



## Mobile Cloud Computing: Inflicted Changes and Challenges by Global Pandemic

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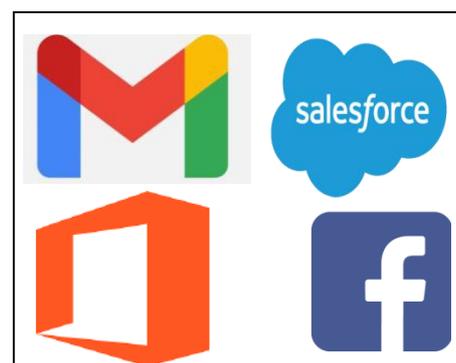
**Abstract:** *In the current global pandemic scenario, every aspect of one's daily life including Cloud Computing in Mobile world also known as Mobile Cloud Computing (MCC) is virtually affected. In today's world these mobile devices or what we say smart phone devices have a huge purification in our society from different category of people to different level of application such that it has created a revolution in the communication path, jobs, education etc. and so, has cloud computing. Almost all companies and educational institutions have switched to a remote working i.e., Work from home environment. According to a Devan Adams, analyst at Omdia, data center operators are getting massive increase in usage of resources due to closure of schools, work at home mandates. This requires new rules, new norms, more reliability, scalability and security over cloud. In the current COVID-19 scenario, IT infrastructure services such as IaaS, CaaS, PaaS all are experiencing negative impacts due to financial viability. The rapid increase in storage, application, analysis and implementation of such huge data requires improvised software platforms and infrastructure needs, more over serious challenges related to security, privacy, connection quality hardware device issues etc. are growing. This paper briefs about what is Mobile Cloud Computing, how it works, how the current scenario has developed and changed from the pre-COVID-19 situation and hence, concludes with challenges faced and their possible solutions along with future research scopes.*

**Key Words:** *Mobile Cloud Computing, Global Pandemic, RevolutiSon, Metaverse, NFTs.*

### 1. INTRODUCTION:

Throughout the Global pandemic there has been a huge increase in mobile subscriptions due to extensive internet usage by increasing number of users. Today's advancement in cloud computing is providing significant benefits to mobile users as most of the work is now being done on mobile. The primary vendors that dominate the Mobile Cloud as well as Cloud are Amazon, Terremark worldwide, IBM and Salesforce.com. Cloud infrastructures and platforms supply large-scale computing power with elastic scalability and higher resource sharing and usage. Mobile Cloud Computing has certain advantages such as:

- Computing and storing efficiency: By offloading demanding workloads and large data to the cloud, the mobile device can limit the amount of processing power and data storage that it requires
- More Powerful mobile apps: Since the mobile device now has access to a powerful cloud on the back end, there lies an ability to create more powerful mobile applications.
- Energy efficiency: Maximum of the resource-intensive work in mobile applications can be offloaded to the cloud, which means that mobile clients can focus more on reducing energy consumption without trading off on performance.
- Thin Mobile Clients: Less resource demands on the mobile devices that achieve better overall performance when coupled with a cloud platform. This gives the ability to put down the mobile clients, to the extent that they only handle user interaction and offload all application work and the data to the cloud



### 1.1. Mobile Cloud Computing:

MCC can be defined as a framework where the data storage along with the data processing happens which is outside the mobile device. Mobile Cloud Applications move the power of computing and storage away from mobile devices and move them to cloud, which brings MC and the applications to not just mobile phone users but a much wide range of subscribers of mobiles. Example-

- **Dropbox** which offers cloud storage, letting the user access their files in the 'Dropbox' from their android devices which can be synced to mobile devices.
- **Amazon Cloud Player** which is used to store and play MP3 files, where 'Cloud Drive' serves as a hard drive set in the cloud. Users can play and stream their MP3, using an application, Amazon 'Cloud' MP3 application.

In the past 8 months, there is a remarkable or significant increase of mobile subscriptions because of the speedy growth and advancements in mobile cloud computing and wireless technology.

During 2020 to 2021, cloud computing has exploded as work went virtual and businesses adapted to the global pandemic by focusing on the delivery of digital services. In 2022, we will undoubtedly see a continuation of rapid adoption and growth. We are likely to see the migration of strategies from the deployment of cloud platforms towards enterprise-wide cloud migration. There is going to be a massive innovation in cloud and data center infrastructure. Here are some key materializing factors in 2022: According to predictions from Gartner, global spending on cloud services is expected to reach over \$482 billion in 2022, up from \$313 billion in 2020.

