MBID2103-8173-1
INNOVATION AND DESIGN THINKING

THE PANDEMIC ACCELERATED CLOUD:

Explore the impact on Cloud Computing During COVID-19 pandemic and strategic reaction

Student Name : Hemal Samaranayake

Student ID   : 105123

Table of Contents

1.0 How does cloud computing services effect on Business organizations due to COVID-19 pandemic

In the modern era Cloud Computing Technology in Information Technology (IT) is an important and most powerful internet based architecture in computation. It is compiled with integrated networked hardware, software and internet infrastructure. Cloud computing is a collection of networks. User could use any modality of cloud computing as he demands boundlessly. The users ordinary prefer a moderator for the cloud computing service, instead of setting their own physical infrastructure. The payments are done only for the service they used. In order to reduce the workload in the cloud computing, workload could be shifted. Load of local computers are not heavy while running applications because a load of services are handled by the networks formed by the cloud. Requirement of hardware and software is minimal. To utilize cloud computing all we need is a web browser like chrome. Key features of cloud computing are,

- Resource pooling and elasticity
- Self service and On-demand services
- Pricing
- Quality of Service (Srivastava et al. 2018)

Figure 1 : Network cloud

Due to the Global Health emergency announcement and sudden impost travel restrictions and logged down restrictions a fewer client interaction was compelled in the routing business patterns and in public personal movements and activities and perform their official duties and delegated job tasks alternatively through work from home (WFH) concept. Cloud computing facilitated collaboration, communication and online service during COVID-19 crisis. The cloud computing environment (CCE) focused on fast-paced practices for uninterrupted services despite the increase use of cloud computing applications to evaluate the data connection challenges in specific domain, guarantee for data security to provide IT service best practice and best approached basis(Rivera and Ezema 2022).

Impact on COVID-19 situation towards cloud computing relating to key business areas.

♣ Health services

During pandemic situation healthcare sector emerging new technologies such as Cloud computing, Internet of things (IoT) and 5G where information could be transformed more securely and faster providing optimal and significant solutions to the public based on clinical and medical treatments. New applications with dash boards by linking them with cloud base electronic health records were used for priorities treatments relating to high risk and critical illness patients (Iranpak, Shahbahrami, and Shakeri 2021). The Health organization Health Insurance Portability and Accountability Act (HIPAA) related to protection sensitivity data of the patients which are confidential and critical covering the areas of administrative, physical security in a Health organization (Lawley 2012).

♣ Banking and Financial Service

Banking and financial services adopt all aspects of digital transformation modernizing their operations by curtailing the involvement of physical staff and deploying only the key essential staff for duty with cloud solution during the COVID-19 to maintain social distance. Cloud computing is an ecosystem which the services are assembled, connected and configured automatically in order to complete the tasks assigned. Banking and Non-banking monitory administration use cloud computing innovation with security and persistent quality. Moving to cloud based administration is getting expanded in the finance industry since it is cost effective (Nirmala et al. 2020).

➕ **Educational services**

Covid-19 Pandemic was affected the billions of people adversely across the world and education was also badly affected in parallel. At early stage people were not ready for this emergency situation but subsequently people gradually got adapted to the situation. It provided a great hope for the children and the education sector as most of the education providers such as Schools, Universities, Private Institutes and Academies across the globe shifted to online teaching and learning, now which it has become a trend. It is also an opportunity for the educational providers to develop new teaching models for future to avoid affecting the smooth functioning of the study program in such crisis as a pandemic, war, decreasing student number enrolment, etc (Khan et al. 2020).

2.0 Progression from Infrastructure-as-a-Service (IaaS) to Software-as-a-Service (SaaS) and how important it is for the organizations to move to Cloud

Infrastructure-as-a-Service (IaaS) relates to how the computer related resources are managed through the cloud services, hardware, software, networks and other related infrastructure components which are managed in the cloud service providers. The end user will be responsible only for performing middleware, data and application software (Abdelazime and Marie 2021). However Software–as-a-Service (SaaS) is a software delivery method grand access to users enabling to connect and utilize cloud base applications through the internet. The software vendors will ensure the users that during the utilization only the subscription need to provide base on a model (Tsai, Bai, and Huang 2014).

