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Can Internet of Things (Cloud) Deliver True Business Transformation?

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Abstract:

In this paper, we envision IoT based Cloud to extract value other than the specified purpose for which it is to be utilized. It is hereby apprehended that different types of values, rather business values could efficiently be assimilated from the Internet of Things Cloud platforms. It is also investigated to identify numerous domains of applications that are currently being associated with the similar cloud platforms. A case study on various types of value generation methods has been performed. A novel Internet of Things Cloud stack is proposed to disseminate and aggregate the business values. Few research challenges are observed that shall need appropriate indulgence to generate more values out of Internet of Things based Cloud.

Keywords: IoT, cloud, value creation, business

1. Introduction

Recently, a large portion of the IT based industries is getting into a new buzz word “IoT Cloud” i.e., Internet of Things enabled Cloud. Various forms of cloud deployment models such as public, community, private, and hybrid can be seen around the day to day lively hood. According to a recent report, Internet of Things (IoT) is being popularized as a business concept among the leading IT market players of the world that counts the giants like Intel, Microsoft, CISCO, Google, IBM, Samsung, Apple, Oracle, ARM, Accenture, Amazon etc. [3]. Similarly, global consumers are eventually developing their affinity towards full-time connectivity to the internet based commodities such as smart phones, PDAs, tablets etc. In this context, new businesses policies are being intrigued by the overwhelming efficiency, business process implication, and revenue generation opportunities from the available IoT cloud solutions [2]. IDC has also estimated the market growth of IoT and enabled cloud services to reach up to \$7.1 trillion by 2020.

IoT being a new concept in industry, as well as in scientific community, the definition, protocol stack, and interoperability issues need to be revamped by the researchers, and work group members. Before going into the details, the definition of IoT and associated terms may be understood. IoT may be defined as “A global infrastructure for the information society enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies” [4].

The definition of “Cloud” is presented as prescribed by the NIST (National Institute of Standards and Technology) in its Special Publication of 7 pages (800-1457) in September, 2011.

According to it, “Cloud Computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction”.

Henceforth, the novel definition of IoT Cloud may be framed as “A model designed to facilitate the information society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies through ennoblement of ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction that leverage the need and heterogeneous connectivity issues of the user centric things in well-defined fashion”.

The filed applications of IoT cloud is diverse. The most promising area of application includes Industry 4.0 [7] or the smart industry, where the production systems and production sites are built to be intelligent, connected, and autonomous in nature. In smart home or living area, intelligent refrigerators, security cameras, intelligent lights, doors, even kitchen utensils are earning huge attentions, while smart energy meters, water meters and gas meters helping in optimized usage of the consumable resources. Similarly, smart city and vehicles are counting the bus timing, identifying less traffic routes, monitoring the status of parking space while smart health care systems are measuring vital signs of individual 24x7, helping in-taking preventive measure before the actual disease may prune itself into the body-connecting health to user, medical facilities and care givers [5][6][11]. In defence area [15], drones and high flight balloons do surveillance over the suspect region over the earth, while in smart agriculture area [17], dairy farming, bee keeping, cattle monitoring, vine yard monitoring are getting popular, further, information regarding resident or remote environmental parameters [18] are no longer difficult to be accessed, sports area is also being in assimilated with IoT cloud so as to set up a connectedecosystem [10][16]. Robotics is used to automate tiresome and continuous process of performing specific task. Apart from their specified jobs, a novel way to merge IoT with robotics has been recently proposed [14]. Model driven tree reference model [12] and generalized

domain model architecture [13] are proposed to cater the architectural value creation process in IoT. [21] propose a wood equilibrium moisture content measurement system using IoT to obtain value from the wood. Air borne 2.5 micro meter particles has been valued by IoT cloud based system until recently [22]. The ultimate goal of this paper is to provide a detailed concept so as to utilize IoT cloud platforms other than they are proposed to be used. Here, value creation mechanism has been repeatedly depicted for better understanding to what is meant for. "Value" is envisaged as performance that has been assigned to particular thing/object. In this paper, we provide a case study (See Figure 2) to make reader understand about what else can be achieved from a designated "thing". An IoT cloud stack is proposed to augment the needs of mere value generation from the attached devices/things with the system so as to enhance the capability of the envisaged setup. Few research challenges are discussed to motivate the researchers to continue the paths prescribed in this article.

