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Distributed Cloud Computing and Mobile Cloud Computing: A Review

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ABSTRACT

Cloud-based data storage has grown in popularity due to its flexibility and concerns about security and confidentiality. In computer science, cloud computing is a relatively new concept. Users are using fewer resources while increasing their reliance on cloud resources. Cloud computing, mobile computing, and wireless networks are combined in Mobile Cloud Computing (MCC). On the other hand, Mobiles provide vast computational resources to mobile consumers due to their capabilities. On the other hand, cloud computing refers to data centers that are accessible via the Internet to a large number of people. The purpose of this paper is to provide an overview of cloud computing and mobile cloud computing. The study covers delivery and deployment models of cloud computing and the main features of mobile cloud computing.

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1. Introduction

During the last several years, innovations in network-based computing have resulted in an explosion of modelling approaches such as software as a service, online stores, community networks, cloud computing, and many more(Qi & Gani, n.d.).

Cloud computing is a modern technology that allows a third-party "cloud provider" to deliver services to customers from everywhere, at any time, and under diverse conditions. Cloud computing uses virtualization and service delivery strategies to provide customers with cloud resources and meet their demands. Cloud computing allows you to use the services of a distant computer rather than keeping and accessing data from your computer. Clients employ cloud services instead of functioning on their infrastructure, which means they do not know anything about the network's infrastructure. (Shukur et al., 2020). Cloud computing allows users to access content and use applications from every connected device(A. Rashid & Chaturvedi, 2019).

Cloud computing refers to a distributed computing system that provides software, central processing power, memory, hard drive, and other computer resources. It offers on-demand products and services to customers as a pay-per-use service. (Mahmood Ibrahim et al., 2021). There are three technologies used by cloud computing: the first one is Data Center, then Virtualization, and the last one is On-Demand Computing (Z. N. Rashid et al., 2021).

In a cloud system, task distribution allows for improved resource usage, which is essentially required(R. Z. Z. S. S. K. J. K. et al Najat Z, 2018)

Furthermore, with the fast advancement of wireless network technology, smartphones have considered all mobile phones already connected to the Network. Two key characteristics of the later generations network are Ubiquity and mobility, which offers a variety of individualized network services via a variety of network terminals and access methods. Cloud computing's core concept is the centralization of computers, services, and particular applications as a utility offered to customers. As a result, a new computing mode known as Mobile Cloud Computing appears by combining ubiquity mobile networks and cloud computing (Qi & Gani, n.d.).

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A collection of mobile devices might be used to create a distributed computing system, with each node defined by a device and connectivity architecture based on wireless communication systems (Massari et al., 2016).

Mobile computing (MC) has emerged as a study topic in recent years due to remarkable advancements in mobile networks and technology. Because of that reason, this review paper defined MC. People utilized computer systems for computing tasks in previous decades. According to recent studies, people prefer to utilize mobile, personal digital assistants (PDA), iPads, tablets, and other similar devices instead of desktop PCs (Arun & Prabu, 2017).

Also, with the rapid growth of mobile devices and the rapid development of cloud computing, a modern computing model known as mobile cloud computing (MCC) has been established. This new paradigm has overcome mobile devices' storage, connectivity, and processing limitations (He et al., 2018).

The review paper is divided into two sections: the first one, handled by Section II, which describes the main approaches to distributed cloud computing, and the second, covered by Section III, presents the key mobile cloud computing technologies. Section IV discusses the important feature. Section V conclude the paper.

2. Distributed Cloud Computing

Researchers appear to be becoming more interested in cloud-based scientific applications, while many big businesses are considering transitioning to hybrid clouds. For complicated applications to execute jobs effectively, parallel processing is required. Synchronization and communication are present in parallel processes, allowing for more efficient utilization of CPU resources. As a result, a data center's entire responsiveness to parallel tasks must be maintained while attaining effective node usage (R. Z. Z. S. S. K. J. K. et al Najat Z, 2018). A distributed system is a system, and distributed computing is a computer sector that studies distributed systems. This occurs on computers and other devices, allowing them to interact via messages passed among them. The use of distributed computing systems has expanded because of decreased hardware costs and developments in computer network technology(Zebari et al., 2020).