In terms of services IaaS providers offer the services as pay-as-you-go and it is built and managed based on infrastructure. The infrastructure provides storage capacity, resources for networking, web based and application based services. However SaaS providers offer their services for a diversified and multiuser accessibility range of services including any tailor made service or utility extended services and the applications has the easy accessible path by processing through a interface or so called a web browser or processed by pre designed application (Jagli, Purohit, and Chandra 2018).

In IaaS system the services are offered on a subscription basis where meaning that user has to pay only for the utilization for the resources used. IaaS has the features of automation with standardize practices with simplified and centralized nature where the cost will be reduced. However in terms of SaaS users will reach to access to a state-of-the-art being the newest technology with sophisticated features without large initial investment. Hence great opportunity cost being derived and the software vendors provide value added services such as software maintenance providing backup solutions ensuring continuous uninterrupted quality and standardize services (Azadi et al. 2021).
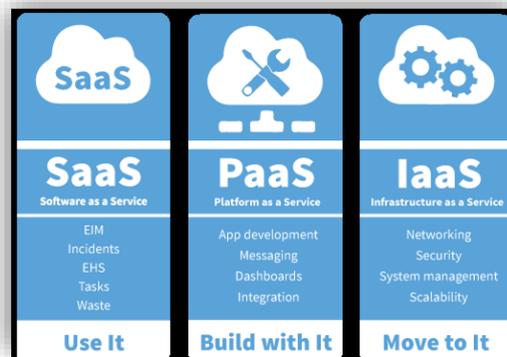

Figure 2 : Cloud computing Services

As per thematic findings the progressions are denoted in the SaaS the main objective is to identify the challenges and the expected solutions with past experience to improve IT service standards in an innovative and to find smart solutions. The organization need to coordinate with the SaaS vendors to reach conclusions on mutual agreement basis with the job responsibilities and to grant delegated authority for a project to be tested and perform in a live production. Further the organization needs to have a strong aptitude for learning and experiencing new technology concepts and previous experience supporting to software utilization and development. Strong troubleshooting skills need to capitalized and service helpdesk standards should be in practice (Saltan and Smolander 2021).

Further the organization need to provide technical and functional support to end users to maintain a high standard service level in terms of business continuity and proper incident management system to be in place to update, communicate and seek for in-house technical assistance (Rahul et al. 2021)

3.0   Discussion the key business components to the transformation of data to the cloud

Cloud data security will ensure to protect cloud base application in terms of underline data providing technological solution, governing policies and procedures. Confidentiality, integrity and availability will be the co principles of information security to maintain data processing, storage and during data transmission. The Risk of business interruption need to mitigate and need to control financial and reputational losses, public trust and confidence (Sun 2019). Since cloud service and applications heavily rely on application programming interfaces (API) mis-configuration is a high threat which will lead compromising authority access (Brabra et al. 2018). Using week passwords or compromising password will adversely impact the organization user profile administration matrix which will lead to cyber attacks which will expose the critical data to an high risk exposure (Rahul et al. 2021). Malware injection attacks are done will take over control of users sensitive information which will lead to cyber attacks through a virtual machine in cloud based system by injecting malicious service. Multifactor authentication and a solid data encryption will mitigate such risk to a great extend and employee awareness relating to cyber attacks and implications need to communicate to users as a precautionary measure (Li et al. 2021). A social engineering attack in terms of phishing by a malicious link will expose sensitive information (Ahmed et al. 2022).

Possible attacks on cloud computing

Author	Attack	Description
Khalaf et al., 2019	Daniel of Service (DoS) attacks	This attack is done by forwarding large number of requests at the same time to a given target network creating a flood situation as a traffic conjunction causing with interruptions for the routine service.
Fidele and Hartanto, 2019	Sniffing attacks	Performing unsecured network communication while intercepting during data on transit and capturing all the data packets in a form of wire tapping through the system network.

Duarte et al., 2022	Message injection	Creating a security vulnerability while performing a disrupt the network by intentionally and fraudulently inserting a wrong message in the network to mislead users.
Kumar, R.A., Konda, S.G. and Karnati, 2022	Sybil Attack	The attack uses a single node to operate many active fraudulent identities in the same time including a peer-to-peer net work. This will gain the majority of influence by aiming to undermine the authority.
Gumaei et al. 2019	Spoofing attack	This attack will create a situation in which a user will successfully identify as another person by falsifying information to obtain an illegitimate advantage or benefit.

