International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-6, Issue-4)
Research Article
April 2017

Survey on Integration of Cloud Computing and Internet of Things Using Application Perspective

[1]S. Sivakumar, [2]V. Anuratha, [3]S. Gunasekaran
[1]Ph.D Research Scholar, Sree Saraswathi Thiyagaraja College, Pollachi, TN, India
[2]Head, PG Department of Computer Science, Sree Saraswathi Thiyagaraja College, Pollachi, TN, India
[3]Prof and Head, Department of CSE, Coimbatore Institute of Engineering and Technology, TN, India

Abstract—

Cloud computing is one of emerging virtualization technology used in the internet which provides unlimited computational, unlimited storage and service delivery in the Internet. IoT is also upcoming emerged field which limited with computational and storage capacity. Cloud computing technology is ubiquitous whereas IoT is pervasive in nature. By combining cloud computing and Internet of Things together have lot of scope for research. This paper discusses the study of integrating the Cloud computing technology with IoT using its general architecture and application. The needs for Integration of Cloud based Internet of Things are to describe in the literature and the concept of integration of Cloud and IoT executed using any one of the real world scenario or applications such as smart city, health care, agriculture, smart classroom, biometric things and video surveillance. This paper details and compares the various applications of Cloud with IoT using architecture model, protocols, service models, database technologies, sensors and algorithms which are used to improvise the model. Further this work can also be extended to provide a secure data transfer between cloud and IoT environment.

Keyword- Cloud Computing, Internet of Things (IOT), Integration of Cloud with IoT, CoT.

I. INTRODUCTION

Cloud Computing and Internet of Things (IoT) are two emerging field in modern internet era. Their massive adoptions and use in day to day life are expected to increase in future, making them important components of the future internet. Most of the papers proposed the model for cloud and IoT separately. IoT is generally characterized by real world and small things with limited storage and processing capacity which has the consequential issues regarding reliability, performance, security and privacy. At the same time, cloud computing has virtually unlimited capabilities such as storage, processing power, privacy and security. Cloud computing provides infinite computation and storage through a shared pool of resources, which can be dynamically allocated and easily obtained by any IoT application. This paper discusses the new architecture which solves IoT issues by integrated with cloud platform. The figure 1 shows the architectural views of IoT combined with Cloud computing where the application layer or end user application that run on smart phones, tablets and personal computer with control panels and visualization capabilities include end user interactions and dash boards. Cloud structures including storage of device data, analytics, process management for IoT system, visualization of data, host components for device management including a device registry. Cloud structure is bi-directionally connected with IoT system by Internet technologies using wired and wireless networks. Network connection is direct to the public network. Communication technology helped to power consumption and low range method using Bluetooth, WiFi, 2G, 3G and 4GLTE. IoT backbone structure connects IoT end point devices to the internet or public network. IoT end points contain a sensing system which used to gather the information about the environment.

A. Internet of Things Layers

Internet of things can be viewed into five divided different layers [1] with distinguished functionality. The associated devices for the different layers and their functionality are given in the Table I.

1).Perception Layer

This layer collects information through the sensing devices such as RFID, Zigbee and all kinds of sensors. Radio Frequency Identification (RFID) technology enables the design of microchips for wireless data communication and helps in automatic identification of anything they are attached to, acting as an electronic barcode

2).Network Layer

Network layer supports secure data transfer over the sensor networks and responsible for routing. It transfers the information through wireless technology such as Wi-Fi, Bluetooth, and Infrared etc. Hence, this layer is mainly responsible for transferring the information from perception layer to upper layer.

3).Middleware layer

In this layer the collected information can be stored in database cluster and performs information processing and based the result it takes required decision. This layer is responsible for service management related tasks.