This article is framed as follows. Section II illustrates about the various IoT cloud platforms available in current market and their association with business value creation. Section III describes about the technologies behind the IoT cloud. A similar framework has been proposed in this section. Section IV points out few issues to be taken care of by the scientific community, which is followed by Section V by concluding this paper.

2. IOT Cloud Platforms and Business Value Creation

Besides the giant IT farms as mentioned in section I, a few new comers have intruded themselves into the IoT cloud market. Though, IoT clouds vary in many factors, such as-real time data capture, data visualization, cloud type, data analytics, device configuration, API protocols, cost, big data etc.; the main purpose of IoT cloud is to facilitate intelligent integration and accessibility of the things/devices and associated surrounding eco system thus bridging the gap in the physical-digital divide. Among many Xively, Thing Speak, Plotly, Exosite, Grove Streams, Temboo, ThingWorx, Carriots, Nimbits, KAA, IBM IoT, Oracle Open IoT, Microsoft Research Lab of Things, Sensor Cloud, Ayla's IoT Cloud Fabric, Arrayent Connect TM, Aer Cloud, the things, io, See ControlIoT, Jasper Control Center etc. are to name a few that provide end-to-end IoT based analytical, storage, and real time processing supports and services to the customers and business farms.

The opportunities of IoT cloud providers are multi-fold. Figure 1 illustrates various areas where corporate investments are currently being sought for. It starts with leveraging a common platform for consumer-electronics and appliances design sector, while heterogeneous Machine-to-Machine (M2M) communication platform is cumulating the digital telephony among the devices, ubiquitous transportation systems are being implemented at various smart cities, smart health care facilitation gives the fully connected ambience to the patients, and environment monitoring is deliberately getting huge attention. Similarly, defence, security, and military forces seem to be keen at getting full exploration with IoT cloud using NFC (Near Field Communication) and innovative nanotechnology solutions at the war site. Smart agriculture systems are being popularized among the global farmers that use intelligence of IoT cloud platform to result into a beginning of a new era of precision cum optimized agriculture for better yield. Ambient intelligence is another area where IoT cloud is momentarily getting itself.

The original business value of IoT cloud lies on its actual process of dissemination with things/devices to the extraction of information for some specific purposes. Value creation primarily depends on the IoT cloud stack which will be discussed in next section. Figure 2 presents the logical schema of such value creation. It illustrates that IoT cloud based solutions typically combine physical things/devices with Information Technology (IT) in the form of available hardware and software. IoT stack plays the crucial role in resolving these issues. IoT cloud stack is placed on top of IoT stack which results in thing based functionalities either physical or local influence. Intelligent and assisted IoT cloud services empower user/customer/corporate farms to solicit in decision making, revenue generation, and inductive cum incumbent processes.