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While cloud computing offers many benefits, it also solves problems for corporate executives and IT teams. The most prevalent drawbacks that continue to influence cloud views are uneven performance and security issues. It's a different type of internet technology, which can provide a web-based network, RAM, software resources, storage, and CPU (Eshtawie, n.d.)

Cloud computing uses hardware and software to provide a service across a network. Customers can gather information, share resources, software, and other services at any time that covers their costs utilizing cloud computing, which is extensively used on the Internet and is an on-demand service. A cloud may be used to represent the whole Internet. Development and operating costs are reduced by using the cloud (Z. A. S. A. et al Najat Z, 2019). In addition, the cloud provider is in charge of maintaining and managing information stored in the cloud (Alam, n.d.).

2.1 The Deployment Model of Cloud

Various application models can be implemented on service models via cloud computing. These unique deployment methods can be implemented depending on the nature of their distribution, which is dependent on the cloud service's location (Alam, n.d.). There are four types of cloud deployment models: private, public, community, and hybrid clouds (Kumari & Singh, 2021):

1) Private Cloud: This kind of cloud is designed for a single company or organization, such as a cloud for a specific company (A. Rashid & Chaturvedi, 2019). These allow cloud computing benefits such as data security, flexibility, scalability, and dependability to be delivered. (Bokhari et al., 2018).
2) Public Cloud: The vast majority of services are delivered in a public cloud environment, with consumers having access to a resource pool managed by a hosting company. This type of setup will create considerable security issues due to its presence (Alam, n.d.). This environment is managed and monitored by a third-party, public cloud service provider, making such clouds acceptable for non-sensitive data (Saudi Computer Society. et al., n.d.).
3) Community Cloud: In this deployment approach, the whole cloud infrastructure is shared across multiple organizations part of the same community (Singh & Kumar Baheti, 2017). Files on multiple machines can be stored and accessed remotely.

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Community cloud might be maintained cooperatively or by a cloud service provider (Tavbulatova et al., 2020).

4) Hybrid cloud: This deployment architecture consists of two clouds, when vital data is stored on a private cloud and less secure data is put on a public cloud (Haris & Khan, 2018). Even though the clouds are mixed, each has its identification, which helps numerous deployments (A. Rashid & Chaturvedi, 2019).

2.2 Services model of Cloud Computing

The required components, such as servers, hardware, and networks, can enable cloud computing. Users of cloud computing also pick how they want to use the cloud computing services when they need them (Ouda & Yas, 2021). This review paper also defines cloud services usually classified into three types. They are hierarchically structured based on the abstract capacity level and the supplier's service model (Sunyaev, 2020).

1) Infrastructure as a service (IaaS): The Infrastructure as a Service (IaaS) cloud offers customers virtual computing resources like a Virtual Machine (VM) (Auxsorn et al., 2020). The service suppliers in this approach allow the participants to utilize virtual servers within their data center. The clients can use virtual servers, i.e., the row hardware, in its all without the need for infrastructure maintenance (Eshtawie, n.d.). In this situation, unlike the other categories, customers are in charge of managing components such as programs and operating systems (Rita & Pinto, 2021).
2) Platform as a service (PaaS): offers an infrastructure or platform for the development of applications and technologies to be distributed over the Internet, without downloading or handling the user interface(Mustafa Mohammed & M Zeebaree, 2021). Users can use programming languages, packages, resources, and tools the cloud operator offers to publish customer-created or bought applications to a cloud infrastructure. A cloud client controls the distributed apps and the application-hosting environment's configuration information. Of course, they cannot manage the cloud infrastructure or control it (Sunyaev, 2020). PaaS provides a software development platform with

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computer language libraries and tools, allowing users to create and deploy applications (Floerecke & Lehner, 2018).

