses were collected.

In most of the countries there is no licensing or registration mechanism for M2M and IoT service providers. However, it is possible that M2M and IoT services are being provided using

the services of licensed telecom services. Most of these countries are studying the impact of these services and thinking over the need for the appropriate framework.

In most of the member countries, M2M and IoT devices are being used extensively particularly in Power metering, Traffic and Fleet management, Agriculture and Industrial applications.

In almost all of these countries no separate numbering series has been allocated for use for M2M and IoT devices which are using the existing cellular network. Many Organizations are struggling with the large number of devices that will become part of their networks in a very short period of time. The existing measures and provisions, as mandated under the licensing and policy regime, should be used to ensure security of networks and data.

In many countries, there are strict rules and regulations around securing and storing personal data of customers. However, there are no consistent norms for data privacy across geographies. Multi party real time information flows may be hampered if privacy issues are not addressed at the outset. In the current scenario, there are patchworks of geographically bound laws that do not apply in the same manner to different technologies and sectors. Information collected in one country may be termed as personal data in a different jurisdiction. Increasingly, various stakeholders are resorting to using aggregated and anonymized data through which no individuals can be identified. There is growing debate on how to balance individual rights on the one hand and ensure law enforcement and maintain surveillance on the other. However, the regulatory position for private data collected by M2M devices is similar to that used for that collected by other means.

6. Bhutan Power Corporation Digital Strategy

To meet the ever-growing expectations and demands of its customers, BPC has to take its business into a digital platform. The digital strategy has been worked around four strategic themes.

- Customer Engagement Digitalisation
- Grid Operations Digitalisation
- Enterprise Operations Digitalisation
- Human Resource Functions Digitalisation

6.1. Smart Grid

The smart grid is “An electricity grid with communication, automation and IT systems that enable real time monitoring and control of bi directional power flows and

information flows from points of generation to points of consumption at the appliance level" *(National Smart Grid Mission, India).*

6.1.1. Benefits of Smart Grid

1. Reduction in system losses and theft.
2. Reduction in equipment failure rate.
3. Better customer services and more accurate bills.
4. Deferred/ reduced capital investment.
5. Improved supply reliability.
6. Enhanced quality of service and energy security.

6.2. Smart grid components and functionalities for Transmission system

In the transmission system, Supervisory Control and Data Acquisition (SCADA), Energy Management System (EMS), Advanced Metering Infrastructure (AMI) and Phasor Measurement Unit (PMU) are the major components of a smart grid.

6.2.1. SCADA Systems for Transmission Network

SCADA is a control system architecture that collects data from various sensors at a factory, power plant, and transmission system or in other remote locations and then sends this data to a central computer which then manages and controls the system. SCADA has the ability to monitor an entire system in real time and can run with relatively little human intervention. This is facilitated by data acquisitions from various sensors and meters.

6.2.2. Energy Management System

EMS is a part of SCADA and is used to carry out real time studies on the network to determine load flow, power factor, transient and dynamic stability and etc. This intelligent energy management software control system is designed to reduce energy consumption, improve the utilization of the system, increase reliability, predict electrical system performance, and optimize energy usage to reduce cost.

6.2.3. Automatic Meter Reading/Advanced Metering Infrastructure

Automatic Meter Reading (AMR) is the technology responsible for collecting all sorts of data from the meters, whether it's real-time information about consumption or diagnostic data. AMR allows the automatic collection of data from energy-metering devices and transfers that data to a central database for analysis and billing purposes.

6.3. Smart Grid Components and Functionalities for Distribution System

BPC's distribution system comprises medium voltage (6.6 kV, 11 kV & 33 kV) and low voltage (0.415/0.230 kV) network spread across the country. The line and distribution transformers form major components of the distribution system, with lines predominantly radial in nature. Power flow in the distribution network from the sending end transmission substations to the low voltage network, and to the end consumers without any visibility due to lack of automation and communication.

- Distribution Management System
- Distribution Supervisory Control and Data Acquisition System
- Advanced Distribution Management System (ADMS)
- Geographic Information System
- Outage Management Systems
- Advanced Metering Infrastructure
- Demand Side Management

AMI comprises Smart Meters working in conjunction with a centralized metering system. The centralized system consists of a head end system, meter data management system and billing applications.

6.4. IoT and Smart Meter

A smart meter is an electronic device that allows remote monitoring and recording of energy consumption designed to replace traditional electricity and gas meters. However, in the age of IoT, standalone smart meters give way to more advanced and multi-purpose smart metering solutions. These solutions offer a broader range of remote monitoring and alerting capabilities as well as provide powerful data analytics tools to help companies and individual users optimize their energy, water, gas, or fuel consumption *(ThingsBoard).*

Installing a smart meter helps to get rid of estimated bills by allowing to control and reduce energy consumption. Akash says that Smart Metering is a technique of digitizing the energy system using smart meters that provides businesses a way to track how much energy they are using so that they can adjust the usage when required. The best way to integrate smart meters within its infrastructure is by using an IoT platform that comes with the data processing capabilities. It will not only allow collecting data from smart meters but can also help to set up a custom visualization dashboard.