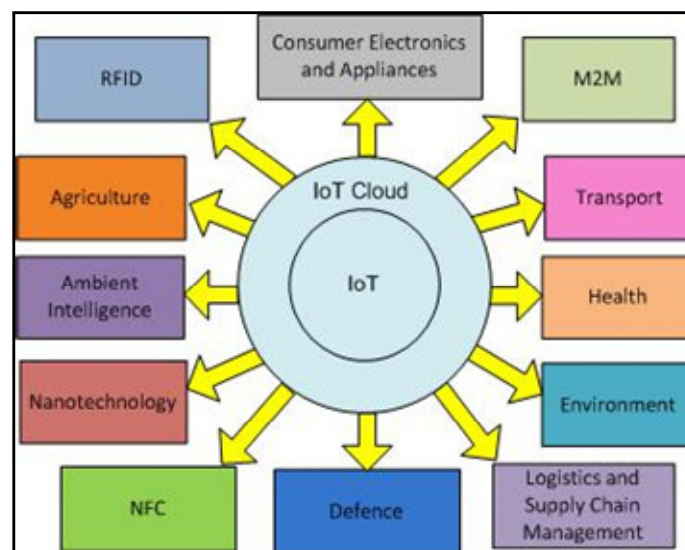


Figure 1: IoT Cloud based investments

For sake of understanding, let take the activities of bulb shown in Figure 2. Normally the physical task of a bulb is to enlightenits periphery. However, if the bulb is attached with a motion detector sensor by IoT cloud stack then it may detect the intervention of human movement in the active circumference, hence serving as an intelligent security system. Further, the information may be passed over the owner in form of e-mail, messages, or social status updates. Similarly, a bin (garbage collector) is primarily used for storage of excess elements of house hold or office. This thing based function may be enhanced with help of IoT cloud technology so that it can autonomously measure and monitor its current load in terms of weight, thus detect its levels of stocks. It may further notify the municipal or community service providers to replenish its contents into the dust trays while activating GPS facilities by providing plan for automatic optimized traffic route through the busy roads of the city. Normally a tractor is meant for towing mechanical devices for farming. However, this physical thing based function when attached with IoT cloud may allow the farmer to know about its predictive nature of maintenance and optimized driving sessions [1].

The value of things/devices are not only limited to the connected behavior of IoT as presented, but it may also be uplifted to a higher abstraction level of superseded flow of business where a cumulative IoT ecosystem would enhance the basic functionality into a larger context. For instance, a set of IoT cloud served bulbs may create intelligent lighting system, which could include active and passive Infra-Red (IR) movement detector, heat sensor etc. to extend the overall equipment efficiency of the lighting system. If it goes beyond the ordinary lighting system, it may be turned into a product system that could be attached with standards and upcoming telecommunication technologies, e.g., 2G, 3G, LTE (4G); besides Bluetooth Low Energy (BLE) 4.0, IEEE 802.11 b/g/n-Wi-Fi, even Zigbee antennas could be plugged-in so that the energy consumption and accidental incidents be easily monitored, analyzed, and apprehended. Data analytics in IoT cloud may improve the system’s throughput in optimized manner. This may incur real value in the lighting system that may replenish the necessity of stochastic behavior by strengthening the base of IoT cloud and provide vibration to other sectors of business.

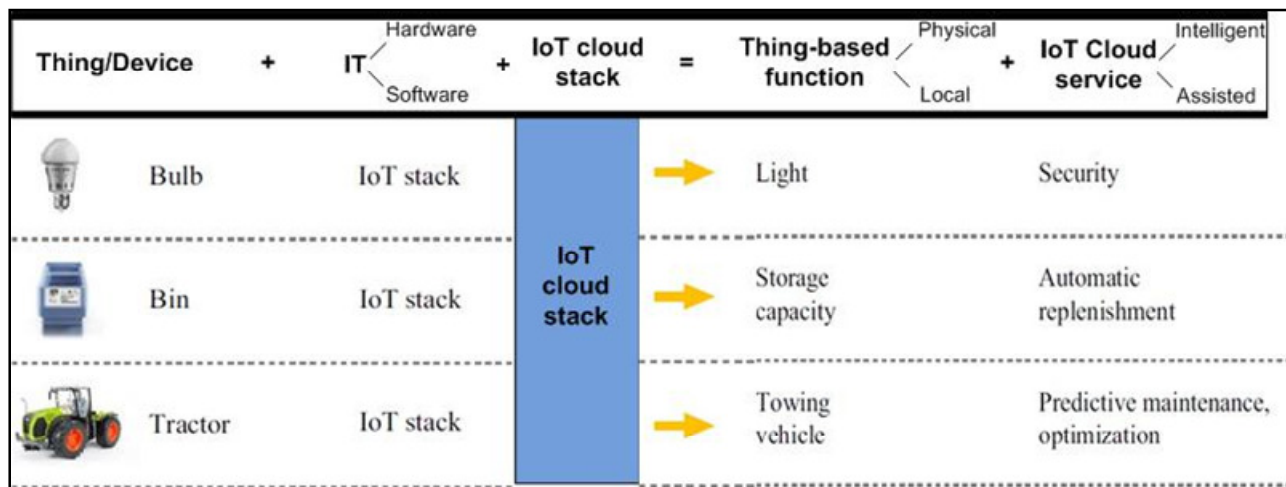


Figure 2: IoT Cloud based value generation (based on [8])