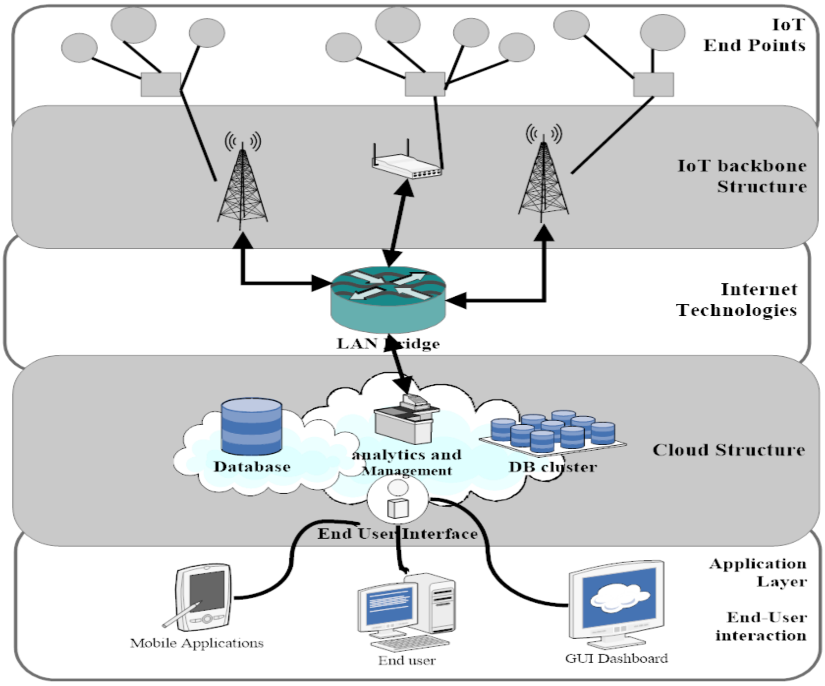

Figure 1. Cloud and Internet of Things Architecture

Table I Layers of Internet of Things

S. No	Layers	Functions	Device/Technology/Method
1	Perception layer	Over all device management viz identification &collection of specific information by each type of sensor devices	RFID,Zigbee,OR Code, Infrared,etc..
2	Network layer	Securely transfers and keeps the sensitive information confidential from sensor devices to the central information	3G,4G,UMTS,WiFi, WiMAX, RFID, Infrared, satellite, etc
3	Middleware layer	Middleware layer has two essential functions including service management and store the lower layer information into the database	This layer has capability to retrieve, process, compute information, and then automatically decide based on the computational results.
4	Application layer	Responsible for inclusive application management based on the processed information in the middleware layer	Smart postal, smart health, smart car, smart glasses, smart home, smart independent living, smart transportation etc..
5	Business layer	Amount of accurate data, received from lower layer and effective data analysis process	Practically graphs, business models flow charts, executive, reports, etc..

4).Application Layer

This layer provides the delivery of all services in various fields. It includes cloud computing, intelligent transportation, environmental monitoring etc. Management of application is smart home, smart city etc.

5).Business Layer

The top most layer business layer responsible for the analysis and it determines the future actions. This layer uses different analytics techniques of produce intelligent knowledge to the user and provides an interactive GUI to visualize the data gather.

B. Challenges in Cloud with IoT [9]

Botta Alessio et.al [9] describe the complementarity and Integrations of Cloud and IoT as in Table II and elucidate the issues in terms of computational speed , storage capacity and communication resources. The distinctiveness of IoT and Cloud from dissimilar schemes which moving the Cloud IoT paradigm are plotted in the TABLE II.

Table II Distinctiveness of IoT and Cloud

IoT	Cloud Computing
Pervasive	Ubiquitous
Real world	Virtual resources
Limited computational	Unlimited computational
Limited storage	Unlimited storage
Point of convergence	Service delivery
Big data source	Means to manage big data

The combination of Cloud Computing and IoT can enable ubiquitous sensing services and powerful processing of sensing data streams beyond the capability of individual things, thus stimulating innovations in both fields. For example, cloud platforms allow the sensing data to be stored and used intelligently for smart monitoring and actuation with the smart devices. Novel data fusion algorithms, machine learning methods, and artificial intelligence techniques can be implemented and run centralized or distributed on the cloud to achieve automated decision making. These will boost the development of new applications, such as smart cities, grids, and transportation systems. New challenges, however, arise when IoT meets cloud—there is an urgent need for novel network architectures that seamlessly integrate them, and protocols that facilitate big data streaming from IoT to the cloud. QoS and QoE, as well as data security, privacy, and reliability, are critical concerns during the integration.

The remainder of this paper organized as follows, Section II Reviews research on integrating Cloud Computing with Internet of Things. Section III describes comparative study among different applications using Cloud of Internet of Things. Finally discuss future directions for CloudIoT platform followed by conclusion.

