A Research Article on Architecture and Applications of Internet of Things (IoT)

Digbijay Guha[1], Souvik Paul[2], Atrayee Chatterjee[3]

[1, 2, 3]Assistant Professor, Department of BCA, The Heritage Academy, Kolkata, West Bengal, India
(E-mail: digbijay.guha@gmail.com[1], souvikpaul.tiu@gmail.com[2], sanyalatrayee@gmail.com[3])

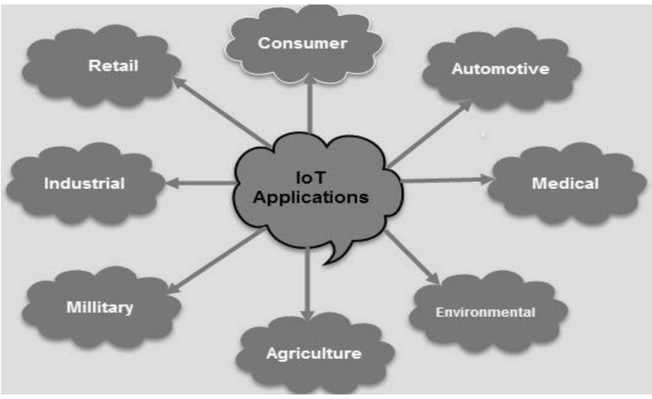
Abstract— The Internet of Things (IoT) is the network of networks of automobiles, physical equipments and other objects which consist of an embedded system with sensors, actuators and network connectivity that enable to collect and transmit data. The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more integration of the physical world into computer-based systems, and result in improved accuracy, efficiency and economic benefit. The IoT is a rapidly increasing and promising technology which becomes more and more present in our daily lives. Furthermore, the technology is an instance of the more general class of cyber-physical systems, which also environs the technologies such as smart grids, smart kitchens, smart drawing rooms, smart hospital and smart cities. IoT makes our life more convenient.

Keywords— *Sensors/Actuators; Internet Gateway; Data Center and Cloud; Streaming Data Processor and Data Lake; Big Data Warehouse; Data Analytics; ML Generators.*

I. INTRODUCTION

In a network every device, every sensor, every software are connected to each other. The ability to access these devices through a smart phone or through a computer is called Internet of Things where devices are accessed remotely. IoT is basically a platform where users connect daily things embedded with electronics, software, and sensors to the internet allowing them to collect and transfer data. In this way, each of the devices will learning from the understanding of other devices, just as humans do. With IoT, the interrelationship in the human will expand- i.e. to *interface, participate* and *commit* to things. For example, an Air Conditioner's sensor can collect the data regarding the outside temperatures, and accordingly adjust the temperature to vary it with respect to the outside temperature to make comfortable inside the room. Similarly, mechanism of refrigerators can also adjust its temperature accordingly.

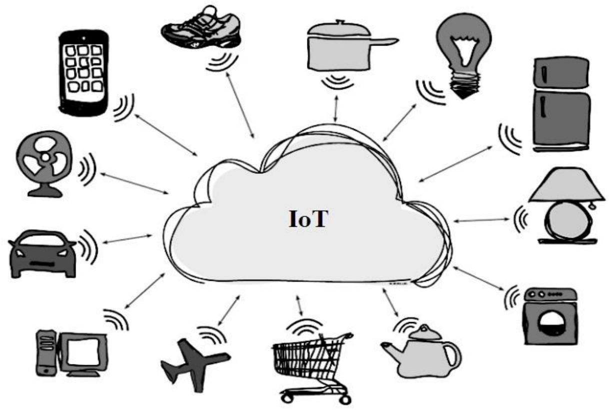
FIGURE I. IOT APPLICATIONS



II. SENSORS/ ACTUATORS

Sensors collect data from the surroundings or object under measurement and convert it into useful data. Think of the particular structures in the cell phone that detect the directional pull of gravity—and the phone's relative position to the "thing" can be called the earth—and convert it into data that the phone can use to adapt the device. Actuators can also involve changing the physical conditions that obtain the data. An actuator might, for example, turn off a power supply, adjust an air flow valve, or move a robotic gripper in an assembly process. The sensing/actuating stage covers everything from legacy industrial devices to robotic camera systems, water-level detectors, light illumination detectors, air quality sensors, accelerometers, and heart rate monitors. The scope of the IoT is expanding rapidly in low-power wireless sensor network technologies and Power over Ethernet, which enable devices on a wired LAN to operate without the need for an A/C power source.

