IOT PLATFORM AND ARCHITECTURE

Abstract

IOT i.e Internet of Things is new age computing technology. Modern technology is revolutionising and IOT acts as a bridge or means to help common masses to have access to this trending new technologies. It is not only capable of interconnecting devices but also plays a key role in processing and monitoring.

Keywords: Revolutionising, Bridge, Processing, Monitoring, Trending, Capable.

Author

Dr. Anemone Koul Chaku
Assistant Professor
Applied Science (Physics)
Noida Institute of Engineering and Technology (NIET, Greater Noida)
19, Institutional Area, Knowledge Park II, Greater Noida, Uttar Pradesh.
anemone@niet.co.in

I. INTRODUCTION

With the rise in internet accessibility the people around the globe are trying to exploit its usage for various applications. One such field where internet is finding its place is IOT (internet of things). IOT refers to connecting different devices to each other through the internet. It is revolutionizing the digital world enmasse. The IOT is a multiple-layer platform that carries out direct management, automating and catering of devices within the Internet's domain. IoT platform relates to a set-up of IoT elements which includes gateways, sensors, actuators, communication protocol, cloud server setup, and end-user application interface. With the speedy evolution in the industry, there are many different ways to device an IoT platform. It is a convenient platform for apprentices and designers for instant use, which runs at an incredible speed. It is a remote device allowing users to manage the linking between hardware and application devices. Having unique features like cloud and various gateways, it has a good scope for the business development. Various stages of IOT Platform are shown in Figure 1.

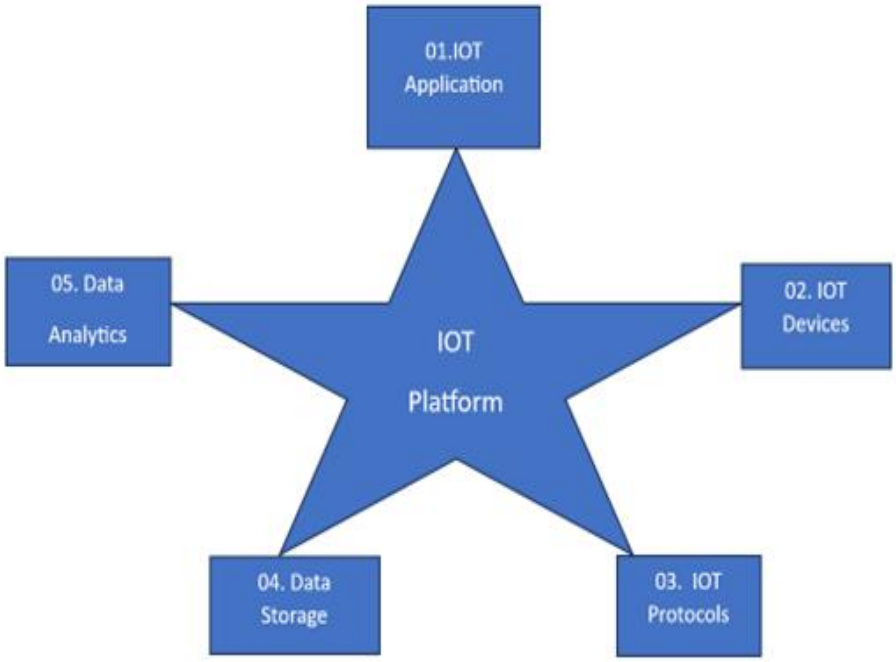

Figure 1: IOT Platform

1. **IOT Platform and Architecture:** "An IoT Platform is a fusion of cloud-based services and applications used to monitor, manage and interact with smart, connected devices."

   We need to have various sets of policies and apparatuses for actual disposition of IOT. The various techniques and apparatuses used in the explicit realm for the unambiguous IoT solution, is known as an integrated

   Platform for IOT. Applications can be deployed and run using IOT Platform. It is a combination of the software programming and hardware components that enable that enable the operation of other program. Platform is made up of hardware that houses the

operating system.[1] By providing a necessary execution environment, this operating system permits programs to operate it. To create IoT applications, IoT platform offer a full range of independent functionality and general claims. [2] Since there is only one communication channel connecting devices of the same kind to one another, only a single service may be configured. For devices of different kinds to conceal the heterogeneity of many devices by providing them with a shared working environment, they must have some sort of common standard application platform. [3] Because it runs on the cloud, an IOT application platform is a practical solution. The IOT platform interprets data into meaning information because of its cloud connectivity. In addition to allowing pay-per-use analytics, predictive maintenance, and real time data management it provides multiple approaches for implementing business use cases.. IOT application platforms offer a whole set for application growth to its distribution and maintenance. IoT platform is generally assembled within the intricate bionetwork of tools, package(software) and the stock, dealing with diverse related issues, straddling from the M2M connectivity, to the data analysis and the visualization. The utmost topographies of the diverse areas are immense computing and security.

