RESEARCH ARTICLE

"INTEGRATING CLOUD COMPUTING IN IOT (INTERNET OF THINGS) APPLICATIONS"

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Manuscript Info	*Abstract*
	The improvement in sensor gadgets, RFID innovation, and sensor systems has made the ground for the alleged Internet of Things (IoT). Rising in Internet advances, expanded registering force, and quick, inescapable computerized correspondences are bringing forth better approaches to oversee ability and resources and additionally new considering authoritative structures. The Internet of Things (IoT), which hopes to unite everything in our world under a common establishment, giving us control of the surrounding things. Data storage might be one of the main problems with the IoT. So, after thoroughly studying various research papers we had proposed a frameworkfor cloud computing integration with IoT. Rest of the paper contains the introduction after that next section contains the data storage problems in IoT with data storage solutions and finally conclusion of thepaper.

Introduction:-

The accompanying pattern in the time of handling will be outside the space of the standard desktop. In the Internet of Things (IoT) point of view, a basic number of the things that conceal us will be on the system in some edge. Radio Frequency Identification (RFID) and sensor sort out movements will ascend to meet this new test, in which data and correspondence structures are unclearly presented in the earth around us. These outcomes in the time of huge measures of information which must be secured, organized and showed in an anticipated, valuable, and effectively translate capable packaging [2]. The increase in information generation may rise to the storage question. And the good answer for data generation storage is the cloud computing. The main benefit to IoT data storage in connection with the cloud storage is anywhere access. In cloud computing, there is a huge room available for data storage.

The Internet of Things (IoT) still does not have a generally acknowledged definition. IoT at first considered RFID labeled physical articles. The vision developed to cover appropriated sensor systems, sensor-empowered gadgets and for the most part, savvy objects teaming up to bolster benefits that permit association with thephysical world [3]. The Internet of Things (IoT) suggests the interminably creating arrangement of physical articles that component an IP address for web accessibility, and the correspondence that happens between these things and other Internet-enabled contraptions and systems. All gadgets which are associated with Internet of Things are creating an enormous measure of information and information stockpiling for this monstrous measure of information is a test for IoT information. In next area answer for information stockpiling of IoT information is clarified.

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Related Work:-

IoT technology is the interconnection of different arranged implanted gadgets utilized as a part of the regular day to day existence coordinated into the Internet. It means to robotize the operation of various spaces, for example, home apparatuses, medicinal services frameworks, security and observation frameworks, modern frameworks, transportation frameworks, military frameworks, electrical frameworks, and numerous others. To accomplish a completely mechanized process, gadgets in the distinctive areas must be furnished with smaller scale controllers, handsets, and conventions to encourage and institutionalize their correspondence with each other and with outer substances [4]. The real thought behind it is that the Internet will exist as a consistent system of interconnected smart objects that structures a worldwide data and correspondence framework. The vision of the Internet of Things comprises in an immense, dynamic, and expandable system of networks, involving billions of substances. These substances all the while producing information and speak with each other. A side effect is then the monstrous volume of information that goes to the system. Ordinary, frameworks of various fields including fabricating, web-based social networking, or distributed computing wrench out gigabytes of information, which can contain content, pictures, recordings and then some [7]. The mix of all gadgets that interface with the system, which can be overseen from the web and thus give data progressively, and that one data is important and need storage. Another idea of IoT is the general thought of things, particularly ordinary items, which are coherent, unmistakable, locatable, addressable and controllable by means of the Internet - either through RFID, remote LAN, wide zone arrange, or by different means [11]. Shrewd accessibility with existing frameworks and setting careful figuring using framework resources is an essential bit of IoT. With the creating proximity of Wi-Fi and 4G-LTE remote Internet gets to, the progression towards all-inclusive information and correspondence frameworks is presently obvious. Nonetheless, for the Internet of Things vision to accomplishment totally develop, the enlisting perspective ought to go past standard adaptable figuring circumstances that usage PDAs and portables, and progress into partner every day existing articles and introducing information into our environment [2]. According to authors [10], Internet of Things (IoT) is about things associated withtheweb. A "thing" is any question of enthusiasm with some correspondence ability. Taking after the Service Oriented Architecture (SOA), "service" exemplification is given to the usefulness of things. These administrations can be utilized as whatever other administrations. Fundamental administrations are consolidated to per-shape complex errands or to assemble composite administrations. Checking and activation are two vital functionalities of IoT administrations. Observing suggests persistent executions, and activation is by activating. Nonstop executions normally include stream handling. Stream input information are subjected to an arrangement of calculations, organized as an information stream chart. The calculation is push-based: when clumps of info arrive, the calculation is activated.