3) Software as a Service (SaaS): A software distribution model known as SaaS as a service is one in which a distributor or provider hosts the software and makes it available to consumers through the internet. (Mustafa Mohammed & M Zeebaree, 2021). Customers don't have to buy or download software in their datacenters; instead, they may utilize it via a service (SaaS) from the cloud (Nguyen, 2021).

Grid computing, parallel computing, and distributed computing are all elements of cloud computing. A load balancing function is a function that distributes the load across nodes in a cloud environment, and it is a topic of cloud computing concerns (Z. A. S. A. et al Najat Z, 2019).

One of the most compelling reasons for using cloud computing is to reduce cost. Geo-replication, Redundancy, and reliability are all advantages of distributed cloud computing. A distributed cloud, which connects many globally disparate and smaller datacenters, might be a strong alternative to today's huge, centralized datacenters. A distributed cloud can minimize connectivity overheads, delays, and costs by providing neighboring compute and storage resources. Improved data locality can also help with confidentiality (Coady et al., n.d.).

Customers in this suggested distributed cloud must locate resources efficiently, such that the resources identified not only meet user needs but also are effective. For instance, the customer who requests computational resources expects to store information and results and access them efficiently. There might be many resource suppliers who can meet the needs of users. Due to the peer-to-peer architecture of the distributed cloud, issues such as free-riding must be managed. One important solution to these issues is allowing customers to give resources and assess the users' involvement factor. The distributed cloud's major objective is to analyze and determine if the system architecture is feasible inefficiency. The major objective is to design and evaluate distributed cloud storage and computing (Khethavath et al., 2017).

Latency is another motivating factor of distributed cloud. While collaborating on an interactive document with a group of mobile users or playing computer games,

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utilizing a nearby datacenter may be beneficial. A local cloud's customers can include humans, self-driving automobiles, robots, and computers (Coady et al., n.d.).

3. Mobile Cloud Computing

The fast advancement of mobile computing, wireless technology, and networking has resulted in considerable growth in mobile subscribers (Eshtawie, n.d.). Most people's preferred personal devices are mobile phones, and mobile users worldwide produce massive volumes of data daily (Borcea et al., n.d.). Mobile Cloud Computing has grown fast in recent years. The increasing need for enterprise mobility is one of the major elements supporting this growth (Eshtawie, n.d.). The quantity of data produced by mobile devices while doing routine operations has also increased (Miguel Castanheira Sanches, n.d.). They benefit customers by letting them access cloud providers' infrastructure, services, and applications in a relatively low-cost on-demand manner (Eshtawie, n.d.). Authors have seen several operating systems like Android, iOS, and Blackberry that can handle complex computation operations since the beginning of the Smartphone era (Salem, n.d.).

Individuals with varying health conditions were able to benefit from mobile computer technology. They now have several sensors that may be utilized for various purposes. The resource-restricted challenges of mobile devices might be successfully solved by integrating mobile computing technologies with cloud computing (Ponciano et al., 2020).

MCC (Mobile Cloud Computing) integrates mobile computing, cloud computing, and wireless networks to manage and analyze data outside of the mobile device (Najat et al., 2020). Mobile Cloud Computing (MCC) represents a new era in computing, in which cloud users may access a variety of services over the Internet (Mitrpanont et al., n.d.). The resource-constrained issues of smartphones might be successfully handled with this combination. As the number of MCC service types grows, the distributed MCC is being used in more practical applications, where various CSPs may offer consumers a variety of cloud services. Due to messages in the MCC environment being transferred through wireless connectivity, the adversary has easy control over the communication channel, allowing them to intercept, delay, and alter transmissions.

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On the other hand, the MCC services system is more exposed to different sorts of threats than a typical cloud computing services environment. New security measures for the system must be designed to ensure that only the authorized user may obtain MCC services and prevent the adversary from accessing MCC services. The privacy-aware authentication (PAA) method is critical for addressing security issues in MCC services environments because it can identify participants' identities and protect their privacy. Several PAA solutions have been introduced in recent years. Moreover, most of them are unsuitable for MCC services because they have significant security issues or poor performance. As a result, new PAA schemes must be created to provide safety and confidentiality in the MCC services context (He et al., 2018).