Stankovic [4] emphasized the following directions for IoT application platform based on research work:

- Massive scaling (which involves to address, discover, architectural models supporting the anticipated heterogeneity),
- Framework and dependencies (involving IoT applications, execution, determining interfering problem in opting the utility devices for diverse apps by various kinds of multiplexing, requirements encompassing applications specifically for the safety purposes),
- Generating information and huge amount of data (knowledge formation, real-time data elucidation, innovative techniques, confidence levels for believing data, consistent data analysis),
- Augmentation and susceptibility,
- Safekeeping (finding and analysis of attack and disposition of other means without fail),
- Privacy (assess needs contrary to policies, resolution of the various policies)
- Individuals in the loop (displaying people’s behaviours, requirements and controlling).

The skills and values for the purpose of the IoT devices, engineering and deliverance are in the initial stage of evolution, so the IoT platforms must hold a role of IoT experimentation facilities. Gluhak [5] recognized the necessities for the coming generation with investigational research amenities for the IoT:

- Scalability - “For supporting the number of nodes: minimize human involvement, maximize plug-and-play configuration and automated fault management”.
- Heterogeneousness - “For the management of devices and to ease configurability of heterogeneous devices”
- Repeatability – “between various test beds; contracts on standards”.
- Partnership – “with the other test beds/ experiments: For the shared infrastructure for validation and the interoperability”

Concurrence- “containerization of the appliances and numerous experiments used for a device”.

- Experimental environment – “strength to the ecological conditions”.
- Flexibility- “For management of system dynamics and movement of devices”
- The impact and the user involvement- “For multi-modal apparatuses for the user feedback and automatic finding of conditions where the user behaviours influence the data justifiability”.

The design and development of the Internet of Things takes into account its various application areas. Even so, there isn’t a clear architecture that is adhered to by everyone. The functionality and application in various sectors serve as the foundation for the IoT architecture. All IoT is built around a fundamental process flow. Different IoT architecture are displayed in Figure 2.