IoT innovation incorporated twisting in the keen power matrix accompanies a cost of putting away and handling thevolume of information consistently. This information incorporates end clients stack request, control lines blames, system's parts status, booking vitality utilization, gauge conditions, progressed metering records, blackout administration records, endeavor resources, and numerous all the more Hence, service organizations must have the product and equipment abilities store, oversee, and handle the generated data effectively [4]. Authors [4] proposed cloud support data management smart cities and according to the authors the expanding significance of conveying smart city advances and applications, which brought about an expanding measure of information produced by these applications, the requirement for a comprehensive information administration framework expanded because of the need for effectively gathering and preparing these information's.

Internet of Things (IoT) Architecture and data storage:-

A key stride towards the accomplishment of the IoT vision is the reuse of information gathered from broadly dispersed heterogeneous sensor-enabled devices. In this level approach applications can utilize information in an incorporated way notwithstanding the specialized parts of every framework. Sensors in such case speak to a crucial approach to gathering information from their surroundings bringing conditions of certifiable things by creating setting information. Development of IoT and extension of web associated sensor-empowered gadgets has brought about monstrous measures of information raising the requirement for immense information stockpiling and figuring power. This brought about the rise of IoT cloud-based stages [3].

Internet of things architecture comprises one to one connected layers. Each layer is connected with each other. There are three layers in IoT system 1) Sensor layer 2) Network layer and 3) user layer [4]. Figure 1 shows the architecture of IoT which clearly indicate that Sensors like RFID and Barcodes are in sensor layer which is also called perception layer which includes a group of intelligent devices which can percept and detect devices and perception layer devices are connected to internet and devices communicate with each other through internet

communication. The second one layer is the network layer which is responsible for transmission of data packets of perception layer to the next layer. The third one layer is the application layer where approaching information is prepared to prompt experiences whereupon we can outline better power's dissemination and administration systems. Applications expect to make smart homes, brilliant urban areas, control framework observing, and request side vitality administration, coordination of conveyed power stockpiling, and joining of renewable vitality generators. The following subsections talk about these gathering of uses. But according to authors [5], there are four layers in IoT architecture and the fourth one layer is the cloud layer which is used for the data analysis, data collection, and data management.

