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Cloud Computing: Review on Recent Research Progress and Issues

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ABSTRACT

The current trend of research in cloud computing is challenging and keenly marginal to understand for the researchers and the learners due to its over-cover and complementary nature towards the new technologies. Cloud Computing is part and parcel of its applications with a majority of the extending concepts of Fog Computing, Internet of Things (IoT) and Big Data Analytics. In the current scenario, it is difficult for a researcher to identify the domain applicability and interrelationship among all the specified areas. In view of this, the current study is planned to focus on the research requirements and the basics for majorly two categories of stakeholders – the learners and the researchers exploring the needs of users to cater by cloud and also the current research trends in cloud computing.

Key words: cloud computing; fog computing; internet of things; Big Data Analytics, Virtual machines, virtualization.

1. INTRODUCTION

Cloud Computing could be a quickly growing analysis domain due to its monumental benefits and simple to use anyplace data includes numerous challenges of the present analysis as laid out in [1][2].As the technology upgrades, the interdisciplinary nature of relevance ideas of technology strengthens the utilization of cloud in numerous domains [3][4][5][6].Fog computing, associate degree extension of cloud computing whereby it deals with shifting resources, services, and data to the sting of a network to decrease latency, network congestion and could be a comparatively covers numerous applications could be a recent analysis trend. Cloud computing and also the IoT each serve to extend potency in our everyday tasks, and these two have a complementary relationship. IoT gadgets has an intensive form of utilization areas including wellness trackers, rambles, cameras, wellbeing screens, and home mechanization for individual utilize, and transportation, co-ordinations, assembling and agribusiness applications for business or mechanical utilize. The IoT generates large amounts of data, and cloud computing provides a pathway for that data to visit its destination [6]. Several organizations and institutions creating lots of data on daily, social media could be a fully completely different world, wherever each marketers and customary users generate numerous data every day eventually become tough to manage. However cloud computing and big data together provides a solution that is scalable and extends to big data and business analytics.

2. CLOUD BASICS, SERVICE PROVIDERS AND USERS

Cloud Computing is a pool of resources[1] which are used by many public and private sectors like Small and Medium Enterprises, Universities, Hospitals, and IT companies to store data and to use different services based on the resources required like different software, Operating systems, Processors(CPU), different tools and applications etc. Cloud service providers (CSP)[7][8] are the companies that offer various network services, infrastructure, or business applications in the cloud with its huge data centers. A server farm is a place where it consolidates segments, for example, servers, correspondence media, and information storerooms. The following figure 1 shows data centers of various cloud providers.
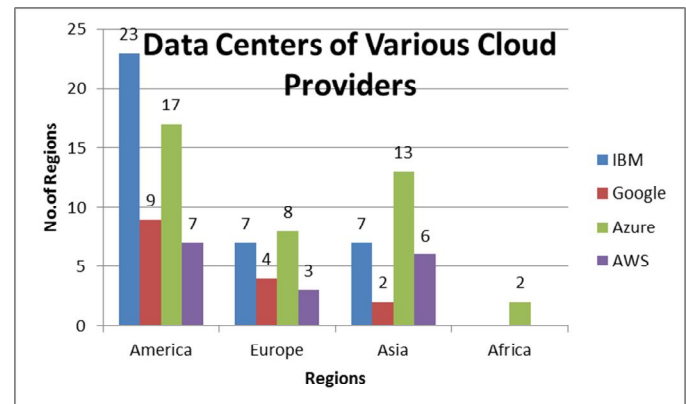

Figure 1: No.of Data Center regions of various Cloud Service Providers

There are different cloud service providers(CSP), [2][[7][8] for example, Amazon, Salesforce, Microsoft, Google, IBM, Facebook, Yahoo, Twitter, Rackspace open cloud.

2.1Models of Cloud Services

Cloud Service providers [7][8][9] services are categories as (figure 2)

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a service (IaaS)

Figure.2 Vaious Cloud Service Models and notion of its use.

The SaaS provides application [7] software to implement the day-to-day activities of a business. The PaaS provides the platform to perform various business operations. The IaaS provide physical or virtual device access. Table-1 [7][8][9] Provides the details of services offered by various cloud service providers [10][11][12].

Table.1 Models of Cloud Services offered by various Service Providers[11][12][13].