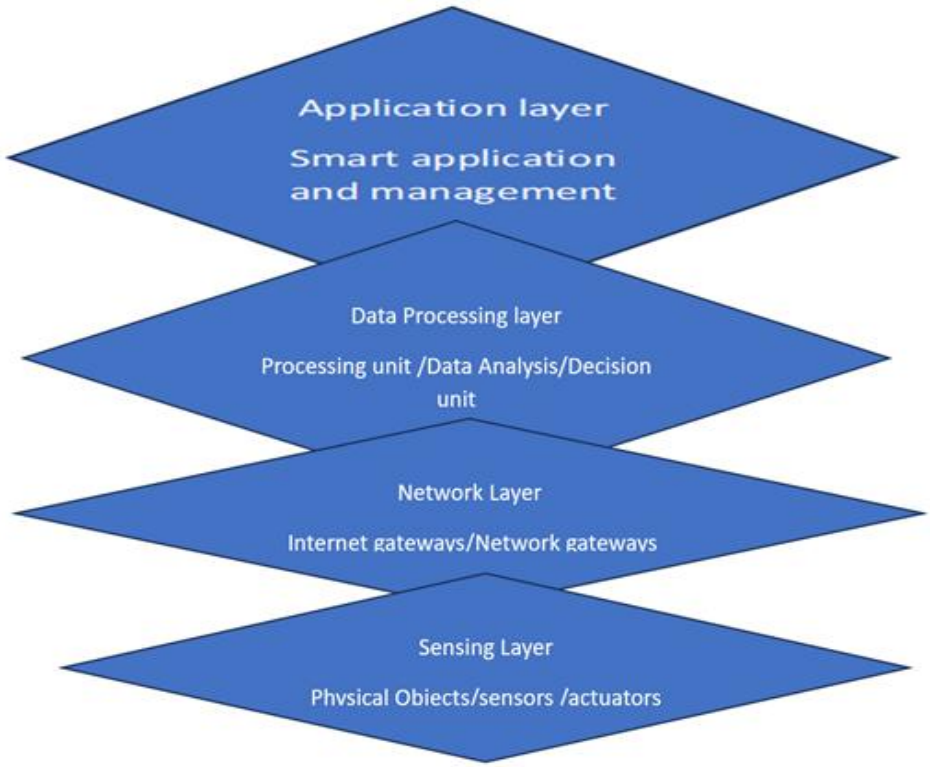

Figure 2: Stages of IOT architecture

II. VARIOUS LAYERS/STAGES OF IOT ARCHITECTURE ARE LISTED BELOW:[6]

1. **Sensing Layer:** The initial tier of the IoT architecture is sensing layer tasked with the collection of data from diverse sources. This layer consists of sensors and actuators strategically positioned in the environment to collect information concerning factors such as temperature, humidity, light, sound, and various other physical parameters. These devices establish connection to the network layer via wired or wireless communication protocols.

2. **Network Layer:** Within an IoT architecture, the network layer serves the critical role of facilitating communication and connectivity among the various devices in the IoT system. This layer encompasses a range of protocols and technologies that enable devices not only to establish connections and communicate with each other but also to connect to the broader internet. Numerous instances are network technologies frequently employed in IoT encompass Bluetooth, WIFI, Zigbee and 4G, 5G networks. Additionally, this network layer incorporates gateways and routers, functioning as intermediaries connecting devices to the broader internet. Moreover, these gateways and routers have the potential to provide security features such as encryption and authentication, thereby fortifying against unauthorized access.

3. **Data processing Layer:** The data processing layer represents the third tier of IoT architecture, encompassing both software and hardware components responsible for collection, analysis and interpretation of data derived from IoT devices. This layer assumes the role of acquiring the raw data from the devices, subjecting it to processing and subsequently rendering it available for further examination and potential action. Within the data processing layer, a diverse range of technologies and tools comes into play, including data management systems, analytics platforms and also machine learning algorithms. These tools serve the purpose of extracting meaningful insights from the data, subsequently guiding decision based on this information.

   One illustrative examples of a technology employed in the data processing layer is data lake, which functions as a centralized repository for housing raw data sourced from IoT devices.

4. **Application Layer:** The uppermost tier in the IoT architecture is the application layer, directly engaging with end-users. Its primary role lies in furnishing user-friendly interfaces and functionalities that enable the users to access and oversee IoT devices effectively. Within the application layer, a variety of software and applications such as mobile apps, web portals, and other user interfaces are incorporated to facilitate interaction with the underlying IoT infrastructure. Additionally, middleware services are integrated into this layer, fostering uninterrupted communication and data sharing among diverse IoT devices and systems. The application layer also encompasses analytical and processing capabilities, enabling the analysis and conversion of data into meaningful insights. This encompasses the use of machine learning algorithms, data visualization tools and other advanced analytics features.

   In nutshell components of Iot architecture can be placed as:

   - Sensors/ Devices
   - Gateways and Networks
   - Cloud based management service layer
   - Application layer

1. **Various IOT Platform:** IOT support platforms are listed below.[7]

   - **Arrayent Platform:** Composed of four components this IoT platform provides liable service. Link/i.e connect Agent is a microcode, a trivial agent installed in

machines/appliances (huge microcode updates are enabled). This agent helps data to connect through the Cloud by making use of 128-bit Advanced Encryption Standard (AES) encryption which is highly sensitive. Each of the device having its private digital replica in the Connect Cloud organizing the virtual devices which are connected with mobile apps. Mobile template is aimed for expansion of apps which organize the allied devices. It also uses engines for dealing and distribution generated signals that can also then activate reply actions in the product that produced the alert. Lastly the acumen offers safe access to data through the dash, data- streaming, consignment exports and the data connections as well.

- **Autodesk SeeControl Platform:** It offers IoT cloud service used for virtualization, connecting with the devices responsible for reporting and also usage of analytics for data revelation. Coding less, copy -paste methods are executed. This Platform focusses on the necessities of the trade industries, making performance data of the products then forecasting a product failure, accomplishment of maintenance and enhancing supply chain and also material renewal costs. This Platform offers a huge library of prevailing protocol and retailer device adapters. It facilitates light Enterprise Resource planning modules and also the business management tools etc.