Cloud infrastructure is the heart and soul of delivery of almost every digital service from social networks, OTT platforms entertainment industry, news, sports, education to the self-driven car and autonomous IoT (internet of things) infrastructure.

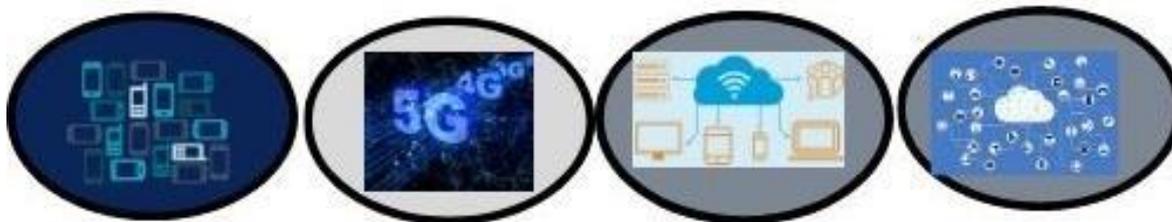
#### Some of its unique advantages are-

- **Flexibility-** Mobile Cloud Computing is flexible as the data can be accessed from anywhere and at any time, only proper internet connection and a device is required.
- **Economical-** Applications developed for cloud computing has abolished the cost of hardware and has become one of the most cost-efficient method for using and maintaining it.
- **Backup and Recovery-** Data can be easily backed up and retrieved when in need with the help of mobile cloud applications.
- **Multiple Platform Availability-** Multiple platforms such as Android, IOS, and many more are available for the cloud computing applications. The cloud can modify and access data regardless of from which platform it is.

MCC is one of the most leading edge of modern technologies in the current scenario. MCC has demonstrated itself to be highly beneficial or favorable for all the smart phone users and cloud-based service providers. MCC integrates the fast-growing Cloud Computing Applications market with the ubiquity smart phone. In this technique, some mobile applications are developed which are user friendly and are powered and organized by using cloud computing technology by cloud service providers. This technique of 'mobile cloud' enables the developers to build applications which are designed chiefly for mobile users without being bound to the operating system of the mobile device or the storage capacity of data. Data processing and data storage is carried out of the mobile device. We can differentiate MCC, as it gives allowance to devices to run cloud-based web applications which is distinct from other native applications. Here the users can access the store applications and the data associated with them any time on the internet just by subscribing to the cloud services. Now-a-days the trend has slightly shifted towards the services and convenience offered by mobile cloud as compared to mixture of web-based and native applications. Serious efforts



have been acknowledged by the researchers to form a strong and concerted platform, which can be termed as 'Third Platform which would connect or pair mobile and cloud in future. Many such predictions by experts also transpires the uprising of MCC which has given its users a better means to access and store their data with the latest techniques of data synchronization, better performance and improved reliability. Because of such beneficial aspects lot of people are inclining towards MCC for their smart phones.



Mobile Devices

Wireless

Internet

Cloud

### Network Technologies

Mobile Cloud Computing underwent the impact of certain trends and factors. Here are some of the factors that have had an astonishing impact -

- **Enhancement of broad band coverage:** Better connectivity in such a pandemic is being furnished to our mobile devices via 4G, Wi Fi, fixed wireless etc.
- **Profuse Storage:** Cloud technology based mobile applications are considered to be more capable than any smart-phone, as it offers ample storage space. This technique of Cloud server-based computing framework which is accessible through mobile interface of an app is in contrast to the limited data-storage space and processing power in a mobile device.
- **Blooming Technologies:** Advanced technologies like HTML5, CSS3, Hyper-Visor virtual machines for smart-phones, cloudlets and Web 4.0 etc. play a basic role in MCC's rising popularity by contributing lot many technologies.

#### 1.2. Latest Trends:

- At the current time, mobile apps have advanced so much, individuals can carry out various tasks on a mobile device using voice, expressions gestures, and the degree of user-friendliness is increasing due to the availability of more and more stored and easily accessible data over the cloud.
- Mobile Cloud Computing has seen a high rise in demand and is now a popular option for mobile and desktop application developers. This is due to the lack of restrictions in app development tools and sources offered by the cloud.
- The previous mobile application development faced constraints as Limited space available in mobile devices also the incompatibility of the operating system. Now with the combination of cloud computing and mobile, the developers can easily make sure all tasks such as data processing and storage take place seamlessly and smoothly.