FIGURE II. IOT SENSORS/ACTUATORS



III. INTERNET GATEWAY

The data from the sensors record in analog form. Recorded data need to be accumulated and converted into digital streams for further processing downstream. Data acquisition systems (DAS) perform these data aggregation and conversion functions. The DAS connects to the sensor network, aggregates outputs, and performs the analog-to-digital conversion. The Internet gateway receives the aggregated and digitized data and routes it over Wi-Fi, wired LANs, or the Internet, to the systems for further processing. The systems often sit in close adjacency to the sensors and actuators. For example, a pump might contain almost six sensors and actuators that feed data into a data aggregation device that also digitizes the data. This device might be physically combined to the pump. An adjacent gateway device or server would then process the data and forward it to the next systems. Intelligent gateways can frame on additional, basic gateway functionality by adding such effectiveness as analytics, malware protection, and data management services. These systems facilitate the analysis of data streams in real time. Although delivering business insights from the data is a little less immediate at the gateway than it would be when sent directly from the sensor/actuator zone, the gateway has the compute power to restore the information in a form that is more understandable to business participants.

FIGURE III. INTERNET GATEWAY

IV. DATA CENTER AND CLOUD

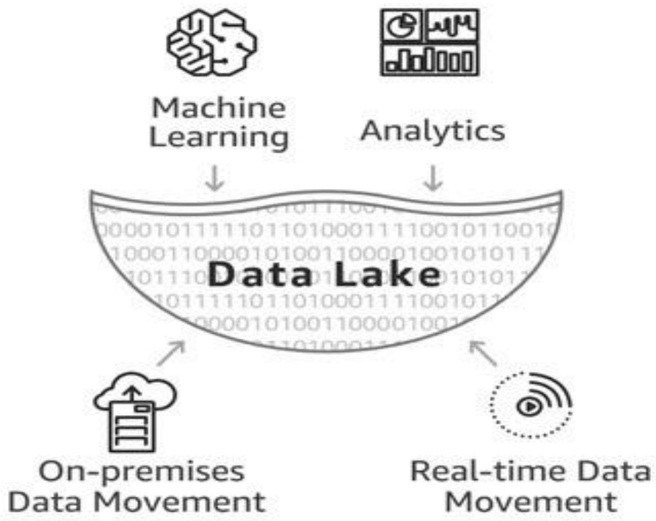
Data that requires detailed processing, and where feedback doesn't have to be immediate, gets forwarded to physical data center or cloud-based systems, where more powerful Information Technology systems can analyze, manage, and securely store the data. It takes longer to get results when you wait until data reaches next stage, but it can execute a comprehensive analysis, as well as aggregate the sensor data with data from other sources for broad understanding. Next stage processing may take place on-premises, in the cloud, or in a hybrid cloud system, but the type of processing executed in this stage remains the same, regardless of the platform.

FIGURE IV. DATA CENTER AND CLOUD

V. STREAMING DATA PROCESSOR AND DATA LAKE

Streaming data processor provide efficient transition of input data to a data lake and control its applications. No data can be hardly lost or corrupted. A data lake is used for storing the data achieved by connected devices in its natural format. Big data comes in "batches" or in “streams”. When the data is needed for relevant understanding it is extracted from a data lake and loaded to a big data warehouse.

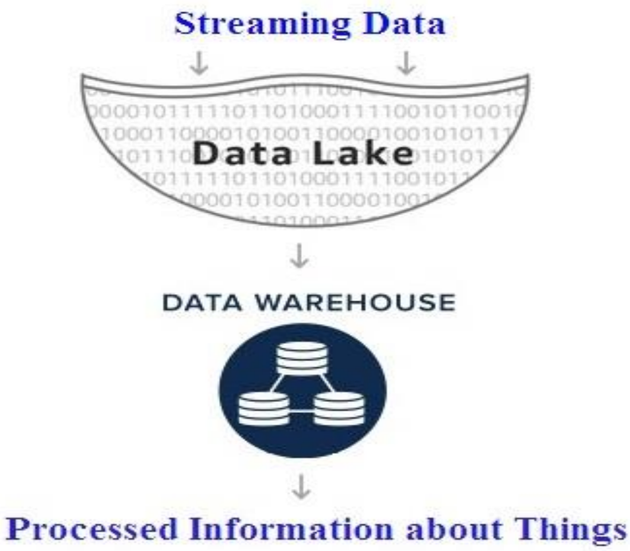
FIGURE V. DATA PROCESSING THROUGH DATA LAKE



VI. BIG DATA WAREHOUSE

Filtered and preprocessed data needed for relevant understanding is extracted from a data lake to a big data warehouse. A big data warehouse contains only cleaned, structured and matched data where as data lake contains all types of data generated by sensors/actuators. Also, data warehouse stores context information about objects and sensors/actuators and the commands control applications send to things.