- **Axeda Platform:** Axeda acts as a connectivity middleware for the easy connection of machines/tools and the appliances to the cloud. This Application empowerment platform abridges expansion of IoT apps, by the skills like the management of data, Engine Scripting, Framework Integration, Software development kits and the network services for retrieving data and the courseware in the cloud without any issue. Connecting machine management applications enable the distant surveillance, operation, service and the regulator of distant devices. Competences includes the software (client and macrocodes) delivery and the configuration management as well.

- **Bugswarm Platform:** It acts as a trivial means that can gain the data and then control the devices using the software like the Java-Script or the plain hypertext transfer protocol. It states a “swarm” – the arrangement of resources for communicating to the further resources within the system, corresponding to the well-defined access policy. Resources join through HTTP, which are not only confined to devices but also web or mobile applications. For connecting prevailing devices as a resource to a swarm various thing like the Device-specific platform, Client-side platform applications and device connectives are made available for the use. Specific devices send the private messages loaded with the list of skills and services to all the swarm members. Also, the other resources which are concerned about the services are liable to direct a feed request to the device, replying with a feed answer in turn.

- **Carriots Platform:** This platform acts like a compiler; enabling connectivity between various types of devices to the web connectivity sending a cascade of the data, by making use of the Message Queing Telemetry Transport (protocol),Client forURLs (software), Poster, RESTful API. A client installation for individual protocols is desired for the device. Also, a Trigger component is established and installed to perform operations on the data. For status checking, configurations managing, microcode updating the device control and maintenance are enabled. Further development is carried by using Java Carriots Software development Kits (SWKs), by

introducing codes to the specific fields in web application. Unrestricted use is enabled but with partial functionality for up to 10 devices.

- **Digital Service Cloud:** It is an open IoT platform that empowers IoT innovators to have the same level of ownership over their customers as customers have over their products. This platform supports product launches, start-ups, global tech brands and the product innovations like, fostering the development of new innovations. Through this platform, individuals can create customised IoT solutions by connecting devices and utilizing a plug- and play dashboard, leveraging the readymade infrastructure offered by Digital Service Cloud. Subsequently, they only need to monitor and manage the product throughout its lifecycle. This facilitates the connection of the product to a vast network of millions of devices. The foundation of DSC encompasses the following steps:

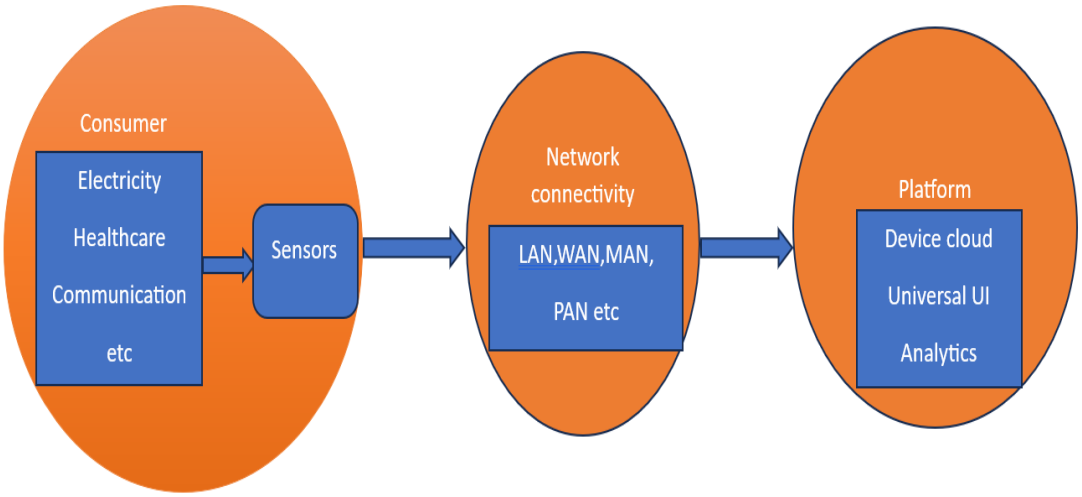

Figure 4: Digital Service Cloud Platform

The IoT application is readily available on the cloud and can be connected to the consumer devices equipped with various sensors thereby communicating with the application. For connecting the device over cloud various networking-connectivity techniques' do exist. Cloud delivers device management and application development.