#### The arrival of 5G technology and Wi-Fi- 6E:

It doesn't mean just that more data is going to flow on the cloud, it also means that new and various different types of data are going to flow in enormous amounts. There is going to be an explosion in the availability of cloud gaming platforms such as Google's Stadia, Amazon Luna as there is going to be a massive surge in levels of investment in upcoming months of 2022

#### Arrival of Cloud Virtual and Augmented Reality:

Arrival of Cloud Virtual and Augmented Reality will make cheaper and smaller headsets. Cloud technology makes all available and implemented technologies work faster, lighter and more accessible to both server and customer, it is going to be a key driver in the migration of more and more new trends of services to cloud platforms

#### 1.3. Arrival of Metaverse:

*Impact on Businesses Strategies:*



### **I. According to Adam Gary:**

The online world is full of enormous evolutions happening every single moment. What lies ahead is hard to quantify the Metaverse will present organizations with opportunities and an equal number of risks in the coming years. Web 1.0, 2.0 and 3.0 refer to the technologies currently in use but is a poor classification because as users are not concerned with what powers the technology they user rather what attracts them is what they get in terms of user experience.

### **II. Web 1.0 - where we were**

Internet 1.0 is currently in use (for most websites) where websites behave like a collection of booklets and brochures. There are many advanced technologies as well which we call “interactive” or “responsive” but does responsiveness really just confine to view ability in mobile devices? When a car configurator or VR spectacles trying program or simulation games present the user with auto-generated car model, lens frames infinite game environments, are they really creating those simulations? They clearly display the pre-loaded data in a differently compiled format from the cloud servers where their programs and the huge data set are stored based on the options selected by the user. There are three broad categories of such websites:

- Wikipedia - an encyclopedia
- Amazon - catalog shopping
- A company website - a sales brochure

When Web 1.0 started, early creators of websites were benefitted. They were massively benefitted and made huge fortunes.

### **III .Web 2.0**

The era of social networking where the main meals are content creating and consuming. The greatest example is YouTube. It doesn't create and content on its own, rather encourages others to work for it and reach out to global audience via a single platform. The examples of Web 2.0 are

- YouTube
- Facebook
- LinkedIn

These have different content but the same principle. They are elements of Web 1.0 sites that offer similar functionalities

Mobile cloud computing has seen a great traffic boom as people adopted Web 2.0 from Web 1.0. Putting data on Instagram, Whatsapp, Facebook, and YouTube, is engaging millions of people to millions of data.

### **IV Web 3.0 - the Metaverse**

Almost all the technology required to build the Metaverse already existed since quite some time and had been in use in gaming. The multi-person games like Battlefield, Pubg, Call of Duty ,World War Z, have already used the idea of virtual worlds where users can enter and engage with others sharing game and their all along journey. It established much more closeness among users and AR environments than Web 1.0 and Web 2.0.

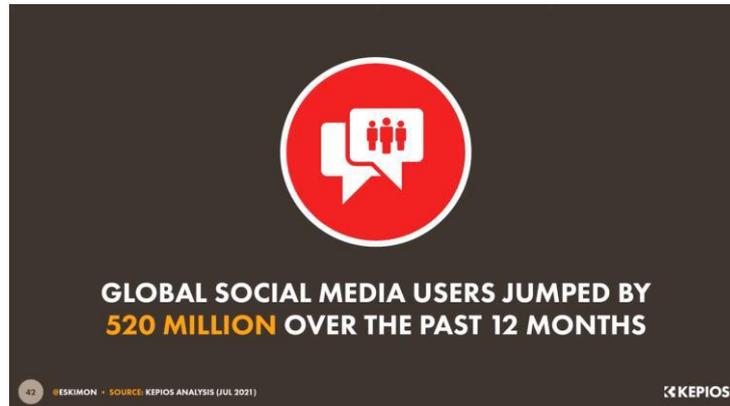
Now this virtual environment is being monetized .It began with buying skin and arms in games and has now reached to Crypto currency and NFTs.