II. REVIEWS RESEARCH ON INTEGRATING CLOUD COMPUTING WITH INTERNET OF THINGS

A. Integrating Internet of Things and Cloud Computing and the issues involved

Mohammad aazam et al, [2] propose a integration of IoT and Cloud Computing as a Cloud of Things (CoT). To provided enhancing more useful service provisioning to the user and efficient utilization of resources. This integration or working in coordination, termed here as Cloud of Things (CoT), involves some key challenges. More study on the impact of these issues, keeping in view the type of IoT and type of service being provided, can be done in future. Some of the data being generated by a specific IoT may require special type of storage and momentarily, the data may not be required. In that scenario, either the device must be stopped form generating data or gateway device must device when it is required to stop uploading the data and not to consume resources of the network and cloud for that while. It will also help in efficient utilization of power. For this purpose, the gateway device, connecting IoT to the Cloud, should having extra functionality to do a little processing before sending it to the internet and eventually to the CloudIoT based on the feedback from applications; gateway must decide the timings and type of development of application on it.

B. A Common Architecture for Integrating the Internet of Things with Cloud Computing

Jiehan Zhou et al [3] focus on a common approach to integrate the Internet of Things and Cloud Computing under the name of Cloud Things Architecture. Cloud Things architecture, Cloud-based Internet of Things platform which accommodates Cloud Things IaaS, PaaS, and SaaS for accelerating IoT application, development, and management. Cloud based internet of things different than conventional Internet of Things is basically the ability to develop, deploy, run, and manage things applications online via the cloud. Cloud based IoT platform and their interaction with the three cloud computing models of Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Fig.2 shows Cloud Things architecture is an online platform that allows system integrators and solution providers to leverage a complete Things application infrastructure for developing, deploying, operating, and composing things applications and services that consist of three major modules:

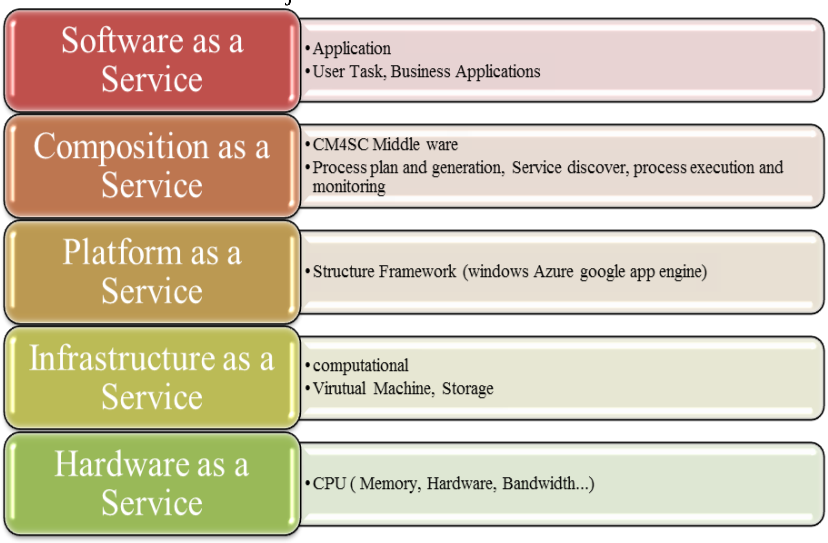

Fig.2 Cloud architecture for Dynamic Service Composition

The Cloud Things service platform for Things is a set of Cloud services (IaaS), allowing users to run any applications on Cloud hardware. The Cloud Things service platform for Things dramatically simplifies the application development, eliminates need for infrastructure development, shortens time to market, and reduces Things management and maintenance costs. The Cloud Things service platform offers users unique device management capabilities. It communicates directly with devices and provides storage to collect Things data and transmit Things events. Vast amount of sensor data can be processed, analyzed, and stored using the computational and storage resources of the Cloud. The Cloud Things service platform allows sharing of sensor resources by different users and applications under a flexible usage mode. The Cloud Things Developer Suite for Things is a set of Cloud service tools (PaaS) for Things application development. These tools include open Web service application programming interfaces (APIs), which provide complete development and deployment capabilities to Things developers. The Cloud Things Operating Portal for Things is a set of Cloud services (SaaS) that support deployment and handle or support specialized processing services including service subscription management, community coordination, Things connection, Things discovery, data intelligence, and Things composition.

C. Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS)

Antonio Puliafito, Antonio Celesti et al[4] deals with the automatic configuration of IoT devices in a secure way through the Cloud, in order to provide new added value services. Cloud-based architecture that allows IoT devices to interact with several federated Cloud providers. In this paper present two possible scenarios, that is, single Cloud and federated Cloud environments, interacting with IoT devices address specific issues of both. More design highlights on how to operate considering real open hardware and software products already available in the market. In this system presented analysing the different elements involved and how they interact with each other. Using the Arduino Yun for example, the author discussed how IoT devices can be extended to support the interaction with the Cloud. In particular, a system that allows Cloud provider to deploy the firmware and configure the device and on the one hand to perform sensed data transfer from the device to the Cloud provider. They are not ready yet to support complex Cloud scenarios.

D. Cloud-Assisted Data Fusion and Sensor Selection for Internet-of-Things

Bijarbooneh et al.,[5] this paper focus on cloud-based solution that takes into account the link quality and spatiotemporal correlation of data to minimize energy consumption by selecting sensors for sampling and relaying data. Multiphase adaptive sensing algorithm with belief propagation protocol, which can provide high data quality and reduce energy consumption by turning on only a small number of nodes in the network. It also uses belief propagation to perform inference and reconstruct the missing sensing data.

E. Twenty security considerations for Cloud-supported Internet of Things

Jatinder Singh et al.,[6] deals with on security considerations for IoT from the perspectives of Cloud tenants, end-users, and Cloud providers, in the context of wide-scale IoT proliferation, working across the range of IoT technologies. It analyses the current state of IoT-Cloud offerings to make explicit the security considerations that require further work.

F. Scalable Cloud–Sensor Architecture for the Internet of Things

Xu and Helal,[7] proposed that the massive scale of sensors and devices that will be deployed in smart cities of the future will be mind bugling. Without an ecosystem and a scalable architecture in place, it will be extremely difficult to manage or program such an expanding and massive IoT. The author introduces the cloud-edge beneath architecture and presents its salient scalability features and validation study based on an event-driven programming model.

G. Optimizing Cloud-Based Video Crowd sensing

Hong et al.,[8] the author proposed studies the optimal trans coding problem on wearable and mobile cameras and implement algorithm to optimally select the coding parameters to fit more videos at higher quality on wearable and mobile cameras. It then empirically investigates the throughput of different file transfer protocols from wearable and mobile devices to Cloud servers. A real-time algorithm is used to select the best protocol under diverse network conditions, so as to leverage the intermittent WiFi access. It finally looks into the performance of Cloud databases for sensor annotated videos, and implements a practical algorithm to search videos overlapping with a target geographical region.

H. On the Integration of Cloud Computing and Internet of Things

Alessio Botta, Walter de Donato et al.,[9] authors proposed analyzing and discussing the need for integration, how these issues been tackled in literature.

1) Storage Resources: IoT involves by definition a large amount of information source, which produce a huge amount of non-structured or semi-structured like data volume (data size), variety (data types), and velocity (data generation, frequency). It implies collecting, accessing, processing, visualizing, archiving, sharing and searching large amount of data. Offering virtually unlimited, low-cost, and on demand storage capacity, Cloud is the most convenient and cost effective solution to deal with data produced by IoT.

2) Computational Resources: IoT device have limited processing resources that do not allow on-site data processing. Data collected is usually transmitted to more powerful nodes where aggregation and processing is possible. But scalability is challenging to achieve without a proper infrastructure. The unlimited processing capabilities of cloud and its on-demand model allow IoT processing needs to be properly satisfied and enable analyses of unprecedented complexity. Data-driven decision making and prediction algorithms would be possible at low cost and would provide increasing revenues and reduced risks. *other* perspectives would be to perform real-time processing, to implement scalable, real time, collaborative, sensor-centric applications, to manage complex events and to implement task offloading for energy saving.

3) Communications: One of the requirements of IoT is to make IP-enabled devices communicate through dedicated hardware, and the support for such communication can be very expensive. Cloud offers an effective and cheap solution to connect, track and manage anything from anywhere at any time using customized portals and build-in apps.

4) New capabilities: IoT is characterized by a very high heterogeneity of devices, technologies, and protocols. Therefore, scalability, interoperability, efficiency, availability, and security can be very difficult to obtain. The integration with the cloud solves most of these problems also providing additional features such as case-of access, ease-of-use, and reduced deployment costs. Extension of cloud through the things as mentioned in the following TABLE

I. Novel Programming Model for IoT Applications on Cloud Platforms

Stefan Nastic,Sanjin Sehie et al.,[10] propose PatRICIA framework for programming cloud-scale IoT applications and presented programming abstractions; Intent, Intent Scope, and a set of runtime mechanisms to support developers in dealing with the complexity and diversity of IoT systems and to enable development of IoT applications in a cloud-scale manner. The set of proposed concepts is not exhaustive, but is sufficient to express many common behaviors of cloud-scale IoT applications. Also provides programming model flexibility for a scalable, more intuitive and efficient programming of the cloud-scale IoT applications.