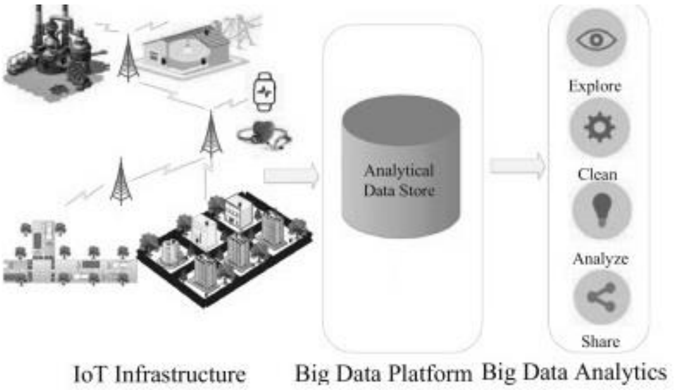
FIGURE VI. BIG DATA WAREHOUSE



VII. DATA ANALYTICS

Data analysts can use data from the big data warehouse to find progression and gain prosecutable observation. Data analyzed in the way of visualization in schemes, diagrams, infographics etc. For example, the performance of devices, help identify inabilities and work out the ways to upgrade an IoT system to make it more reliable, more consumer-oriented. The correlations and patterns found manually can further contribute to creating algorithms for control applications.

FIGURE VII. DATA ANALYTICS



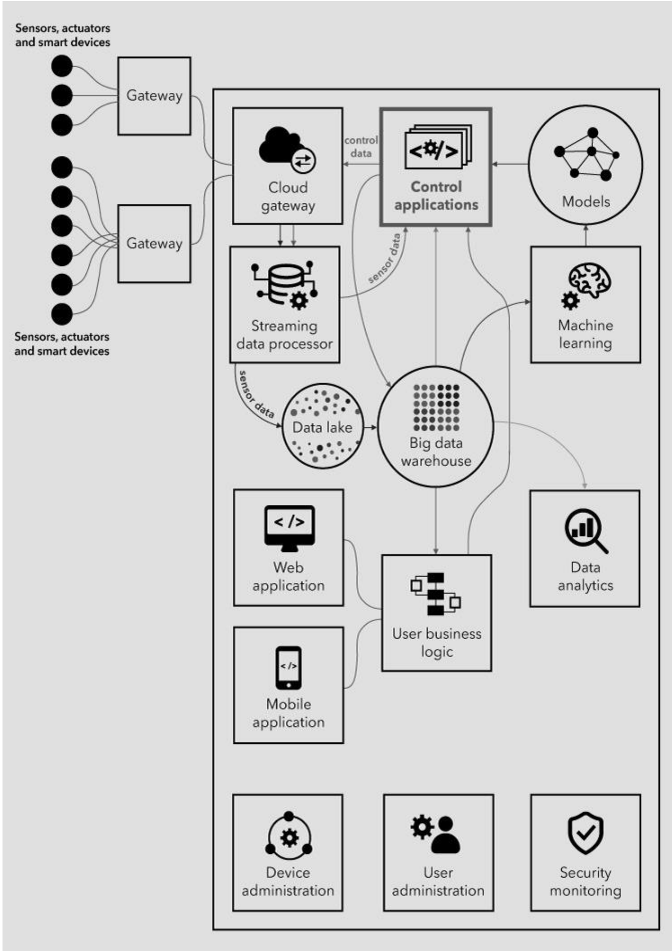
VIII. ML GENERATORS

There is an occasion with machine learning to generate more explicit and more competent models for control applications. Models are regularly updated such as once in a week or once in a month based on the past data assembled in a big data warehouse. When the appropriateness and ability of new models are examined and accepted by data analysts, new models are used by control applications.

IX. CONTROL APPLICATIONS OF IOT

Control Apps' commands sent to actuators can be also additionally stored in a big data warehouse. This may help examine ambiguous cases such as a control app sends commands, but these are not performed by actuators – then connectivity, gateways and actuators need to be analyzed. Storing commands from control apps may grant to security, as an IoT system can identify that some commands are too weird or come in too big volume which may witness security breaches. Control applications can be either rule-based or machine-learning based. In the first case, control apps work according to the rules stated by specialists. In the second case, control apps are using models which are regularly updated with the past data stored in a big data warehouse. Although control apps ensure better automation of an IoT system, there should be always an option for users to influence the behavior of such applications.