Service Provider/ Service Models	IaaS	PaaS	SaaS
Amazon	EC2 (Elastic Cloud Compute)	AWS Elastic Beanstalk	Amazon Web Services
HP	Enterprise Services Cloud – Compute	Cloud Application Delivery	HP Software as a Service
IBM	SmartCloud Enterprise	SmartCloud Application Services	SaaS products
Microsoft	Microsoft Private Cloud	Windows Azure	MS Office 365
JoyentCloud	SmartMachines	Node.js	
Rackspace	Cloud Servers	Cloud Sites	Email & Apps
VMware	VMware	VMware vs Fabric	SlideRocket
Salesforce.com		Force.com	Salesforce.com
Google	Google Compute Engine	Google App Engine	Google Aps

2.2 Cloud Deployment Models

A cloud deployment model [1] represents a specific type of cloud environment, primarily distinguished by ownership, size, and access [2][9].Each of the service providers offers cloud deployment models based on the characteristics of tasks and the requirements of users.

Public Cloud: The whole computing infrastructure located outside of an organization and anyone can access it but none of the users has physical control over the infrastructure called the public cloud [9]. The features of the public cloud are cost-effective, high scalability, reliability, flexibility and location independence. For instance,[11][12] Amazon Elastic Compute Cloud (EC2), Google AppEngine, Windows Azure Services Platform provides the services of the public cloud.

Private Cloud: In this model,[9] private cloud infrastructure provisioned for exclusive use by a single organization. Provides increased security, reliability, and performance. For instance, Microsoft Azure Stack, Helion CloudSystem hardware, Hyper-V virtualization, NetApp Private Storage (NPS), IBM Storage, IBM Cloud Managed Services [11][12].

Hybrid Cloud: A hybrid cloud includes resources from both private and public and henceforth unquestionably turn into the requested decision for ventures. For instance, general computing enterprise could choose its own server farm when at that point there is a requirement for secure access to data. In other cases, when security is not a major barrier the organization can make use of external services of data centers [1]. It is more scalable, flexible and secure. For instance[11][12] IBM Z hybrid cloud, IBM's Bluemix, Rackconnect, HP's Rightmix.

Community Cloud: In the Community Cloud could be a style between many organizations that belong to a particular network, i.e. banks and trading firms. Community cloud is proper for organizations and businesses that work on joint endeavors, tenders or research.

2.3 Products offered by Cloud Service Providers

Each Cloud Service Provider has various products like data storage, networking, security tools etc. The user can choose any product based on the application requirements. Below table 2,3 and 4 shows various cloud products of IBM, Google, Microsoft Azure [8][15][16][17].

Table.2 List of IBM Products

IBM Products		
1.Computing	6.Networking	11.Storage
2.Containers	7.Developers Tools	12.Analytics
3.Internet of Things	8.Enterprise Integration	13.Azure Stack
4.Web+mobile	9.Management Tools	14.Database
5.AI+Machine Learning	10.Security+Identity	

Table.3 List of Google Products

Google Products

1.Computing	5.Data Transfer	9.Management Tools
2.Storage	6.Cloud AI	10.Developer Tools
3.Networking	7.API Platform and Ecosystems	11.Internet of Things
4.Big Data	8.Security+Identity	

Table.4 List of Microsoft Azure Products

Microsoft Azure Products

1.Computing	6.Containers	11.Management Tools
2.Storage	7.Database	12.Developer Tools
3.Networking	8.Analytics	13.Internet of Things
4.Web+mobile	9.AI+Machine Learning	14.Enterprise Integration
5.Security+Identity	10.Azure Stack	