J. Future Internet of Things and Cloud

Stefan Nastic, Sanjin Sehie et al.,[11] the authors propose the concept of software-defined IoT units-a novel approach to IoT cloud computing encapsulates fine-grained IoT resources and IoT capabilities in well-defined APIs in order to provide a unifies view on accessing, configuring and operating IoT cloud systems. Also gives framework for dynamic, on-demand provisioning and deploying such software-defined IoT cloud systems. By automating provisioning process and supporting managed configuration models.

Table III. Extension of Cloud through the Things

SaaS	Sensing as a Service	Providing ubiquitous access to sensor data.
SAaaS	Sensig and Actuation as a Service	Enabling automatic control logics implemented in the cloud.
SEaaS	Sensor Event as a Service	Dispatching messaging services triggered by sensor events.
SenaaS	Sensor as a Service	Enabling ubiquitous management of remote sensors.
DBaaS	DataBase as a Service	Enabling ubiquitous database management.
DaaS	Data as a Service	Providing ubiquitous access to any kind of data.
EaaS	Ethernet as a Service	Providing ubiquitous layer-2 connectivity to remote devices.
IPMaas	Identity and Policy Management as a Service	Enabling ubiquitous access to policy and identity management functionalities.
VSaaS	Video Surveillance as a Service	Providing ubiquitous access to recorded video and implementing complex analyses in the cloud.

K. Cloud of Things for Sensing-as-a-Service: Architecture, Algorithms, and Use Case

Sheriff Abdelwahab et al.,[12] propose a distributed sensing resource discovery and virtualization algorithm that efficiently deploy virtual sensor network on top of a subset of the selected IoT devices. Through analysis and simulations, the potential of the proposed solutions to realize virtual sensor networks with minimal physical resources, reduced communication overhead and low complexity. And Design, uncoordinated, distributed algorithm that relies on the selected sensors to estimate a set of parameters without requiring synchronization among the sensors.

L. Multi-objective Optimization in Cloud Brokering Systems for Connected Internet of Things

Teerawat Kumrai,kaoru Ota et al.[13] propose a multi-objective particle swarm optimization MOPSO scheme for cloud brokering to find the appropriate connections between clients and service providers to optimize the energy consumption of service providers, the profit of the cloud broker and the response time of requests from clients. Extensive simulations have been conducted, and the results demonstrate that the MOPSO is able to find appropriate sets of solutions for cloud brokering also compared the performance of the MOPSO with that of a well-known genetic algorithm (NSGA-II) and a random search algorithm. In this algorithm successfully reduces the response time and the energy consumption of the system and increases the profit of the cloud broker better than the NSGA-II and the random search algorithm. In future author conduct experiments under large-scale and well known cloud simulations as CloudSim, GreenCloud, icanCloud and complexity of the MOPSO as a parameter of energy consumption also find the operator to reduce the complexity of MOPSO.

M. Enhancing Dependability of Cloud-based IoT Services through Virtualization

Kashif Sana Dar et al.[14] propose a generic model based approach for enhancing these two important features at the application layer of cloud-based IoT systems. To design, and perform framework based on the concept of efficiently and simultaneously meet the dependability requirements of multiple cloud-based IoT applications. Virtualization approach supports a variety of different dependability patterns and implements them according to the demands of the target application. Virtualization framework using the Sixth Sense cloud platform with satisfactory evaluation results on dependability metrics, such as maximum availability and the probability of failure on demand.

III. APPLICATIONS

In this section Table IV describes a wide set of applications that are made possible or significantly improved thanks to the cloud with IoT paradigm.