### **V. Why?**

The pandemic has driven people from the physical to the virtual world at a faster rate than ever, so according to Simon Kemp's research 520,000,000 new people have joined social networks in the months of July 2021 and as



more lockdowns occur this rate would increase tremendously and so would have to the mobile cloud computing servers and service providers

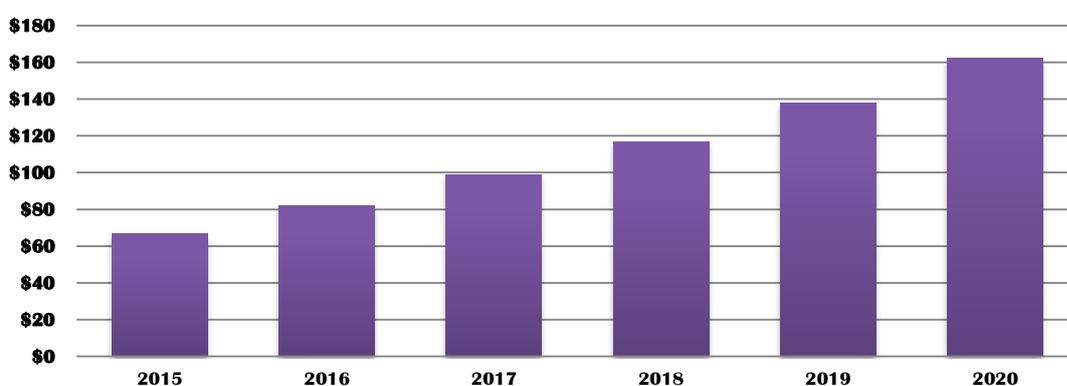


With the maturing of Metaverse, people have started to embrace the fact that the crucial business understands both opportunity and risks in the upcoming new world. There might be no opportunity to stay behind after coming this far in this era.

**Reasons for considering MCC as the future of mobile devices are:**

- **Extension of Battery Life:** Mobile devices battery usage is reduced as the vital role of processing the data is handled by the cloud.
- **Rich Storage Space:** Mobile users now need not to worry about their device’s limited storage capacity or go for buying memory cards because of the enormous storage capacity provided by cloud services to mobile users.
- **Improvement in data-synching techniques:** Cloud storage services allow their users to store and manage their data by providing speedy data synchronization between the device and any device chosen by the user. Here elimination of problems of storing all the data files and maintaining a separate backup gives a glimpse of benefits which users enjoy.
- **Enhancement in processing facilities:** Through the processor mobile device’s speed and performance can be determined. Nevertheless, in mobile cloud computing, almost all or most of the processing is performed at the cloud level. This reduces the load off the device and thereby enhances its overall performance.
- **Superior user-experience:** MCC concept came so that the users can enjoy the benefits by using this platform. It is always the user not the developers who benefits the most. The broad spectrum of benefits which are offered by this platform makes for an optimum productivity and an enhanced user experience.

**Rapid Growth of Cloud Computing 2015 - 2020**



■ RAPID GROWTH OF CLOUD COMPUTING, 2015-2020



**Scope for new technologies:** MCC can easily adjust to the ever-evolving nature of technologies. It is capable enough to perform efficiently with all the upgrades in cloud computing methods and changes in the smart-phones' designs, features and latest technologies being adapted everyday

### **The Future of Mobile Cloud Computing**

Mobile Cloud Computing is a rapidly growing industry. As per Mordor Intelligence by 2020 the market registered a total value of above USD 30 Million. It is rapidly growing at a CAGR of 25.28% and is also expected to reach USD 118.70 billion by 2026.

There would be infinite scope for rising startups as an MCC business doesn't need the significant investment amount as same as a traditional startup. One could just set up a startup with no money in hand at all. Also with the rise of cloud computing the requirement and supply of cloud services would definitely bring a boom in business anyway.

### **Impact of the global pandemic**

By 2020, COVID-19 pandemic has changed all sorts of institutions and businesses on a high level. This has helped the cloud emerge stronger than ever before. Internet and its surroundings have become the most valuable. We see how the service providers are coping up with this sudden rise in demand for infrastructure

### **Productivity with Social Distancing**

Since no physical interaction is acceptable in society, industries, educational institutions, business organizations all have adopted certain digital solutions such as online working, webinars, online classes etc. as an alternative to live presence. Many nations like Europe and the US are hiring employees at non-essential businesses to work from home that to with or without time limitation. Schools and universities are arranging online live lectures, tests and exams through forms and other video conferencing platforms. Little do people know where all this data of recorded classes and live sessions is going? It is all getting uploaded to the cloud.

Apps such as Slack, Zoom, Microsoft teams, Cisco WebEx, Google all have seen record breaking growth during this whole period. According to a Microsoft blog from March, Microsoft Teams has seen a usage spike of 775% in Italy. The virtual desktop also saw 300% usage rise.