2.4 Cloud services and pricing

While choosing any cloud the user needs to focus on two important considerations. The first is whether the cloud serves to carry out the organizational need or not and the other is how much price need to be incurred for the services used. Cloud Service Providers charge the customers based on the demand of services and for the used instances or resources through a pay-as-you-go model without any requirement for long-term contracts (shown in figure 3, figure 4, figure 5 and figure 6). Some of the CSP [7][8] like Amazon Web Services (AWS) cloud, IBM cloud, Azure cloud, Google cloud offer free tiers in which the user can utilize some cloud services with certain limitations. Once the usage exceeds the limit it will be charged pay-per-use system. These free tiers are more useful for individuals, small firms and other organizations to experience cloud environment before purchasing the [8][18][19][20][21][22][23].
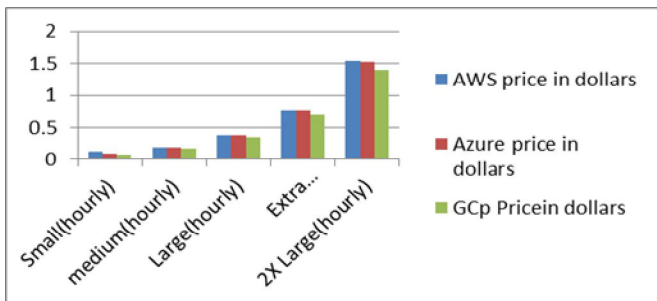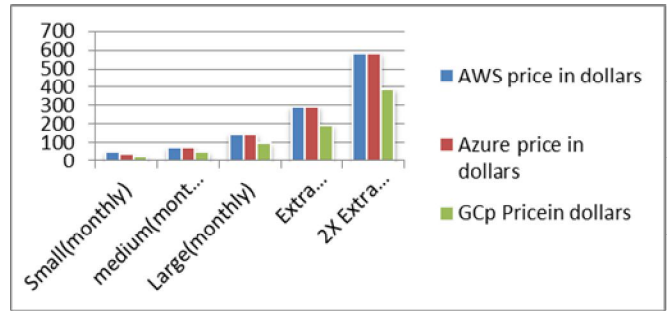

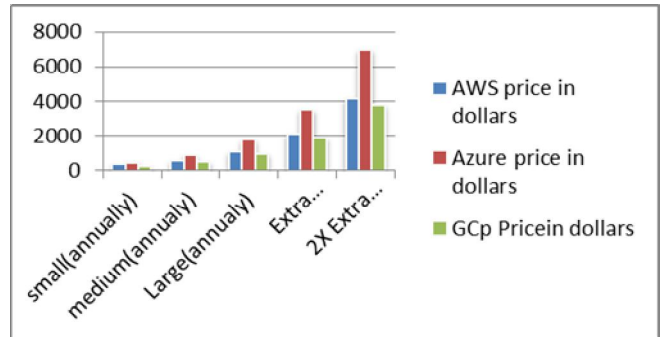**Figure.4** Comparison of various Cloud services and monthly pricing.

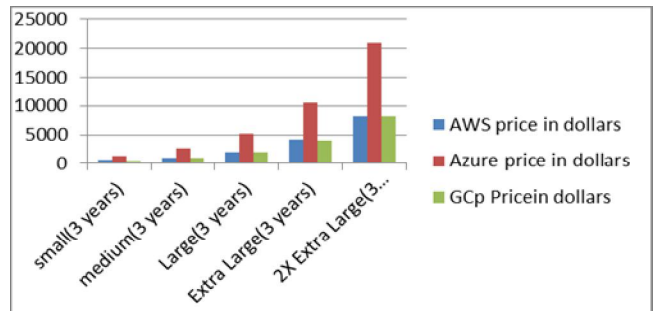**Figure.5** Comparison of various Cloud services and annually pricing.

Figure.6 Comparison of various Cloud services and yearly pricing.

2.5 Cloud Users

Cloud Computing reduces the capital expenditure for maintaining their own data centers (servers, storage, network, security, maintenance etc). This technology is widely used by many small and medium enterprises to run their organizations more efficiently, to provide better service to their customers, and dramatically increase their overall profit margins. Below mention table 5 shows some users of various clouds.

Figure.3 Comparison of various Cloud services and hourly pricing.

Table. 5 Users of various clouds and Purpose of usage

Cloud Service Provider (CSP)	Instiution	Purpose
Amazon Web Services (AWS)	Unilever	Extensive reinforcement, disaster recovery and arrangement of foundation.
	GE Oil & Gas	To store and transport the information, and for information examination and preparing.
	Kellogg's	To run the SAP application on AWS, rather than on-premises
	Met Office	Deployed a large application called 'The Weather Cloud' on AWS
	Netflix	IT operations, including transactions, customer databases
	Intuit	IT operations, including transactions, customer databases
	Hertz	IT operations, including transactions, customer databases
	Time	IT operations, including transactions, customer databases
International Business Machines Corporation (IBM) Cloud	Caterpillar	e-commerce platform
	Princess Cruises	SoftLayer cloud infrastructure for analysing the impact of local weather on store and category sales.
	Tangerine Bank	Enhances its custom by mobile banking app
	The Hartford	Delivers IT services
	Delhaize	SoftLayer cloud infrastructure for analysing the impact of local weather on store and category sales.
	.Pearson	Delivers education worldwide.
Google	JDA Software	Google Cloud Platform for application development and delivery.
	Coca Cola	To store data ,IT operations, new cloud tools for testing, computing workload
	HTC	Store and fast access to data and apps
	Best Buy	app development Giftag
	Sungard	Google Cloud Storage to store the data, Google BigTable to structure the data, and Google Big Query to analyze it.
Microsoft Azure	GeekWire	Use best-of-breed Linux-based solutions including NGINX, PHP-FPM, Redis, Docker, and MySQL.
	ASOS	e-commerce microservices platform
	Swiss Re	PaaS environment
	Mosaic	SAP enterprise application