Table IV Comparison the Parameters, Technologies and Algorithms used Internet of Things with Cloud Technologies in Various Applications

Applications	Architech/ Protocol/ Parameter	Service Model/ Front-end	Database Technology	Energy/ Reliability/ Efficiency	Internet Connection	IoT Device Sensor	Algorithm/ Software/ Security
Smart System: loT for University[15]	Two tire, Zigbee, Z-wave, Wi-Fi, Bluetooth LE	Mobile App	Big data	Energy lead to Saving	GPRS, 3G,WiFi, RJ 45, LAN, RFID, RF, Internet	Wireless, Zigbee, Gateway	Network Security, SMS alerts, E-mail
Agriculture and Forestry[16]	Three tire B/S,C/S PDA,IR, RFID	SaaS, PaaS, GPS	Knowledge Managemen t database	High Reliability, High Efficiency.	TD/GPRS	Barcodes, IR Sensor, RFID, Wireless Transmission network.	PDA Cycle Software core Calculation, Core Calculation R&D Platform, ES,DSS, 3S, Safety Traceability System.
Smart Classroom[17]	Three tire, Fidgeting Noise Sound level	Real-time feedback, Real Vs Laboratory world, Sound interaction integrity	Data Center	N/A	HTTP/ XML	PIR Sensor, Microphone Existence camera, Sound Sensor.	Signal Analysis & Classification
Smart Building with cloud computing[18]	Three tire Communicati on Standards Internet Protocol	SaaS, PaaS, IassS, Mobile, System, User Terminals	Big data	Computatio nal power, Enhance Reliability	N/A	Arduino Raspberry Pi	JS Service Under Arch Linux, JavaScript
Medical and Smart Health Care[19]	Multi tire, RFID,IPv6, TCP/IP	Smart Phone	Cloud storage Cloud SQL Big Query	Efficient storing, Processing, Retrieving valuable data.	3G,4G,AD SL DSLAM Routers WiFi	RTX-4100, AEKG, Arduino Raspberry Pi Blood oxygen sensor, Pulse oximatry, Smart phone Sensor.	Restful Services for iOS, Android, Java Script/ Machine Learning Algorithm
Smart Cities[20]	Three tier, Hierarchical Contextual Parameters	N/A	Firebase, Real time data, Bigdata, Service data	N/A	N/A	N/A	N/A
Pervasive Healthcare[21]	REST, API'S	PaaS, Pachube, Nimbits, Thing Speak	My SQL database	Scalabilty, Interoperab lity, Light weight access.	WiFi, Bluetooth model, GPRS,3G	Arduino, Mobile Sensor, Wearable Sensor	Java EE Application Dataencryption, Java Cryptographi, AES data Encryption
Laboratory Environment[22]	Three, HTTP	N/A	Simple database, Data.Spkarf un.com server	Realiable	Blue tooth Ethernet, Wireless	Arduino ARM Cortex M4 (Nucleo) Micro Controller boards.	Pubic key, Private key.
Medical	RMCPHI,	IaaS,	Big data	Improve	N/A	N/A	PSOSAA

Monitoring Systems[23]	Ant number Updating constant, Evaporation Parameter, Initial Temperative Population Size.	CloudSim		Efficiency of about 50%			Algorithm, ACO, SA.
Biometric Things[24]	Biometric Identification Architecture Cloud centric secure IOBT FAR EER	DAaaS, False Accept Rations (FAR) Mobile Application	Big data, Cloud-based Know -ledge base	Robustness of hard Biometrics	WiFi	N/A	Liveness detection Techniques, Finger print recognition, Multi-model bio-metric authentication techniques

IV. CONCLUSION

This paper compares the integration of Cloud with IoT by different authors' perceptions. IoT devices can perform more efficiently by using the services of Cloud and storing and analytical process of data which becomes very effective and powerful when using cloud technologies. Out of these models security features are lacking more when compare to the performance.

In this paper we have also compared the parameters, technologies and major algorithms used in ten different application of IoT combined with Cloud Technologies. The main motivation behind this survey is to provide a detailed study about the integration Cloud Computing and Internet of Things with perspective of applications, issues and challenges in IoT.

REFERENCES

[1] Tan, Lu, and Neng Wang. "Future internet: The internet of things." 2010 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE). Vol. 5. IEEE, 2010.

[2] Aazam, Mohammad, et al. "Cloud of Things: Integrating Internet of Things and cloud computing and the issues involved." Proceedings of 2014 11th International Bhurban Conference on Applied Sciences & Technology (IBCAST) Islamabad, Pakistan, 14th-18th January, 2014. IEEE, 2014.

[3] Zhou, Jiehan, et al. "Cloudthings: A common architecture for integrating the internet of things with cloud computing." Computer Supported Cooperative Work in Design (CSCWD), 2013 IEEE 17th International Conference on. IEEE, 2013.