4.0   Analysis of how characteristics of cloud computing become a strategic advantage for business during post-COVID era
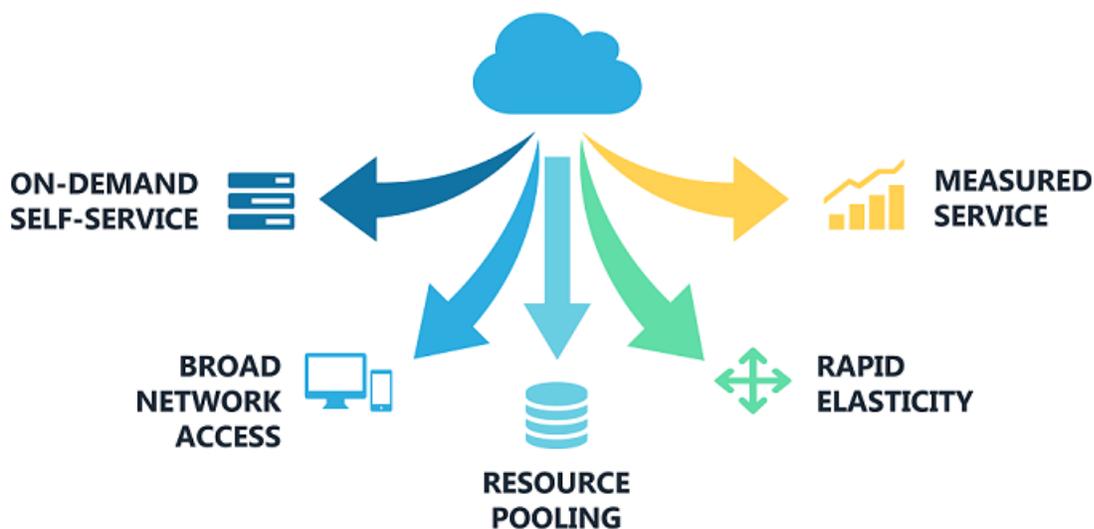
➢ *On demand self-service –*

Customer is allowed to utilize the cloud computing whenever it required without contact between consumers and the service providers. The process of fulfilling the requirement of the customer is fully automated. It is more efficient and effective, and offers advantage for the both customer and the service provider. Customer could easily and quickly access to the service as they required rather than waiting for a longer period. It is advantageous for both service provider as well as the customer saving time cost and opportunity cost. This will also helps to reduce the service provider's administrative burden to certain extend (Rountree and Castrillo 2014).

➢ *Broad network access*

The cloud can be accessible and available to any device from any location, which is why it is possible for broad network access as well as very cost effective. The network infrastructure will be able to connect with a wide range of devices including internal and external customers through tablets, laptops, workstations, and mobile phones giving seamless access to computing resources through this multiple platforms removing device-based barriers. Early days of cloud computing, resources were finite, storage systems were limited as it was hosted locally, and devices could only access networking. Democratizing access to compute, storage and network resources through radical shift were introduced by cloud computing. Today's public and private cloud wouldn't exist if the broad network access possibility was not available (Griebel et al. 2015).

➢ *Multi tenancy and resource pooling*

The characteristic of a software program that serves different customers (tenants) at the same time where each of them is isolated from each other is referred as multi tenancy. In order to provide cloud service to multiple customers cloud provider utilize a virtualization technology based multitenancy models and pools out IT resources and could be assigned and reassigned according to the cloud customer's demand request. In order to serve multiple cloud customers

cloud providers are allowed to pool large scale of IT resources and followed by an execution through multiplexing and according to the demand of the cloud customers physical and virtual resources are assigned and reassigned dynamically (Abd et al. 2016).

> ➤ *Rapid elasticity and scalability*

The Elasticity is the ability of the cloud that according to the infrastructural resources on sudden ups and downs to automatically expand or compress in the requirement to manage the work load efficiently. The elasticity minimize the cost of the infrastructure but not suitable for all kinds of environments, it only applicable for the scenarios where the resources requirements sudden up and down fluctuations for a specific time interval. It is not practical to handle heavy workload where continuous resource infrastructure is required. Most IT managers pay only for the duration they consumed the resources which known as pay-per-use (Shukla and Simmhan 2018). Growing work load also need to be handled efficiently with applications or software by could scalability which commonly handle the work load statistically by deploying of resources persistently (Zhao and Zhou 2014).