		software,(on helping companies operate their business processes, and seemingly unrelated to mining and manufacturing)
	GE Healthcare	Delivers Core Customer Solutions (patient monitoring , medical diagnostics, drug discovery etc.)

3. CURRENT RESEARCH TRENDS AND ISSUES

3.1 Current Trends of Cloud Research

In order to raise the growth in the economy of the country through communication and technology upgrades, the fundamental connecting component is a cloud in order to streamline the business transactions. The computational world relies on the cloud for all kinds of analytics and corresponding decision making. Hence, cloud usage has become a basic requirement of every human's in their day-to-day activities. Most of the cloud functionality need to be observed and addressed based on a few important areas which involve Continuous research upgrades even after decades of implementations using cloud technology. The following areas
of research are widely focused in view of the proliferation of world [2][7][9][13].

Load Balancing: Load Balancing allows cloud computing to "scale up to increasing demand". To achieve the desired goal load balancing provides several algorithms. Some algorithms aim at getting maximum resource utilization, minimum response time and achieve higher throughput etc.

Energy Optimization: Energy efficiency in distributed computing is winding up vital because of the utilization of distributed computing in each field. With the quick advancement of distributed computing, the server farm is getting to be bigger in scale and devours more energy. Thus energy consumption has become a critical concern in designing modern Cloud systems.

Security and Privacy: Despite Cloud computing offers various services at the low cost still some of the users hesitate to use cloud services due to some security problems related to cloud. Those issues are Data Loss, Data Breaches: Due to malicious attack [2] and generally in light of server crashes. And also damaging events sort of a tremor and fireplace may be the needs behind data misfortune. Malicious Insiders: [7][37] for example, database managers or representatives of the organization offering cloud services, accomplices, and Contractors who have access to the data. Account or Service Hijacking: The unauthorized user who has a password will access the clients' data by stealing it, altering it, or deleting it, or for the benefit of selling it to others. Denial of Service: Some organizations need their frameworks to be accessible all the time since accessibility is important to them due to the essential administrations they provide [10].

Scheduling for Resource Optimization: Effective execution of undertaking planning for mists is a standout amongst the most imperative research issues which should be centered around. Distributed computing encourage tremendous changes in the IT world [1][2] to builds the greatest benefits. For this reason, task scheduling plays a most essential responsibility in current researchers to supply productive use of cloud services, to get greatest ROI (Return on Investment) from those assets.

Virtualization: One of the principle cost sparing, equipment decreasing, vitality sparing procedures utilized by cloud suppliers is virtualization. Virtualization assumes a critical job in distributed computing innovation, which permits sharing a solitary physical occurrence of an asset or an application among various clients and associations. [1][9][24].

4. LITERATURE SURVEY

The current study further focuses on the current research issues in the above-mentioned research areas. A survey of the recent works carried by the authors is summarized to identify the scope of extensions for the upcoming researchers.

Table 6: Existing Research Contribution on Cloud Resource Management ,Security and privacy of data

S.No	Authors/ Years	Contributions	Merits	Demerits/Challenges
1	**Nomula Suresh et al.[25] 2016**	Reformulated the normal conception of load balancing and distributed the work equally to the smallest set of servers at an optimum energy. [25].	Provides [25] an optimal energy level, while observing (Quality of Service) QoS constraints, such as the response time.	SaaS applications once there's instant demand for resources cannot be accurately foretold and systems are forced to work in an exceedingly non-optimal region [25]. PaaS applications last extended periods of your time and also the smallest set of servers operating at an optimal power level to ensure the specified turnaround may be determined accurately. This is also true for many IaaS applications in the area of computational science and engineering[25].
2	**Dorian Minarolli et al.[26] 2017**	Addresses the challenge of how to detect a overloaded host to initiate live migration in time[26].	It [26] reduces Virtual Machine (VM) Service level Agreement (SLA) violations and energy consumption.	The sudden and sharp increaments in the load cannot be predicted easily[26].
3	**Jian Yang et al.[27] 2017**	Addressed the problem of resource allocation in cloud computing environment [27].	The proposed algorithm [27] co-ordinate different outline goals, and increases the performances of resource allocation in both private and public clouds.	The proposed algorithm can be extended to other data processing frameworks, for instance, Storm, Spark [27]. And Docker,[27] is a hot compartment innovation with highlights of solid seclusion, solid movability, and more lightweight than the virtual machine.
4	**Sukhpal et al.[28] 2017**	Addressed the challenge of resource management in large heterogeneous	Proposed algorithm [28] increases security,vitality proficiency, unwavering quality and accessibility of cloud-based services in real cloud platforms.	The proposed algorithm can be extended to include affectability of presumptions in weight figuring of both homogenous and heterogeneous cloud workloads [28]. And by recognizing the relationship between