3. Technology Behind IOT Cloud Stack

It is evident that the proper functioning of business-value-incorporated connected device is comprised of a stringent layered stack of relevant technologies as show in Figure 3. The figure illustrates the principal activities of IoT cloud in a stack form on top of the IoT (includes things, network connectivity, and middleware; also supported by security issues while extends the interface of business computing) which paves the foundation of the prescribed system. The IoT cloud stack may be sub divided into four portions such as Infrastructure, Business applications, Business services, and Business processes. In infrastructure module, networking components such as switches, servers, storages devices, routers, virtualization techniques, operating system, and other elements are included, while, middleware and unstructured contents are placed over the database. Next higher level of abstraction is business applications layer that provides the APP based services. Modular (Java based composite/process app), packaged (CRM, ERP, HCM etc.), and dedicated business Support apps (BI, BPM, BAM etc.) do run over here. In IaaS layer, software attributed computing, definition, and networking attributes that do control the resources (hardware/software) for optimization, orchestration, and abstraction. Cloud operating environment is created on the next higher layer i.e., PaaS (Platform-as-a-Service), where various APIs are collaborated with the specific business related tasks; the result is obtained from SaaS layer, where collaborative market place is numerated by e-commerce, and external business ecosystems. In business services layer, web portal, product catalogue, inventory management, billing, product shipping etc. core components are present.

In business process layer, mainly transaction related operations are performed. Order management, cash handling, transaction, and procurement monitoring tasks get processed. This top most layer of IoT cloud stack holds interface with business users and customer providing sheer experience without exploring the underlying architecture of IoT based business protocols. Afore mentioned IoT cloud platform is capable to produce value out of connected objects in a modular fashion. Relevant corporate ancillaries act on the discussed IoT platform. To author's best knowledge, there is no standard IoT cloud stack is available till date, hence a multitude of versions are being opted by the users and business farms. Each platform varies from the other in terms of protocol inclusion and value generation methodologies.

4. Issues to be Solved

Being at the nascent stage of development the stack needs to be revised and re-assessed based on few issues-

4.1. Strategic Level

Here, new and innovative dimensions need to be sought to make better and efficient implementation of IoT cloud stack into the business. Corporate houses should rethink over the fundamental questions such as how to cover up the business around the newly developed technologies, how to frame the skeleton of the business rules, how to adapt the incremental benefits from the stack etc. so that production be enhanced with less effort.

4.2. Operational Level

Initial product development stage may now be redesigned for sake of leveraging space to new segments of improvisations including IoT. Questions such as, how to degenerate the initiation of product development in view of smart IoT connected devices, how to integrate the follow-ups with the existing business model, how to negotiate the sales procedure, how to market the deliverables in advanced variations etc. should be addressed.

4.3. Capacity Building

When talking about social involvement, IoT cloud stack shall revolutionize the human life in more ways than one. New knowledge and skills sets in nearly every field (statistics, engineering, medicine) should be set in such a way that skilled man power be generated; citizen participation is another factor that should be grown among the people of society towards the hands on experience of IoT; moreover, quality of livelihood need to be rebuilt while implying efficient urban-civic operations by a guaranteed framework of high yielding economic, societal and environmental values for future generations.

4.4. Technological Level

This area should better be highlighted to make IoT cloud based business process profit yielding by incorporating novel theories, structures, and applications, especially in the subject like computer science, and mathematics.