According to [2] a standout between the bossiest out happens to this creating pitch is the making of an excellent measure of information stockpiling, proprietorship and expiry of the data get the opportunity to be fundamental issues. In the event that we considered utilizations of IoT huge numbers of the applications come in our mind like shrewd applications which incorporates keen homes, savvy urban communities, brilliant vehicular framework and so forth. These all smart objects are generating tons of data and unlimited storage room is required to store the data. So in IoT applications, data storage is a problem and solution for the aforementioned problem is cloud computing.
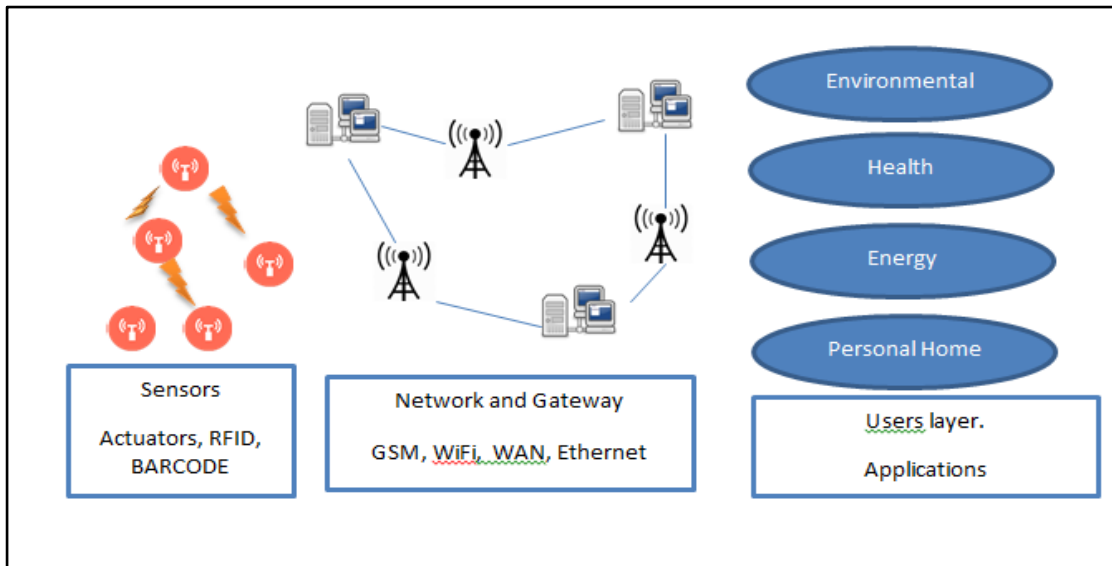

Figure 1:- Architecture of IoT.

Proposed framework:-
Internet of Things now a day is the most focused one research area. The World is getting smart day by day from smartphones to smart cities. All these smart gadgets, applications, smart homes, cities or smart hospitals are generating a huge amount of data. Data generated by IoT applications is useful and can be utilized scientifically. So, storage of this huge amount of data need a big room and for analysis of data expensive software is also required. Cloud can be the solution for IoT data as thecloud is providing unlimited storage and cloud analysis service also.
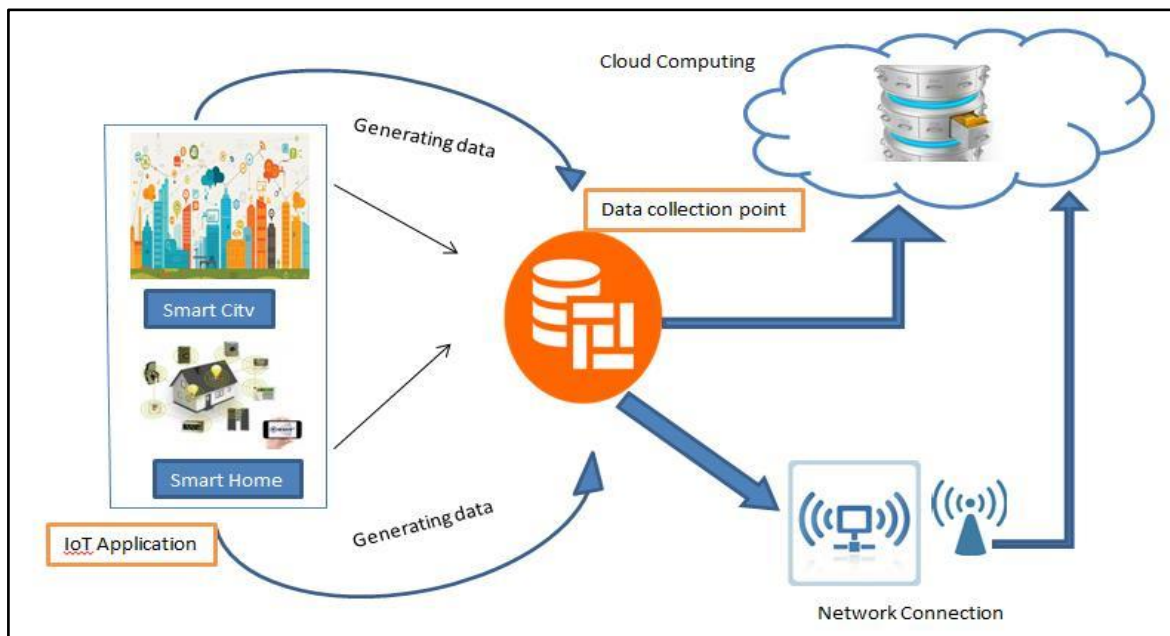
Cloud Storage for IoT data:-
Cloud computing is another innovation in an IT that roll out improvement, how, web and data framework to work everywhere throughout the world. Cloud figuring has virtual administrations like equipment, user interface and rationale application with an assortment of QoS (Quality of Service) rely on upon the need of the client. These administrations can be spread through the web Cloud registering can be the new option for organizations to keep up their information [13]. Cloud-based limit plans are ending up being continuously standard and in the years ahead, Cloud-based examination and representation stages are anticipated [2].