> ➤ *Measured Service*

Cloud computing will ensure to control and utilize maximum resource usage with the measured service implementing the automatic framework leveraging the capabilities of the system. The controls can be made over the resource usage of the cloud provider and monitor by reporting the status of transparency and creditability in terms of billing clients usage over the services (Yoo and Kim 2020).

5.0   Evaluation how cloud based IT infrastructure for a cost effective and better performing organization in the future

Lower upfront cost will manage the financial feasibility in cloud computing since a heavy investment cost is not permitted. Pooling of resources among diversified nature of expenditure will be benefitted by saving the financials and gain budgetary controls. Further lowering the maintaining cost and expected expenditure for system development and updates have a very low possibility in cloud computing administration the financial projection could be effectively

managed (Nayar and Kumar 2018). Since the cloud computing is developed based on the industry specific norms and features the resource virtualization can utilize in configuring with customer centric IT solutions. The specific competency level and specialized human resource are being involved, the system upgrades are performed by respond to the external market conditions in the nature of high turbulence in the environment (Borangiu et al. 2019). Deploying options in accordance with the tailor made requirements in when initiating the frameworks for software the architectural knowledge need to be effectively utilized focusing the scalability (Hasselbring 2022).

The accessibility will ensure through cloud computing based on internet connection where the connectivity assumes globally anytime anywhere. The users, clients, and inter related parties can reach to update information and data from any location. The updates through software are being updated on real time and automatically (Wadnare, Sherekar, and Thakare 2021). Cloud computing will deliver the best practices on equal share basis and access enabling to access for information and for usage for functionality. The process power will contribute for the efficiency and continuous improvement due to turbulence in nature to have the improved versions of service by developing infrastructures (White 2011).

Mobile cloud computing (MCC) enables to access through mobile devices and tablets connecting through internet. The key advantage is access privilege anywhere or anytime for connectivity by utilizing the features of flexibility, multiple platform availability such as Android, IOS. The backup facilities were inconvenience and retrieval of data was in great control and usability (Qi and Gani 2014).

The economic, social and technological aspects relating to cloud computing has given a value added benefit in terms of environmental contribution towards organization's sustainability. Onsite servers need to contently and heavily consume powered by electricity and that adversely affect the environmental pollution. Cloud computing provides an opportunity to dramatically reduces and many cloud data centers are powered by renewable energy sources resulting reducing "Green Home Gas Emissions" (Bajdor 2019).

In critique the smooth functioning is distorted due to weak Internet connectivity or data center malfunctioning. This will result the disturbance for the routine functionalities in day-to-day activities. The down time of the services will lose business opportunities and data accessibilities in business forums mainly. An incident management system needs to establish enabling to report the service unavailability and provide restore path with connections to the solution providers linking with service desk and ticketing systems (Peralta and Garrido, 2019).

6.0   Conclusion

Modern technological developments has a continuous imrpovements in the society at large and the requirement are continuously developing. Creativity and ubpgrading the IT service is a much needed requirement due to complex nature and finding solutions on tailor made basis and cloud computing has supported towards IT infrastructural developments along with software and application implementation. During the COVID-19 pandemic situation the cloud computing services has contributed in a great extend by over coming the major cyber risk creating by unauthorized access and indutry wise specific solutions were communicated to mitigate such risks.

References

Abd, Sura Khalil, Rawia Tahrir Salih, S. A. R. Al-Haddad, Fazirulhisyam Hashim, Azizol B. H. Abdullah, and Salman Yussof. 2016. "Cloud Computing Security Risks with Authorization Access for Secure Multi-Tenancy Based on AAAS Protocol." *IEEE Region 10 Annual International Conference, Proceedings/TENCON* 2016-January. doi: 10.1109/TENCON.2015.7373063.

Abdelazime, Reham, and Mohamed Marie. 2021. "Effects of Coronavirus Crisis in Organizations Decisions to Adopt Software as a Service." 3(3).