## **2. CHALLENGES:**

### **1. Increased customer traffic != increased revenue**

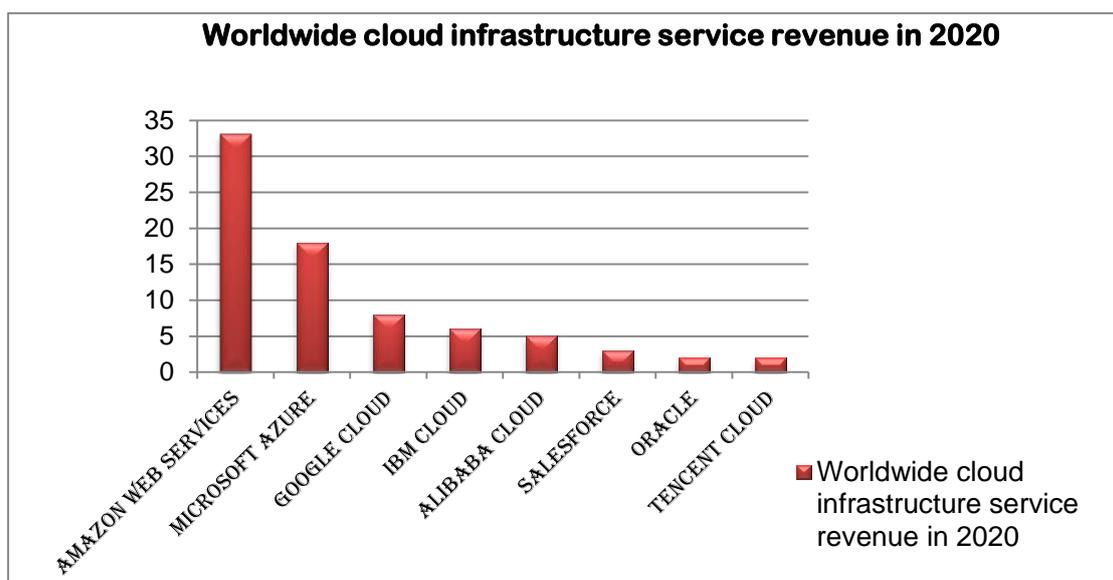
- 290 million Zoom users no one is paying for the servers, so where is this money coming from? Obviously Zoom is paying from their pocket
- There is 20% increase in Netflix usage, people are still paying the same amount as earlier but defiantly people are watching much more than earlier and Netflix has to service all that increasing usage which doesn't represent the increase in revenue. According to a report , Netflix has recently signed 18 million new users but other companies like Netflix that are providing similar services might not be getting this much demand but have to pay for servers
- Ad traffic has increased tremendously ,all sites such as Facebook Google etc. are used for ads and news , local sites are getting more visitors to which they need more and more servers but businesses are closed and revenues are down to their isn't enough money to handle the increase in traffic.

### **Financial impact of Covid 19 on cloud consumption**

- In 2012 EC2 was 80% of Amazon's of all spend today also majority of spend is on Cloud Compute
- There is still a finite amount of compute servers future difficult position is of Mobile Cloud henceforth it is the most affected by increasing demand , volatility and also the tremendous surge in demand increases in the bandwidth

### **How can one pay and consume these resources?**

- *On demand instances*- pay as you go model it is flexible but one has to pay full price and with time it gets extremely expensive
- *Long term reserved capacity*- this represents reserved instances such as 1 year, 3 year, regional etc. saving plans that are recently introduced essential commitment to either 1 or 3 year packages to pay. 50 to 70% savings can be made. But here you are locked in, if the business goes south you still have to pay for the servers for the coming time there is not so much liquidity.
- *Highly affordable spot instances* – here customers can save 75% to 90%.



**Low Bandwidth:** As the mobile networking resources are much smaller as compared to the traditional networks the surge in usage due to the pandemic the P2P Media streaming disturbs the small bandwidth among the users who are located in the same area using the same network example: JioFiber is now unable to provide enough bandwidth and speed due to rise in connections in the same area.

**Security and Privacy:** in today's mobile computing is a key concern. The establishment of a remote cloud base infrastructure by any organization will send all private information. It gives the all data to the provider to manage, analyze, protect and retain. The existence of the company might be in jeopardy, so decisions need to be thought through, users are always uncomfortable and insecure about handing over their data to a third party which as seen in 2021 when news about WhatsApp invading peoples private data flooded the internet overnight and memes and other video content when viral.