FIGURE VIII. CONTROLLING APPLICATIONS OF IOT



X. APPLICATIONS OF IOT

IoT has many applications, in different areas. Most acceptable applications will discuss in the following section:

A. Smart Home

The most important and capable application ranked as highest IOT application on all categories is Smart Home. The number of people searching for smart homes increases every day. Another interesting thing is that the database of smart homes for IoT Analytics includes different companies and startups. More companies are now actively being involved in smart homes than similar other applications in the field of IoT.

FIGURE IX. SMART HOME

B. *Smart City*

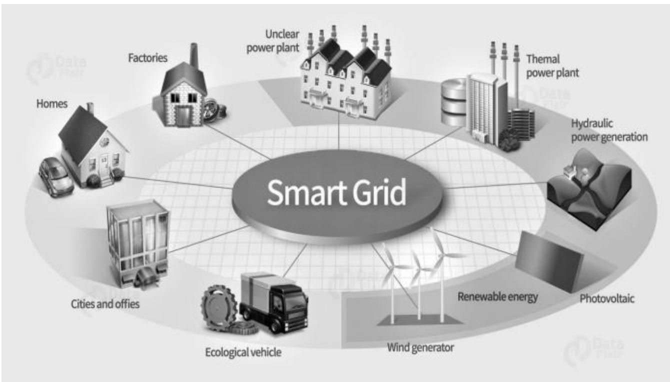
The smart city is a very big modernization and spans a wide variation of use cases such as water distribution, traffic management, waste management, environmental monitoring like reduce air and noise pollution, urban security etc. It is very popular because it tries to remove the discomfort and problems of people who live in cities.

FIGURE X. SMART CITY

C. *Smart Grid*

A smart grid basically used to collect information on the behaviours of customers and electricity suppliers in an automated fashion in order to improve the efficiency, economics, and reliability of electricity distribution. This concept is gaining more popularity day by day.

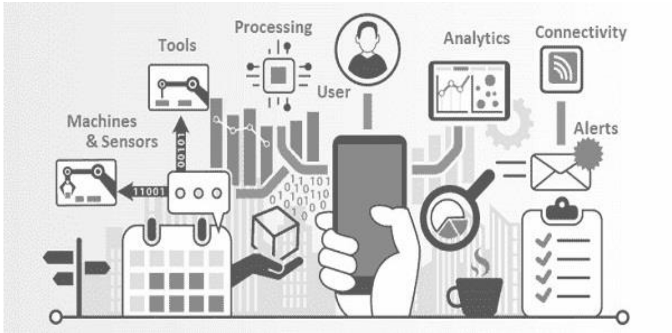
FIGURE XI. APPLICATIONS OF SMART GRID



D. *Use of Industrial Internet*

Industrial Internet is used for connecting machines and devices in industries such as power generation, oil, gas, and healthcare etc. It is also used for the situations where unplanned break and system failures can result in life-threatening situations. A system embedded with the IoT tends to include devices such as fitness bands for heart monitoring or smart home appliances.

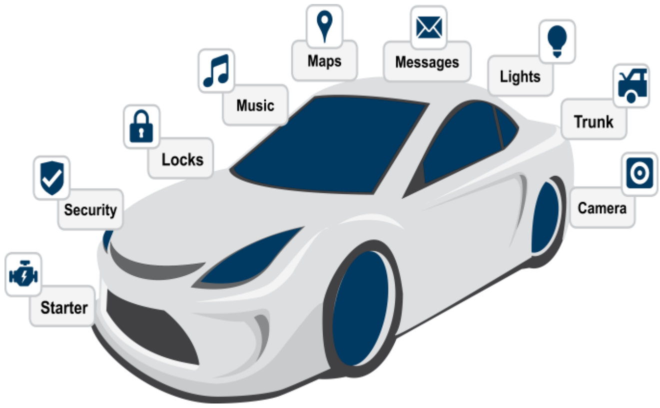
FIGURE XII. INDUSTRIAL INTERNET



E. *Connected Car*

Connected car technology is a broad and a costly network of multiple sensors, antennas, embedded software, and technologies that assist in communication to navigate in the fast lifestyle. It has the duty of making choice with consistency, accuracy, and speed. These requirements will become even more reliable when entirely the control of the steering wheel and brakes to the autonomous or automated vehicles that are being successfully tested on highways.

