

Internet of Things (IoT) applications in Power System

Sonia Kolhe
P.G. Student

Department of Electrical Engineering
Ballarpur Institute of Technology

Heena Sheikh
Assistant Professor

Department of Electrical Engineering
Ballarpur Institute of Technology

Abstract— Electrical power demand has drastically increased globally. To accomplish this energy demand power engineer needs to erect a rigid infrastructure to control and monitor the complex power system. Internet of Things (IoT) is the key solution mitigate this issue. IoT help to identify the power leakages, power theft and consumer satisfaction. IoT can be improve the efficiency of network. This paper focused the application of IoT in power system.

Keywords— IoT, Renewable Energy, Smart Grid

I. INTRODUCTION

India is at 3rd position in power production and power consumption in the world. The total installed capacity of India is 368.79 GW as of 31.12.2019. The per capita electricity consumption is also getting increase day by day as illustrated in Fig. 1. With such a large amount of consumption and production of electricity, it becomes very essential to have a competent infrastructure of the power system is required. In India, around 30 % of the electricity produced is waste in T & D losses.

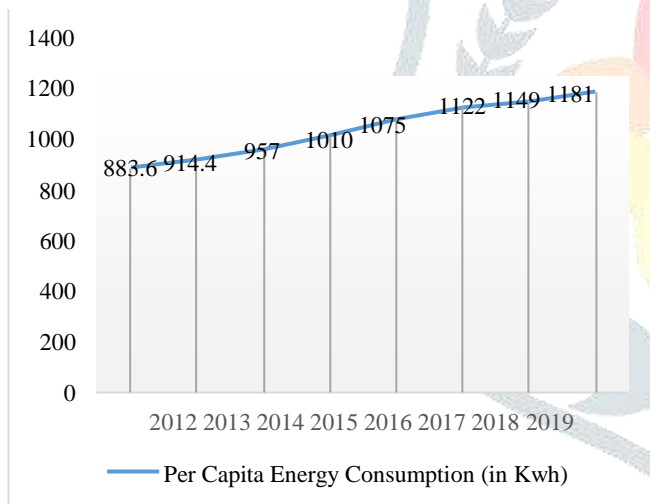


Fig. 1 Per Capita Electricity Consumption in India [12]

To compensate such losses in transmission and distribution network it is required to have some robust mechanism for the same. The Internet of things is a great available option for strengthening the control mechanism for the power system.

II. INTERNET OF THINGS

Internet of Things is a kind of network to connect anything with the internet. It is also defined as an emerging technology utilizing the internet and targeted to give connectivity to physical things or devices. When anything, object machines are interacting with each other through the internet is known as the internet of things. [1]



Fig. 2 Internet of Things

Fig. 2 indicates the basic structure of the Internet of Things. Following are the main stages in the Internet of Things implementation and usage:-

- **Defining Application:** This is the first stage in which the application and its nature is defined for which required the IoT setup.
- **Selection of De vices:** In this stage hardware devices are shortlisted for defined application.
- **Protocols Finalization:** In this stage, finalized the communication protocols compatible with the selected hardware for a defined application. The table shown below shows the comparative analysis of communication protocols [2]

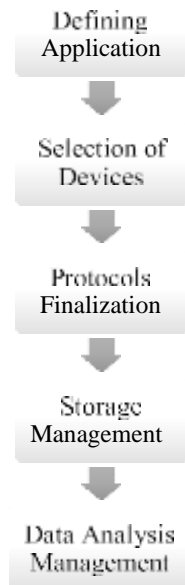


Fig. 3 Stages in the Internet of Things

TABLE 1 COMPARATIVE ANALYSIS OF COMMUNICATION PROTOCOLS

S.No	Technology	Range	Speed	Cost
1	Bluetooth	Up to 50 m	1 Mbps	Low
2	Zigbee	Up to 100 m	250 kbps	Low
3	LTE-M	Upto 200 km	0.2-1 Mbps	Moderate
4	Satellite	Very Long Distance	10 kbps	High

- **Storage Management:** In this stage, the mode of storage for the data is being identified and it allows to interface with hardware through finalized communication protocols. Storage modes may be SD Card, USB drive or cloud storage.
- **Data Analysis Management:** This is the final stage in IoT setup in which a special software package is provided for analysis of collected data in storage. It helps us to control and modify the operation of the whole setup as and when required.