**Prone to Attack:** The data on the cloud is more vulnerable to hackers and nothing on the internet is completely protected. Sensitive data and information may be leveraged as malicious users always look for chances

**Dependency and Vendor Lock-In:** The major issue of mobile cloud computing is the dependency on the provider. Switching providers is also very cumbersome.

**Limited Control and Flexibility:** The running of all the applications and services depending on third-party virtual environments, gives the users very limited control on the whole function of hardware and software. The software being used for mobile cloud computing also usually lacks the features of an application designed to run locally.

Since 2021, the cloud services industry across the globe has seen a rise of over \$370 billion in 2020, a growth of over 380% in a span of 10 years.

But the fact that 90% of the world's data in 2013 was created between 2011 and 2012 it is clear that more storage is required. By the end of 2020 the virtual mass of the information in the world was around **44 ZETTABYTES** (a trillion gigabytes). Around 50 % of all the data of the ever-growing industry, the corporate world is stored on the cloud. There has been a worldwide expenditure on public cloud services and is going to grow heavily in 2022

#### **Solution to Financial Crisis - Spot Instances**

Where the business is not necessarily blooming for the increase in traffic, spot instances seem extremely attractive. Spot instances represent the spare capacity of buffer that Amazon has and there is that caveat that they can pull the plug in any given time and give it to someone who has long-term capacity/reserve/on demand capacity because they are paying more leaving the availability and stability issue aside from a financial perspective this is the best way, as you aren't locked in, neither you are committing to any reserved time, its best affordable solution.

#### **Additional considerations for spot instances**

- Gracefully draining and launching instances during actual interruptions
- Incorporate other pricing models such as reserved instances and savings plans
- Handling unique scaling and sizing issues for containerized workloads
- Ensuring data and IP persistence for tasteful workloads



### The Story of Two Companies:

- Leading SPORTS Apparel company
  - DIY spot instances for their staging environment until COVID-19
  - Lost entire staging environment due to reliance on specific 2-3 spot instance types
- Leading IN-APP VIDEO PLATFORM (specializes in video game ads)
  - Has been using Spot.io for over 2 year for production
  - Increased online gaming =increased in-game ads=40% increase in EC2 usage since February
  - Saved \$1.5 million on EC2 spend, \$700k in just March

Since Covid-19 spot instance markets are similar to holiday season trends with greater constraints on availability. Point-in-time data will not help predict where markets are heading. Knowing that capacity of an instance family is currently deep, does not predict what it will be like in 2 hours. Different markets move in different cycles

### How spot.io can help

- More data=better decisions
- Proactive spot instance replacements
- Blended usage of spot instances , on -demand instances and reserved capacity



**Solutions:** Since cloud traffic has increased, there is a requirement of more and more servers and a better infrastructure in order to cope with the rising demands.

**Problem:** Charging high prices from all customers might seem an easy way to cloud providers but is actually not. High costs for small things seem too much to users which they might not be willing to pay, so amount should be reduced so that all kinds of users may afford. A funding solution can be to collaborate with greater businesses for which the cloud providers may advertise and in turn take monetary support for servers and cloud maintenance.

**Technical solutions :** There may exist type of storage(high quality, low quality) in all mobile Cloud services as there is in services Google photos where there are types of storage namely Normal (Regular) and Express, for which user has to pay different amount. At last, there is also a problem that all jobs and businesses are in crisis right now, and people are not getting proper wages and almost every third person is facing difficulty in coping with expenses and at this high time, sudden rise in cloud service prices is proving to drag people further down Cloud and Mobile Cloud providers should provide more employment opportunities and help people make their own money by working from home as well as offline, this would encourage more and more people to earn via cloud computing and hence more people would generously spend on availing various advanced services leading to overall growth of the cloud industry.

### 3. CONCLUSION:

There is a silver lining to today's new and renewed interest in mobile cloud computing .Changes in business that were once unthinkable have happened overnight and so has in technology. Today it is easier to accept that cultures and process must change to allow cloud computing to work properly. The acceptance and tremendous increase in usage of cloud in all fields is a major shift. This lockdown has had its pros and cons but the technological boom has been the dream of all. One could've never imagined such tremendous growth in tech world that too in field of cloud computing at such a high level and in such less time. By this paper we conclude that no matter how many challenges this Pandemic has brought there are so many feasible solutions to reduce cost issues, meet infrastructure requirements, advancement in mobile technologies, solve hardware issues, and fix connectivity issues. There is such a wide scope of further researches in the field of Mobile Cloud Computing because at the end, Mobiles are the future.



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