		and distributed environment [28].		workload burden (designs) and the resource demands for computing, storage, and network resources) in the cloud which will additionally enhance the execution [28].
5	**Samir Elmougy et.al[29] 2017**	Addressed the problem of long tasks starvation in resource scheduling by using Shortest-Job-First (SJF) and Round Robin (RR) schedulers [29].	The proposed algorithm [29] has better performance with the existing one.	The proposed algorithm for long task starvation can be extended with other scheduling algorithms to increase performance of Resource Management [29].
6	**Mahdi Mollamotalebi et al.[30] 2016**	Addressed the challenge to provide quick access to resources to handle different application request and at the same time minimizing the energy consumed [30].	The proposed method [30] handles the specified objectives all the more adequately contrasted with different methodologies and it(ESDR) has enhanced the score around 40% contrasted with Energy-Reduction and SLAV-Reduction with existing methodologies.	The proposed work [30] primarily depends on CPU burdens to gauge host or VM loads. In future works, [30]the memory and data transfer capacity burdens can be considered also.
7	**Bo Lang et al.[31] 2017**	Addressed the data protection problem in cloud computing [31].	Proposed method [31] does not add any security risk or computational overhead and improves the access control capabilities in a cloud environment.	The Proposed method addressed the data protection in public clouds,the work can be extended with other deployment models [31].
8	**Xiaoyu Li et al.[32] 2016**	Address data access management for multi authority cloud storage systems [32].	[32] planned two-factor protection mechanism to enhances the confidentiality of outsourced data in multi-authority cloud storage systems.Security examination and experimental result shows, the proposed conspire is suitable to address the data access control for multi-authority cloud storage frameworks.	Many features are not yet addressed.
9	**Yubin Xia et al.[33], 2017**	Addressed security accidents, like data leakages or abuses, due to the	Presented [33] a hardware-software framework referred to as Kite that permits the user to totally management the data and execution of the outsourced virtual appliance within the presence of untrusted	The analysis and result show that the performance overhead is small [33].

		malicious insiders in a computing environment [33].	hypervisor and even physical attacks.	
10	**Tania Lorido et al.[34] 2017**	Addressed the problem of noisy-neighbour in cloud data canter environment [34].	Proposed algorithm [34] is a lightweight and viable solution to recognize noisy-neighbor.	This anomaly recognition algorithm can be extended for pattern detection in the pre-alarm time series, to filter out false positives [34].
11	**Abdul Razaque et al.[35] 2017**	Addressed the security of outsourced data in cloud [35].	The proposed PPM [35] is very proficient for safeguarding the data in distributed computing condition.	Many features are not yet addressed.
12	**Meikang Qil et al.[36] 2017**	allengeable task from malicious	Proposed Privacy-Preserving Smart Storage (PS2) model [36] prevents financial enterprises from insiders' massive data mining-based attacks.	The Proposed model can be considered for other sectors or enterprises to avoid data mining attacks from insiders [36].

5. CONCLUSION

In the current world, technology drives the society. The baseline of which is the cloud technology that piles up the other new technologies like Fog Computing and IoT .The current study focus on the extended knowledge on cloud existence and its research trends. The study elaborates the details and comparisons of various cloud service providers (CSP) with respect to their datacenters, services, models, products, users. The current research trends in cloud are based on the issues related to Load Balancing, Energy Optimization, Security& Privacy, Scheduling for Resource Optimization. All research issues are tabulated and the current works carried out are surveyed. It is observed that cloud computing is an ever green topic being extended and helpful for the researchers in the area of Fog Computing and IoT even.

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