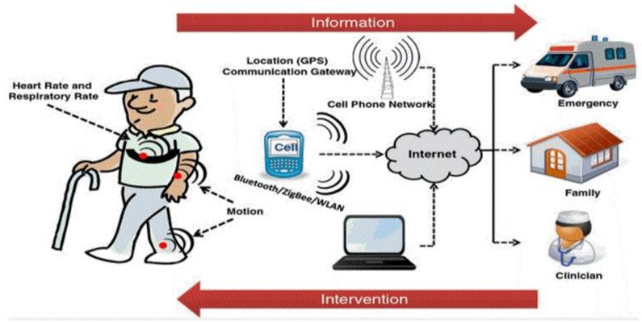
FIGURE XIII. CONNECTED CAR



F. *Connected Health*

IoT has many applications in healthcare in the form of remote monitoring equipment to advance and smart sensors to apparatus integration. It has the potential to improve how doctors deliver care and also keep patients safe and healthy. Healthcare IoT can allow patients to spend more time communicating with their doctors by which it can improve patients' satisfaction. From personal fitness sensors to surgical robots, IoT in healthcare brings new tools updated with the latest technology in the ecosystem that helps in developing better healthcare. IoT helps in revolutionizing healthcare and provides cost effective solutions for the patient and healthcare professional.

FIGURE XIV. REMOTE HEALTH MONITORING



G. Smart Retail

Retailers have started accepting IoT solutions and using IoT embedded systems across many applications that progress store operations such as rising purchases, dropping theft, enabling inventory management, and raising the customers' shopping experience. Through IoT physical retailers can contest against online challengers more strongly. They can recover their lost market share and attract customers into the store easily and cost effectively.

FIGURE XV. SMART RETAIL SERVICE

H. Smart Supply Chain

Supply Chain Management is getting smarter now a days. It offers solutions to problems such as locating goods while these are in transportation, providing suppliers exchange inventory information are some of the popular offerings. With an IoT enabled system, factory apparatus that contains embedded sensors communicate data about different parameters such as pressure, temperature, and utilization of the machine. The IoT system can also process workflow and change equipment settings to maximize performance.

FIGURE XVI. SMART SUPPLY CHAIN MANAGEMENT

I. Smart Agriculture

IoT application is used in smart agriculture. Maximum farming operations is usually remote and the large number of livestock that farmers work on, all of this can be monitored by the IoT and can also transform the way farmers work. This idea is gaining large-scale attention.

FIGURE XVII. SMART AGRICULTURE

J. Application of IoT in Education

IoT improves the conventional education systems into smart education system using smart components in Educational Institutions. The smart gadgets are used within the campus through Wi-Fi for transmitting information. A computational IoT gadgets for faculties and studying facilities enables to create smarter lesson plans, maintain the adjustment of critical resources, improves admission records, design safer campuses etc.

FIGURE XVIII. APPLICATION OF IOT IN EDUCATION

CONCLUSION

Hence, in this study on Internet of Things, it has been discussed how people can integrate technologies in their lives and working on different areas of IoT. Additionally it has been discussed on working architecture of IoT and implementation in the industries. There is lots of scope for improvement such as in education sector where IoT could fit in and be implemented in Indian education system especially in remote areas.

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Digbijay Guha has completed his B.Tech. in Computer Science and Engineering from St. Thomas College of Engineering and Technology and M.Tech. in Computer Science from BIT, Mesra. He has worked in ACES Infotech Private Limited as Computer Teaching Executive. He is now teaching in The Heritage Academy as Assistant Professor of BCA department from May, 2010. His research interests are Operating System, IoT, Cyber Law, Cyber Crime, Network Security, Artificial Neural Network, E-Commerce, Networking, Numerical Methods etc.

Souvik Paul has completed his B.Tech. in Computer Science and Engineering and M.Tech. in Electronics and Communication Engineering from M.C.K.V. Institute of Engineering. He has worked in Infogen Global as Software Developer and also in Technical Assistant in SPG Solutions. He has acted as Assistant Professor in CSE department from May, 2010 to July, 2014 at Calcutta Institute of Technology, Uluberia, Howrah. He is now teaching in The Heritage Academy as Assistant Professor of BCA department from August, 2014. His research interests are Artificial Intelligence, IoT, Remote Sensing, E-Commerce etc.

Atrayee Chatterjee has completed her B.Tech. in IT from Meghnad Saha Institute of Technology in 2010. She has worked in Sree Maheshwari Vidyalaya as Computer Teacher. Currently she is working as Assistant Professor in BCA Department The Heritage Academy from 2010 till present. Her research interests are Artificial Intelligence, IoT, Genetic Algorithm, Bio Informatics, E-Commerce etc.