- **Evrythng:** The inherently digital identity management platform, also known as "Product Relationship Management" (PRM) platform utilizes a semantic data store to alter the dynamic data profiles – digital identities of the products. This enables these products to effectively share data with authorised applications.

- **Exosite:** The cloud-based IoT platform that provides tools and services for data visualization as well as M2M communication. For sophisticated data processing and enterprise application integration, an open application programming interface (API) is available. Groove Streams is a cloud-based data analytics platform that facilitates the collecting of data from many sources, including Internet of Things devices. Data streams can be sent via open API as fixed values in the form of the point streams, or at

random or fixed intervals . Data is reorganized as the Derived Streams, or can be envisaged with the customizable charts and graphs. It is an open access platform. Various organizations, clients and increased/scalable data are the prominent features available with this platform.

- **Google Cloud Platform:** Google provides and utilizes highly scalable and reliable infrastructure for the coding, testing and installation of applications for innovators. Developers should focus more on the code, though; Google handles the remaining concerns with infrastructure, processing power and data storage. [8] Google is one of the best and most well-known IoT platform because it offers quick global networking, Google's BigData tool apps, and a pay as you use model. The Google Cloud platform supports the several cloud services that are available such as BigQuery, PubSub, RiptideIO, Firebase, Connecting Arduino and Firebase and Cassandra on Google Cloud Platform etc. Several features of the Google Cloud platform include: 1. Relies on Google's configuration 2. Equilibrium 3. Calculation 4. Services for packing 5. Assurance of security

- **IBM Blue mix:** The IBM Cloud platform seamlessly combines platform as a service (PaaS) with the infrastructure as a service (IaaS) to provide a unified experience. This platform is designed for scalability catering to both small development teams and large enterprise organizations. With data centres strategically located across the globe, solutions built on IBM Cloud are known for their speed and exceptional reliability.

  IBM Cloud offers a highly secure and open public cloud solution designed for business. It features a next-generation hybrid cloud platform that incorporates advanced data and AI capabilities. This platform allows users to access cloud services either through public cloud resources on-premises infrastructure, or the combination of both, depending on their specific requirements.

  The IoT foundation and IBM BlueMix platform work together to provide strong application access to IoT devices and data. Consequently, facilitating the rapid creation of mobile IoT applications, dashboard for data visualization and analytics applications. Prior to attaching device data to the apps., an IoT based application must be created using IBM Bluemix. IBM then offers a secure and RESTful API for this purpose. The IBM IoT foundation is the location where users can configure and oversee their linked devices. IBM IoT foundation uses Message Queuing Telemetry Transport protocol to securely handover device data to the cloud. [9] Some attributes of IBM Blue mix are: 1. Authoritative web control panel 2. Device Registering 3. Scaled connectivity 4. Safety 5. Proper storage of the data

- **Ifttt (If This Then That) Platform:** Ifttt a non-native IoT platform; it acts like an interoperability-as-a-service platform which permits operators to form network of conditional statements, known as "recipes", which are executes based on the specific events gathered from the diverse customers. This platform allows clients to create their own recipes, which can include actions involving various devices. Examples of IoT related recipes include "postpone garden watering if rain is expected tomorrow", and "receive and emergency call if smoke is detected", among others. Zapier and the

Yubnub are alternative services that provide similar functionality.

- **Kaaproject Platform:** It is an open-source IoT middleware platform which enables the management and the maintenance of device inventory, and also the real-time communication between the devices. It promotes use of structured data. It offers software development kits (SDKs) that are implanted into devices. Comprehensive keys which already exist for the, Raspberry Pi, Android, IoS and like many other platforms as well. This Platform is combined with the present data processing techniques like Oracle, mongoDB, Hadoop, and others.

- **LinkSmart Platform:** Formerly developed by Hydra EU project, LinkSmart Platform is an open-source middleware platform and also a service infrastructure for the building up of IoT applications. This project was introduced by Fraunhofer FIT(Fraunhofer Institute for Applied Information Technology). It comprises of the Device Connectors for mixing the various devices with diverse operations for specific/ precise devices, Supply Cataloguing for supervision of the devices and also the resources they are exposed to, Service Cataloguing (services which are used to access devices and resources) besides Global Connect tunnelling facility that permits accessibility to the devices outside the limitations of a private networking.