Ahmed, Umer, Butt Rashid, Ali Ahmadian, Hamza Aldabbas, Senthilkumar Mohan, and Bader Alouffi. 2022. "Cloud-Based Email Phishing Attack Using Machine and Deep Learning Algorithm." *Complex & Intelligent Systems*. doi: 10.1007/s40747-022-00760-3.

Azadi, M., Z. Moghaddas, T. C. .. Cheng, and R. Farzipoor Saen. 2021. "Assessing the Sustainability of Cloud Computing Service Providers for Industry 4.0: A State-of-the-Art Analytical Approach." *International Journal of Production Research* 1–18.

Bajdor, Paula. 2019. "The Environmental Benefits of Cloud Computing." (June 2016).

Borangiu, Theodor, Damien Trentesaux, André Thomas, Paulo Leitão, and Jose Barata. 2019. "Digital Transformation of Manufacturing through Cloud Services and Resource Virtualization." *Computers in Industry* 108:150–62. doi: 10.1016/j.compind.2019.01.006.

Brabra, Hayet, Achraf Mtibaa, Fabio Petrillo, Philippe Merle, Layth Sliman, Naouel Moha, and Walid Gaaloul. 2018. "AC PT US CR." doi: 10.1016/j.infsof.2018.10.012.

Duarte, Miguel, Joao Pedro Dias, Hugo Sereno Ferreira, and Andre Restivo. 2022. "Evaluation of IoT Self-Healing Mechanisms Using Fault-Injection in Message Brokers." *ArXiv Preprint ArXiv*.

Fidele, Kagiraneza Alexis, and Agus Hartanto. 2019. "DoS Attack Prevention Using Rule-Based Sniffing Technique and Firewall in Cloud Computing." *E3S Web of Conferences* 125(201 9). doi: 10.1051/e3sconf/201912521004.

Griebel, Lena, Hans Ulrich Prokosch, Felix Köpcke, Dennis Toddenroth, Jan Christoph, Ines Leb, Igor Engel, and Martin Sedlmayr. 2015. "A Scoping Review of Cloud Computing in Healthcare." *BMC Medical Informatics and Decision Making* 15(1):1–16. doi: 10.1186/s12911-015-0145-7.

Gumaei, Abdu, Rachid Sammouda, Abdul Malik S. Al-Salman, and Ahmed Alsanad. 2019. "Anti-Spoofing Cloud-Based Multi-Spectral Biometric Identification System for Enterprise Security and Privacy-Preservation." *Journal of Parallel and Distributed Computing* 124:27–40. doi: 10.1016/j.jpdc.2018.10.005.

Hasselbring, Wilhelm. 2022. "A Configurable Method for Benchmarking Scalability of Cloud-Native Applications." 1–42.

Iranpak, Somayeh, Asadollah Shahbahrami, and Hassan Shakeri. 2021. "Remote Patient Monitoring and Classifying Using the Internet of Things Platform Combined with Cloud Computing." *Journal of Big Data*. doi: 10.1186/s40537-021-00507-w.

Jagli, Dhanamma, Seema Purohit, and N. Subhash Chandra. 2018. "Saasqual: A Quality Model for Evaluating SAAS on the Cloud Computing Environment. In Big Data Analytics." *Springer, Singapore.* 429–37.

Khalaf, Bashar Ahmed, Salama A. Mostafa, Aida Mustapha, Mazin Abed Mohammed, and Wafaa Mustafa Abduallah. n.d. "Comprehensive Review of Artificial Intelligence and Statistical Approaches in Distributed Denial of Service Attack and Defense Methods." (1):1–16.

Khan, Shahnawaz, Mustafa Raza Rabbani, Eleftherios I. Thalassinos, and Mohammad Atif. 2020. "Corona Virus Pandemic Paving Ways to Next Generation of Learning and Teaching : Futuristic Cloud Based Educational Model."

Kumar, R.A., Konda, S.G. and Karnati, R. 2022. "A Diagnostic Survey on Sybil Attack on Cloud and Assert Possibilities in Risk Mitigation." *First International Conference on Artificial Intelligence Trends and Pattern Recognition (ICAITPR).*

Lawley, Jeffrey S. 2012. "HIPAA , HITECH and the Practicing Counselor : Electronic Records and Practice Guidelines." 2(3):18–26.