III. ROLE OF INTERNET OF THINGS IN POWER SYSTEM

For a good development of any country Power and Energy, the sector is required at its best. To strengthen the same IoT is observed as a key source. India is also likely to move to embedded IoT in the power system. With the use of IoT, transmission losses can be reduced. Also, it is helpful in the detection of power theft. Controlling outages and overdrawn of power from generating stations. [3]

Most of the parts of the internet of things associated with the energy management system and it is incorporated in the smart grid. With the aid of the Internet of things in the smart grid, the power system can be managed in a more proper manner. It gives several modern and better control system like substation Automation and Load Scheduling can be done in an effective manner. The Major Tasks of the internet of things in the power system is asfollows:-

Smart metering which gives exact consumption of energy.

- Smart Control for the Whole system and various subsections through Supervisory Control and Data Acquisition Packages.
- For Smart Backup with the use of smart power electronics-based Inverters.
- Remote Monitoring and Maintenance of Transmission Lines.
- IoT may be helpful in patrolling of transmission and distribution lines through IoT based drones for locating faults like conductor breakage and Insulator puncture.

As of now, used wired communication power Line Carrier Communication, Wi-Fi, Lease Line, GPRS, and Fiber Cables, etc. in the Indian Power System. If embedded IoT in the power system, can use the following communication modules and protocols effectively like SCADA, DMS, GIS, CIS, OMS, etc. In IoT, have to use several communication layers and through the same, they interface with hardware infrastructure. [4] Key roles performed by IoT are as follows:

- Preventative Maintenance
- Analysis of Energy Demands
- Breakdown Maintenance
- Managing Power generation through digital control systems.
- In the planning of RE integration

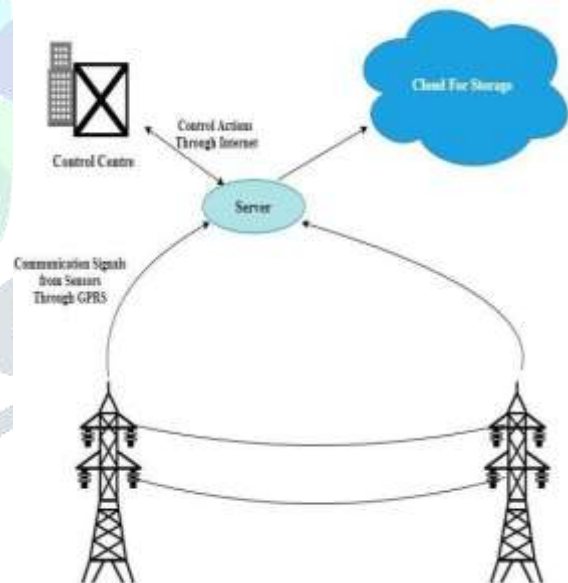


Fig. 4 Internet of Things in Power System

Fig. 4 illustrate the example of the IoT monitored transmission line. As shown various sensors have been embedded on the transmission towers to sense the actual operating conditions. These sensors send signals to the control Centre for corrective and preventative actions as and when required. All control and preventative actions are being recorded in the cloud-based system for access in the future. This is done to take reference in the occurrence of some kind of contingencies [5].

A. Benefits of Using IoT in Power System

Following are major benefits of using IoT in Power System [6]:

- Effective Operation and Control of Power System is possible.
- Physical Breakdown is reduced.
- The overall reliability of the power system is improved.
- It can enhance powersystem stability.
- Rapid action against all types of breakdown can be taken.
- An effective tool for preventative and breakdown maintenance.
- Fault detection and isolation is easy.
- The efficiency of the whole system is improved.
- Data Collaborated can be accessed from anywhere and anytime.



Fig. 5 Challenges Associated With IoT

B. Challenges Associated with IoT in Power System

Following are major challenges associated with IoT in Power Systems:

- **Cost of Equipment's:** The first and foremost challenge with IoT is the cost of equipment used. All the equipment used is very costly in nature.
- **The sensitivity of Equipment's:** The equipment used in IoT based system is sensitive to change in voltages. Such types of equipment are affected by the variation of voltage and may malfunction.[7]
- **Availability of Internet Connectivity:** IoT based setup required continuous and uninterrupted internet service. If failing in doing so the control signals and commands not received by actuators which may lead to failure of the whole system.

- **Complex Hardware:** IoT based system is having complex hardware that may get malfunctioned several times due to operational problems and the aging effect of equipment.
- **Cloud Issues:** Sometimes problems are being observed to fetch data from cloud storage which will affect the operation of the overall system.
- **Security Issues:** In this digital era it is required to keep cloud data secure. If security measure not follows then data can be access by an unauthorized person.
- **Sensors Operational Issues:** Sensors are the backbone of IoT based system. Several types of sensors are used in the system. It is required to make sure that all sensors should work properly in collaboration with each other.