- **Mbed Platform:** Mbed platform treats all its connecting devices as embedded devices and focusses on tighter integration. It comprises of the domestic mbed like open -source i.e non-proprietary Operating System, architecture which is object oriented single threaded that is scaled down to the simplest, least cost and low power consumption devices. Mbed supports the devices which are formed on the Advanced RISC Machine and the Cortex-M microcontroller. The security, connectivity and the manageability which opts for the Open Mobile Alliance Lightweight M2M(protocol), a prevalent protocol used for the monitoring and supervision of the embedded devices are the Key or the prominent features lying with this platform.

- **Microsoft Azure cloud:** Microsoft claims that the first equipment to be used in the commercialisation of the Internet of Things is that which is most directly related to and affect the business. One will gain insight into the information associated to that by starting with the business substructure and adding devices and services as a result of technology advancement, which will enable them to create insightful and potent business decisions. IoT stands for Internet of Things, as a result. A valuable asset to any organization is data about its customers, sales, business processes and inventory. This data may be leveraged to power company operations. By aggregating, storing, and analysing data. Microsoft provides Microsoft Azure Intelligent System Service, a unified platform and services that shapes Internet of Things and applications. Solutions for data processing, storage, consumption and real time/ latent data research are provided by the cloud. IOT applications give linked devices the ability to be monitored, accessed remotely, have material distributed and control configuration.

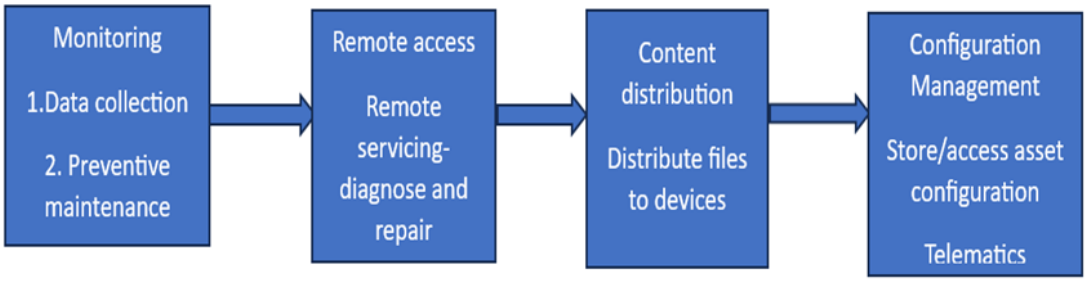

Figure 3: Various steps involved in Microsoft Azure Cloud

Microsoft Azure cloud connects of millions of devices and sensors with IoT application, thus providing big data analysis, social as well as business integration and dash boarding tools for IoT application to shape an IoT solution. Some key attributes are: 1. Figures out on what is already established 2. Does minor changes with bigger reflections 3. Reliable support 4. Skilled in growth and distribution 5.Connectivity to any device 6. Trained allies and commanding innovation 7.Easiest way to transform business

- **Nimbits:** It is a rule engine platform for M2M connectivity and also provides data logging service. For evolving Java it offers nimbits.io i.e. free software Java library, also, Network and Android solutions using Nimbits Server which act as a backend platform available. Geo and time engraved data and execution guidelines on that data like computation, email alerts, push notifications and like others are assembled by backend platform. It also makes the availability of the Allowed and Enterprise editions of the server. The Particle.io offers the computer hardware development kits and building up the macrocodes within the devices, by making use of web-based integrated development environment and installing the macrocodes. Later, from the collected data ParticleJS and Mobile SDK libraries are available to build web and mobile apps.,

- **PTC ThingWorx Platform:** Here, every device is characterized by so-called Thing Template, defining assets (for instance, mass), services (for instance, posting to Instagram) and events/happenings (for instance, malfunction). The devices have the agents to join with the IoT platform; various agents address the various types of devices. Things, business logics, visualizations, data storage, alliance and security essential for generating IoT application are modelled by the Composer applications/web-based applications. The assemblage/mashups can be gathered by the means of various thing templates, namely, UI widgets pre-wired to the thing templates. Later, the mashups are used for interactive IoT applications, real-time dashboards, collaborative workspaces and mobile interfaces as well. Thus, enabling definition, also, for execution of the processes a BPM component is involved, which starts with an alert or even a event for the remote connected devices. For facilitating distant diagnostics, regulated and scheduled software updation of the things device asset management tools are involved. It can be used for free but with limited functionality.