Li, Shudong, Yuan Li, Weihong Han, Xiaojiang Du, Mohsen Guizani, and Zhihong Tian. 2021. "Simulation Modelling Practice and Theory Malicious Mining Code Detection Based on Ensemble Learning in Cloud Computing Environment." *Simulation Modelling Practice and Theory* 113(August):102391. doi: 10.1016/j.simpat.2021.102391.

Nayar, Kiran Bala, and Vikas Kumar. 2018. "Cost Benefit Analysis of Cloud Computing in Education." *International Journal of Business Information Systems* 27(2):205–21. doi: 10.1504/IJBIS.2018.10009814.

Nirmala, Selvaraj, Sugirtha Rajini, Nirmala Sugirtha, Rajini Selvaraj, Ramamoorthy Sundaramoorthy, and Radha Rammohan Shanthanam. 2020. "Reliability of Cloud Services Provided To Non-Banking Financial Institutions Reliability of Cloud Services Provided To Non-Banking Financial Institutions." (April).

Peralta, Goiuri, and Pablo Garrido. 2019. "On the Combination of Multi-Cloud and Network Coding for Cost-Efficient Storage." doi: 10.3390/s19071673.

Qi, Han, and Abdullah Gani. 2014. "Research on Mobile Cloud Computing : Review , Trend and Perspectives." 195–202.

Rahul, M., R. Shukla, S. Singh, V. Yadav, and A. Mishra. 2021. "A Survey on State-of-the-Art of Cloud Computing: Its Challenges and Solutions. Recent Trends in Communication and Electronics." 562–67.

Rivera, Luis, and Ernest Ezema. 2022. "Pr Ep Rin Pe Er r Ev Pr Ep Rin t n Ot Pe Er R." 1–21.

Rountree, Derrick, and Ileana Castrillo. 2014. "Introduction to the Cloud." *The Basics of Cloud Computing* 1–17. doi: 10.1016/b978-0-12-405932-0.00001-3.

Saltan, Andrey, and Kari Smolander. 2021. "Bridging the State-of-the-Art and the State-of-the-Practice of SaaS Pricing : A Multivocal Literature Review." *Information and Software Technology* 133(October 2020):106510. doi: 10.1016/j.infsof.2021.106510.

Shukla, Anshu, and Yogesh Simmhan. 2018. "Toward Reliable and Rapid Elasticity for Streaming Dataflows on Clouds." *Proceedings - International Conference on Distributed Computing Systems* 2018-July:1096–1106. doi: 10.1109/ICDCS.2018.00109.

Srivastava, Priyanshu, Tata Consultancy, Services Limited, and Rizwan Khan. 2018. "A Review Paper on Cloud Computing." (July):4–8. doi: 10.23956/ijarcsse.v8i6.711.

Sun, Pan Jun. 2019. "Privacy Protection and Data Security in Cloud Computing : A Survey , Challenges and Solutions." *IEEE Access* PP:1. doi: 10.1109/ACCESS.2019.2946185.

Tsai, W., Bai, X. and Huang, Y. 2014. "Software-as-a-Service (SaaS): Perspectives and Challenges." *Science China Information Sciences,* 57(5):1–15.

Wadnare, Rupali J., Swathi S. Sherekar, and Vilas M. Thakare. 2021. "Efficient Accessibility in Cloud Databases of Health Networks with Natural Neighbor Approach for RNN-DBSCAN. In Cloud Computing Technologies for Smart Agriculture and Healthcare." *Cloud Computing Technologies for Smart Agriculture and Healthcare* 1(Chapman and Hall/CRC.):217–32.

White, Bebo. 2011. "Accessibility Challenges of the next Decade: Cloud and Mobile Computing and Beyond." *In Proceedings of the International Cross-Disciplinary Conference on Web Accessibility* 1–1.

Yoo, Seok-keun, and Bo-young Kim. 2020. "A Decision-Making Model for Adopting a Cloud Computing System." doi: 10.3390/su10082952.

Zhao, Jun Feng, and Jian Tao Zhou. 2014. "Strategies and Methods for Cloud Migration." *International Journal of Automation and Computing* 11(2):143–52. doi: 10.1007/s11633-014-0776-7.