6.4.1. Benefits of smart meters (Akash)

- Convenience

  Using Smart Meters, readings can be automatically sent to the electricity department. Where the electricity department won't require a representative, who goes to every building to take readings and generate the bill. Moreover, it is also time and energy saving.
- Accuracy

  Won't receive estimated bills with smart meters because usage figures are directly sent to the electricity department in real-time. The traditional way of energy billing requires a higher degree of guesswork. Also, there's no human error as the intelligence of IoT is implemented in generating energy bills.
- Control over energy consumption

  Smart meters come with a smart energy display that allows users to see how much energy generated by your appliances. It helps to track the actual cost of the bill before it is even generated. Can also identify when the least or most energy is being consumed.
- Safety from faulty appliances

  Users can notice sudden spikes that can be related to a faulty appliance, since in-home displays equipped with a smart meter can show how much energy is being used at a specific time. Identifying such appliances can ensure safety and help efficiently consume energy.
- Environment Protection

  Smart meters can also help the environment by eliminating the need to build more power plants or avoiding the use of less efficient power plants because customers can lower their energy demand.

6.5. Communication System for Smart Grid

Smart Grids consist of integrating power grid elements into advanced information systems for the benefit of electricity suppliers, distributors and consumers. These grids combine on demand production and distribution of electrical resources through extensive use of the latest information and communication technologies.

Communications play a critical role in the deployment of smart grids because they must be resilient, secure, reliable, manageable and standards-based to ensure connectivity with other grid elements. Their main function is to bring together the wide range of data available on the

power grid using data processing systems and decision centres to improve the efficiency of power companies by optimizing production, supply and demand.

6.6. Frequency bands licensed from BICMA for wireless communication

sl.no	Frequency Band	Carrier Frequency	Channel Bandwidth	Frequency of Operation	Remarks
1	400MHz	450MHz & 460MHz	50KHz	449.975-450.025 MHz and 459.975-460.025 MHz	TX-RX Pair
2	400MHz	451MHz & 461MHz	50KHz	450.975-451.025 MHz and 460.975-461.025 MHz	TX-RX Pair
3	5.4GHz	5495MHz	10MHz	5490-5500 MHz	
4	5.4GHz	5595MHz	10MHz	5590-5600 MHz	
5	5.4GHz	5695MHz	10MHz	5690-5700 MHz	
6	5.8GHz	5765 MHz	80MHz	5725-5805 MHz	Unlicensed Band
7	5.8GHz	5865 MHz	80MHz	5825-5905 MHz	Unlicensed Band

7. Conclusion

5G will sustainably satisfy requirements of the user with very low latency, high data rate and higher capacity. It will be capable of connecting billions of devices, nearly all IoT devices will benefit from greater speed including those with industry and healthcare applications. The 5G spectrum is a range of radio frequencies in the sub-6 GHz range and the millimetres-wave frequency range. Regulators have assigned 5G spectrum in three broad ranges to deliver widespread coverage and support a wide range of use cases: high bands which support the fastest 5G speeds, mid bands which offer a good mixture of coverage and capacity and low bands which help provide strong wide area.

Globally, the issues of regulatory framework, quality of service, spectrum licensing and etc., need to be dealt with by regulators. 5G is expected to play an important role in the evolution of cellular IoT and therefore suitable provisions need to be made in future band planning. It is important that governments and the mobile industry ensure the needs of IoT applications to be incorporated into 5G spectrum planning. In most of the SATRC countries there is no licensing or registration mechanism for M2M and IoT service providers. However, it is possible that M2M and IoT services are being provided using the services of licensed telecom services. In most of the member countries, M2M and IoT devices are being used extensively particularly in Power metering, Traffic and Fleet management, Agriculture and Industrial applications.

So does the Bhutan Power Corporation take its business into a digital platform to meet the demand of people. The most important strategic theme is the grid operation digitalization which enables real time monitoring and control of bi directional power flows and information flow from points of generation to the points of distribution at the appliances level. It will provide the benefits of accuracy in receiving bills, control over energy consumption, convenience for generating bills and the list goes on. Communications play a critical role in the deployment of smart grids because they must be resilient, secure, reliable, manageable and standards-based to ensure connectivity with other grid elements. Their main function is to bring together the wide range of data available on the power grid using data processing systems and decision centres to

improve the efficiency of power companies by optimizing production, supply and demand.

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