- **SensorCloud Platform:** IoT platform which is cloud based, used for procurement, visualization and investigation of data. This platform intrinsically chains the connectivity by LORD MicroStrain's wireless as well as wired sensors. Also, tools are available for visualization. Simple alerts are setup which are activated through the data threshold values. Provision of MathEngine analytics machines/tools with a very simple interface facilitates operations like FFTs, smoothing, filtering and interpolation etc.

- **ThingSpeak Platform:** Like SensorCloud, ThingSpeak Platform provides open channels to the existing data from the different devices which are available by the users. Thus, enabling triggering, talking back to the device which is carried over by the Hypertext Transfer Protocol (HTTP).

- **Zetta:** Zetta an open-source platform, was developed in Node.js to create Internet of Things servers that operate on cloud and geo-distributed servers. It also combines web sockets, reactive programming, and RESTful API. This combination is ideal for putting together different devices into real-time, data intensive applications. This works flawlessly on PCs, single-board computers, and cloud computing environments. With Zeta assistance Raspberry Pi(operating system) and PC's collaborate with cloud platforms like Heroku to create geo-distributed networks.

  Zetta's ability to redirect any device towards an API. Zeta works with microcontrollers such as Arduino and Spark Core. Core to offer the devices with a RESTful API both locally and in the cloud. Because Zeta is developer friendly, developers can directly access protocols and standards, enabling them to quickly and easily transform sensors, actuators and controllers into cutting-edge IoT applications and systems. Without running into significant problems. Zeta's architecture is designed with real-time applications in mind. It permits tracking system and device behaviour through code and provides tools for visualizing data to provide insights that can be put to use. Zeta enables the assembly of cloud, device, and smartphone apps into massively complex systems. Wearable computing, smart transportation, and home automation are a few applications of this system. [10]

- **Yaler:** This platform is pay-per-use and provides an infrastructure that secures access to embedded devices. It is compatible with any device that has a Transmission control protocol socket. One of the most affordable options suitable for business use is Yaler, which provides a hosted service on dedicated or devoted instances. Reaching the number of devices linked to a dedicated or devoted instances is made easier with a fixed yearly charge per relay instance. Secure sockets layer and transport layer security encryption are also included in this relay service. Using the cloud-based connectivity provider Yaler.net allows for the integration of a secure ad hoc assembly for data streaming.[11] Its primary goal is to give the application a better safe, reliable, and efficient execution environment. [12]

2. **Benefits of IOT:** IoT provides a number of benefits to organizations, permitting them to:

- Monitor their overall business developments
- Expand the customer experience

- Saving time and money
- Boost employee productivity
- Integrating and adapting business models
- Making better business decisions
- Generating more revenue.

3. **Discussion:** The main characteristics of IoT platforms are:

First is connectivity followed by the monitoring and maintaining of the devices which includes microcode updates, data visualizations, data analysis, elementary applications logic via alerts and triggers. By enabling the unrestricted access to the devices for the clients, which are even though positioned at the back of the firewall, a Network address translation (NAT) or mobile network router, connectivity as a service can be attained. Which in turn can collaborate through any device that offers a Transmission control protocol socket. [7]

The following are categories of existing IoT platforms that have been identified:

- **The Domain-specific platforms:** IoT platforms for facilitating the specific domain situations. Such platforms are often made on the topmost generic M2M connectivity providers. Serving specific purpose to the user for various tasks. Rachio (smart irrigation), nest (home automation), getcleverpet etc. are some examples of such platform.

- **Technology-specific IOT platforms:** Are the platforms which are accountable for explicit set of devices. These platforms are often looped and are created via the devices with proprietary (having owners) technology. Various instances are Mbed, supporting devices built on Advanced RISC Machine, Zatar, Nest, Cortex-M microcontroller, etc.

- **M2M:** Connectivity benefactors offering connectivity as a core service and with other limited features which are mostly related to the data analysis. Data acquisition and analysis are the main objective.

- **The Full scale generic IoT middlewares:** Like ThingWorx deliver wide series of connectivity/connecting services and facilitating the application expansion based on data acquisition through the devices and altered by the analytic tools/machines. This type of expansion is conceivable by making use of the unified growth environments, API’s or the linguistic interpreters for easy flow.