IV. IOT IMPLEMENTATION IN INDIAN POWER SYSTEM

India is looking towards a superior infrastructure for supplying electricity to the consumers. Smart Grid with the internet of things has the potential to fulfill the same. It is helpful in serving various tasks like effective usage of the grid system and improving efficiency, also to embedded distributed energy generation sources and also to match demand and supply of electricity. Power Grid Corporation of India [8] is developing a Smart grid Pilot Project in Puducherry, India with the major objectives like Emolument of Policy, use of indigenizing technology and a common platform for exchanging information. It severs benefits to both Utility and consumers. Following issues are being observed in IoT based Smart Grid implementation in India [9]:

- **Financial Constraints:** In IoT based smart grid implementation, the most crucial factor is the availability of funds to purchase new system setups and hardware infrastructure. In-country like India facing a problem that many states are not generating funds through the power Industry. Many distribution companies are operated in loss, Hence it becomes very difficult to expend for new infrastructure.[9]
- **Policy & Regulation:** The existing regulatory framework is not compatible with s smart grid infrastructure completely. As of now the government has moved towards a deregulated power system and break state-owned electricity board into 3 subunits. The generation organization is termed as Genco, Transmission as Transco and Distribution Company as Discom. Government has also established several societies for promoting Smart Grid Task Force, Indian Smart Grid Forum, etc. A rigid policy for IoT based Smart Grid Implementation is yet to be framed for the Indian Power System [8-12].
- **Skill and Knowledge:** For a successful installation, Commissioning and operation of IoT smart grid It is required that professionals, Engineers, Technicians and all supporting staff should be properly trained with technologies like smart grid, Internet of Technology, Data Analytics, Information Security, etc. This transition from existing technology to new technology will take time and a lot of money is required for the same.
- **Privacy and Security of Data:** The involvement of communication networks is increased in the power

system. With this, it is required to keep data safe from malicious attackers and hackers.

CONCLUSION

Based on the aforesaid discussion and data about the effectiveness of IoT in the Power system, this can be concluded that in India incorporation of IoT in power system is at nascent stages and several future research is required. For some locations, this IoT can be implemented in the power system depending upon site conditions and geographical state of the site. IoT is a very effective technique and it is required to be included in the operation and maintenance of the power system it is very efficient and will definitely increase the reliability of the system.

REFERENCES

- [1] G. Bedi, G. K. Venayagamoorthy, R. Singh, R. R. Brooks and K. Wang, "Review of Internet of Things (IoT) in Electric Power and Energy Systems," in *IEEE Internet of Things Journal*, vol. 5, no. 2, pp. 847-870, April 2018.
- [2] Growth of Electricity Sector in India from 1947-2019"(PDF). Central Electricity Authority. May 2018. Retrieved 28 August 2019.
- [3] G. Bedi, G. K. Venayagamoorthy and R. Singh, "Navigating the challenges of Internet of Things (IoT) for power and energy systems," *2016 Clemson University Power Systems Conference (PSC)*, Clemson, SC, 2016, pp. 1-5.
- [4] Y. Saleem, N. Crespi, M. H. Rehmani and R. Copeland, "Internet of Things-Aided Smart Grid: Technologies, Architectures, Applications, Prototypes, and Future Research Directions," in *IEEE Access*, vol. 7, pp. 62962-63003, 2019.
- [5] Hossein Motlagh, N.; Mohammadrezaei, M.; Hunt, J.; Zakeri, B. Internet of Things(IoT) and the Energy Sector. *Energies* 2020, *13*, 494.
- [6] Ramakrishna Kappagantu, S. Arul Daniel, Challenges and issues of smart grid implementation: A case of Indian scenario, *Journal of Electrical Systems and Information Technology*, Volume 5, Issue 3, 2018, Pages 453-467.
- [7] M. Farrag, "Smart network benefits in developed / developing countries," *2016 Eighteenth International Middle East Power Systems Conference (MEPCON)*, Cairo, 2016
- [8] G. Shamim and M. Rihan, "A technical review on smart grids in India," *2017 4th IEEE Uttar Pradesh Section International Conference on Electrical, Computer and Electronics (UPCON)*, Mathura, 2017, pp. 642-648.
- [9] I. S. Jha, S. Sen and R. Kumar, "Smart grid development in India — A case study," *2014 Eighteenth National Power Systems Conference (NPSC)*, Guwahati, 2014, pp. 1-6.
- [10] A. Sharma, B. K. Saxena and K. V. S. Rao, "Comparison of smart grid development in five developed countries with focus on smart grid implementations in India," *2017 International Conference on Circuit, Power and Computing Technologies (ICCPCT)*, Kollam, 2017, pp. 1-6.
- [11] iot.ieee.org
- [12] www.powergridindia.com