[4] Distefano, Salvatore, Giovanni Merlino, and Antonio Puliafito. "Enabling the cloud of things." Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), 2012 Sixth International Conference on. IEEE, 2012.

[5] Hassani Bijarbooneh, Farshid. "Cloud-Assisted Data Fusion and Sensor Selection for Internet-of-Things." (2015).

[6] Singh, Jatinder, et al. "Twenty security considerations for cloud-supported Internet of Things." IEEE Internet of Things Journal 3.3 (2016): 269-284.

[7] Xu, Yi, and Abdelsalam Helal. "Scalable Cloud–Sensor Architecture for the Internet of Things." IEEE Internet of Things Journal 3.3 (2016): 285-298.

[8] Hong, Hua-Jun, et al. "Optimizing Cloud-Based Video Crowdsensing." IEEE Internet of Things Journal 3.3 (2016): 299-313.

[9] Botta Alessio, Walter De Donato, Valerio Persico, and Antonio Pescapé. "On the integration of cloud computing and internet of things." In *Future Internet of Things and Cloud (FiCloud), 2014 International Conference on*, pp. 23-30. IEEE, 2014.

[10] Nastic, Stefan, et al. "PatRICIA--A Novel Programming Model for IoT Applications on Cloud Platforms." 2013 IEEE 6th International Conference on Service-Oriented Computing and Applications. IEEE, 2013.

[11] Stefan Nastic,Sanjin Sehie et al., international conference on Future Internet of Things and Cloud.978-1-4799-4357-9/14,IEEE,2014.

[12] Abdelwahab, S. H. E. R. I. F., et al. "Cloud of Things for Sensing-as-a-Service: Architecture, Algorithms, and Use Case." (2012).

[13] Kumrai, Teerawat, et al. "Multi-objective Optimization in Cloud Brokering Systems for Connected Internet of Things." (2012).

[14] Dar, Kashif Sana, Amir Taherkordi, and Frank Eliassen. "Enhancing Dependability of Cloud-based IoT Services through Virtualization." 2016 IEEE First International Conference on Internet-of-Things Design and Implementation (IoTDI). IEEE, 2016.

[15] Sharma, Kamlesh, and T. Suryakanthi. "Smart system: Iot for university." Green Computing and Internet of Things (ICGCIoT), 2015 International Conference on. IEEE, 2015.

[16] Bo, Yifan, and Haiyan Wang. "The application of cloud computing and the internet of things in agriculture and forestry." Service Sciences (IJCSS), 2011 International Joint Conference on. IEEE, 2011.

[17] Gligorić, Nenad, Ana Uzelac, and Srdjan Krco. "Smart classroom: real-time feedback on lecture quality." Pervasive Computing and Communications Workshops (PERCOM Workshops), 2012 IEEE International Conference on. IEEE, 2012.

[18] Tragos, Elias Z., et al. "An IoT based intelligent building management system for ambient assisted living." 2015 IEEE International Conference on Communication Workshop (ICCW). IEEE, 2015.

[19] Ullah, Kaleem, Munam Ali Shah, and Sijing Zhang. "Effective ways to use Internet of Things in the field of medical and smart health care." 2016 International Conference on Intelligent Systems Engineering (ICISE). IEEE, 2016.

[20] Taherkordi, Amir, and Frank Eliassen. "Scalable modeling of cloud-based IoT services for smart cities." 2016 IEEE International Conference on Pervasive Computing and Communication Workshops (PerCom Workshops). IEEE, 2016.

[21] Doukas, Charalampos, and Ilias Maglogiannis. "Bringing IoT and cloud computing towards pervasive healthcare." Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), 2012 Sixth International Conference on. IEEE, 2012.

[22] Rahul Bhadoriya,Manju K.Chattopadhyay and Prakash W.Dandekar, “Low Cost IoT for Laboratory Environment”,2016 Symposium on Colossal Data Analysis and Networking(CDAN),978-1-5090-0669-4/16.2016 IEEE.

[23] Liu, Yu, et al. "Combination of Cloud Computing and Internet of Things (IOT) in Medical Monitoring Systems." management 8.12 (2015).

[24] Kantarci, Burak, Melike Erol-Kantarci, and Stephanie Schuckers. "Towards secure cloud-centric Internet of Biometric Things." Cloud Networking (CloudNet), 2015 IEEE 4th International Conference on. IEEE, 2015.