- Some other platforms which offer subsidiary services are categorized as important but they don’t facilitate M2M connectivity services and are not placed under IoT platforms in general. But since they do offer functionalities useful for IoT scenarios. Examples are Groove Streams and ifttt, interoperability-as-a service platform offering services.

Cross-platform interoperability and reuse are emerging with the rise of IoT platforms. To reduce conflicts among users/clients more technicality needs to be introduced.

III. CONCLUSIONS

The idea of the "future internet" is associated with the Internet of Things (or IoT), which supposes that every object in the universe -both living things like humans or animals and non-living ones- will be connected to the Internet. The idea behind IoT services is that any object on the network can be individually identified, its position and state can be determined, and it is accessible to services and the network itself. Intelligences to be added to the network is also part of this vision. It has an influence on our social, personal and professional lives and blends the actual world with the virtual world of digital technology. IoT will fundamentally alter the information and technology landscape creating a more comfortable, technologically advanced society for all of us. A range of prototyping computer, hardware boards, on-chip systems, radio frequency identification, sensors and ubiquitous networking capabilities are potential contributors to the advancement of the Internet of Things, improving its usability.[13]

Despite the fact that IoT platforms are still in their infancy according to Gartner's examination of emerging technologies, the survey's results indicate the cloud-based M2M connectivity services are well-established. M2M connectivity, data storage and analysis, data visualization, Interoperability-as-a-Service and other typical market segments are already well-known. An environment for developing IoT ecosystem application is conspicuously absent at this time. The aim should be to set up a novel IoT platform design, the central feature of which will be application development, even if its goal was to identify gaps in the current state of art of IoT platform as compared to the theoretical foundations and vision of IoT. The survey results have led to the definition of the following key concepts for the formal model-driven IoT software execution platform (InoTEP) development: - InoTEP is web application for Internet of Things devices that facilitates the creation and execution of IoT scenarios through a peer-to-peer methodology (several InoTEP instances installed on various devices, interacting through REST). With the help of Application-as-a-Service from InoTEP, any formal model (RDF/RDFS/OWL ontology) may be interpreted in a runtime to produce CRUD (create, read, update delete data) application. By utilizing the capabilities ontology, InoTEP allows for the formal definition of a devices sensing and /or actuator capacity.-RDF is a a transport protocol used by InoTEP for device -to-device communication (via REST).-InoTEP tries to match domain and capability ontologies with any external data supplied via its own REST interface. The selection of the enablers of the essential InoTEP components also takes into account the aforementioned concepts. The OntoApp system will be utilized to provide the Application-as-a-Service component; the W3C Sensor ontology [7] is being expanded to create a capabilities Ontology; an Active Semantic Model method will employed for the matching engine.

REFERENCES

[1] B. Nakhuva, T. Champaneria," Study of various internet of things platforms," International Journal of Computer Science & Engineering Survey (IJCSES) Vol.6, No.6, December 2015.
[2] **"**Platforms for the Internet of Things an Analysis of Existing Solutions."- A university paper.
[3] http://www.zatar.com/blog/what-is-an-iot-application-platform

[4] J.A.Stankovic, Research Directions for the Internet of Things. Internet of Things Journal, 1(1)3-9, 2014
[5] A. Gluhak, S. Krco, M. Nati, D. Pfisterer, N. Mitton, " A Survey on Facilities for Experimental Internet of Things Research". IEEE Communications Magazine, Institute of Electrical and Electronics Engineers, 49 (11), pp.58-6 ,2011
[6] https://www.geeksforgeeks.org/architecture-of-internet-of-things-iot
[7] M. Zdravković, M. Trajanović, J. Sarraipa, R. Jardim-Gonçalves, M. Lezoche, A. Aubry, H. Panetto, "Survey of Internet-of-Things platforms" ICIST , 216-220,2016
[8] https://cloud.google.com/solutions/iot/
[9] https://internetofthings.ibmcloud.com
[10] http://www.zettajs.org
[11] http://blog.yaler.net
[12] https://yaler.net/
[13] L. Coetzee and J. Eksteen, "The Internet of Things Promise for the Future an Introduction," IST Africa Conference Proceedings, pp. 1- 9, 2011.