- Big data-High Volume, High Velocity, High Variety, High Veracity, and High Value (5V) conglomerate into a new term called Big Data problem. Exponential increase of usage patterns of mobile and sensor enabled devices have developed a space where enormous amount of heterogeneous data gets accumulated or trafficked through the network every instance of the clock. New methodologies, algorithms, and databases are to be framed to formulate the access and

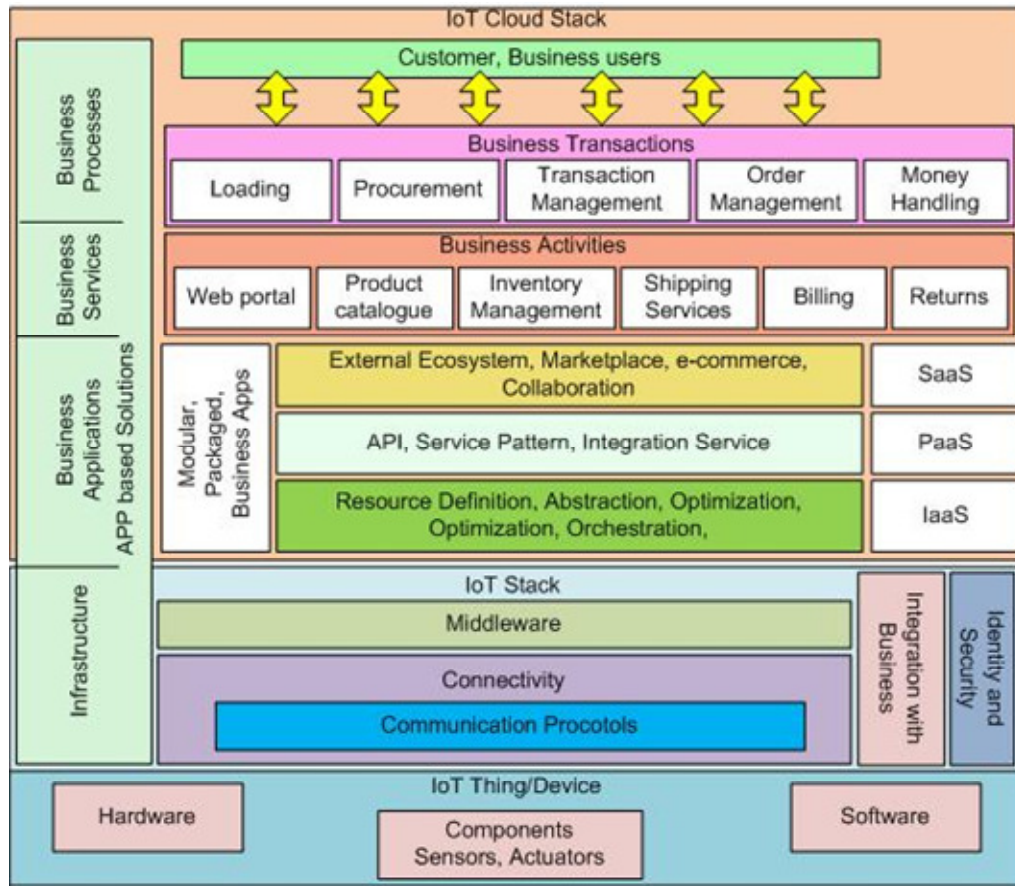


Figure 3: IoT Cloud stack based on IoT stack. manipulation problems in current scenario

- ICP- Format Identification, data Capture, and data Processing fields need to be revisited so as the IoT enabled connected environments may be facilitated by extracting valuable information from with it.
- Security- Privacy, security, and trust issues are no longer a local notion but trans-border measure of distributed data exchange and processing. Each device each people notion should be maintained to safeguard the proclamations of IoT cloud stack.

5. Conclusion

Value is an important parameter of any system. It tells about the functional capabilities of the system. Until recently, value generation from a specific task was concentrated into a certain portion of prescribed rate. Advent of IoT has made this path clear while integrating cloud platforms to itself. Things are now easily integrated to perform targeted job easily. In this paper, IoT cloud is proposed to extract more values (multiple functionalities) from a particular thing. This indeed paves the revenue generation process in business activities more beneficial for the organization. A case study is performed to demonstrate the value generation mechanism from the things associated with IoT cloud. Research challenges are discussed to motivate the scientific community to come forward in this regard.

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