Presently days, associations utilize IoT gadgets to gather constant and ceaseless information and settle on better business choices to build consumer loyalty. An endeavor needs to store information produced by the Internet of Things and this information becomes exponentially and cloud storage is a solution for storing IoT data [5].

We proposed cloud storage for IoT data as shown in figure 2, which consists of following interconnected systems.

- **IoT smart application:** It can be any application of IoT. Such as smart city, smart home, smart organization and etc. Smart application of IoT follows the IoT architecture which described in section three and thesmart application includes sensors which percept the objects and generate data.
- **Data Collection Point (DCP):** DCP collects the data from the IoT smart application with the help of internet. DCP contains the nodes and each node of DCP connected separately with the different applications of IoT. For example Author [8] proposed a smart city system which includes smart water management systems, health care systems, other services, energy management systems, traffic management and transportation systems. Now each area needs separate data collection point.
- **Network Connections:** DCP is connected with the IoT smart applications to collect the data which is generated by IoT applications so DCP will transmit the data towards the storage devices for further process and here we propose the cloud storage so DCP will transmit the collected data to cloud systems. Now each DCP node is connected with the cloud systems. The network connection may include any internet connection like Wi-Fi, LAN and etc.
- **Cloud Storage:** Cloud storage provide the room for data which is generated by IoT applications. Here we use cloud storage because data which is generated by the smart applications is huge and need wide storage room.
- **Cloud data analysis:** Cloud is providing big data analysis, which excerpts the valuable information from agigantic amount of data as IoT applications are generating ahuge amount of data. In Big data analysis, it's hard to get bits of knowledge out of an enormous piece of information. In cloud computing, cloud analytics is a kind of cloud service which demonstrates where information examination and related administrations are performed in an open or private cloud. Cloud examination can allude to any information investigation or business knowledge handle that is done in a joint effort with a cloud specialist organization.

Figure 2:- Cloud data storage architecture for IoT

In figure 2 DCP is collecting the data from smart applications and DCP is connected to the network and cloud storage. Cloud storage is providing enough room for data storage of IoT applications. If DCPs are getting failed to connect with the internet so the DCPs cannot collect the data and will not be able to send the data to cloud storage. So the solution for it is the Gateway. Gateways are used as an intermediate between DCPs and storage room. The other problem might be the cloud storage in sense of data security as in cloud computing third party (cloud providers) is involved. The simple and easy solution for safe data storage over thecloudis the data encryption. DCPs send encrypted form of data to cloud storage so cloud providers will not be capable of misusing data. The main aim of proposed cloud data storage for IoT applications is to minimize the storage problem related to the IoT applications and IoT applications are using hardware devices for the data storage that may lead to limited data storage and can be costly too. So cloud storage is the solution without the need of any data storage device.

Conclusions:-

IoT applications are generating unlimited data and manual data storage is limited which is not enough for data storage. Cloud computing is providing the unlimited data storage with fewer management efforts. This research work is theoretical, in future works this research may include practical work like connecting any IoT application with cloud computing.

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