On the other hand, mobile cloud computing will significantly contribute to our everyday lives, simultaneously posing various obstacles and concerns. As a result, the essence of such issues and problems is figuring out how to merge the two systems smoothly. On the one hand, to guarantee that mobile devices achieve the most of cloud computing's benefits to improve and expand their capabilities. And from the other hand, to address the problem of smartphones' limited resources and computational capabilities to access cloud computing with the same high efficiency as traditional PCs and servers. To address the issues above and identify areas for further research, a complete understanding of the innovative computational paradigm - mobile cloud computing - is required. The characteristics of mobile devices and wireless networks pose the most significant obstacle to mobile cloud computing and its restrictions and limitations. This issue makes developing, programming, and deploying applications on mobile and dispersed devices more difficult than stationary cloud systems. The limits of mobile devices, the efficiency of wireless connectivity, the types of applications, and supports from cloud computing to smartphones are all key variables that impact assessments from cloud computing in a mobile cloud computing environment (Qi & Gani, n.d.).

3.1 Mobile cloud computing architecture

Because mobile phones are increasingly omnipresent in most people's everyday activities, organizations have been motivated to build apps conveniently accessible via mobile phones. The widespread popularity of mobile devices is due to the

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Internet, GPS, and gaming apps. On the other hand, mobile device designers have some design problems due to restricted resources (for instance, CPU, data storage, and memory). Cloud computing is being utilized to address these issues. Today's lifestyle necessitates mobile communication devices to keep in touch. Data transmission and reception are getting more convenient. Cloud computing and mobile computing are combined in mobile cloud computing. This innovation utilizes cloud computing technology over the Internet and takes advantage of data storage and processing (Noor et al., 2018).

MCC (mobile cloud computing) is a technique that uses computing resources that are not on the smartphone. Computing, mobile storage resources, and significant power restrictions related to restricted battery lifespan contribute to a slowdown in mobile hardware. The smartphone should submit jobs to an outside cloud service to efficiently process large-scale workloads (Arun & Prabu, 2018).

Its operation characteristics determine the MCC's whole architecture. Mobile devices use base stations to communicate to networking to execute their tasks. These stations create and manage network and smartphone connectivity and implementation. This design sends messages and requests to the centralized processor interconnected to the servers that provide mobile network services. The requests are processed by cloud administrators, who then offer the appropriate cloud services to mobile users (Eshtawie, n.d.).

Data security concerns characterize several MCC architecture models (Tawalbeh & Saldamli, 2021). MCC's service-oriented architecture (SOA) has three layers: mobile network, Internet service, and cloud service (Arun & Prabu, 2017).

1) Mobile User Layer. This layer comprises numerous mobile cloud service customers who utilize their devices to access cloud services (e.g., smartphones and tablets). Wireless Access Points (WAPs), Base Transceiver Stations (BTS), or satellites connects these smartphones to the Mobile Network Layer (Noor et al., 2018).
2) Internet service: The internet service connects every mobile network and the cloud. Customer requests are sent over a high-speed Internet connection to the cloud. The user may obtain smooth service from the cloud via wired connections

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or advanced 3G or 4G technologies, including HSPA, UMTS, WCDMA, LTE, and so forth (Arun & Prabu, 2017).

3) Cloud Services Provider Layer. This layer comprises several different service providers who offer various cloud services such as IaaS, PaaS, and SaaS. These cloud computing services are flexible, expanding or bringingown based on demand (Noor et al., 2018). The cloud controller receives all of the demands from the customers, analyzes them, and delivers service to them in accordance with their needs (Arun & Prabu, 2017).

To operate high-end applications, the battery capacity of a smartphone is restricted. When moving, it is impossible to rely on other external power sources. The battery's charge will be depleted within a few hours about limited storage capacity. Every mobile device comes with 8 GB of storage, whereas a laptop comes with 500 GB. Also, external memory can be added to it. And about Limited processing capacity. Because an ARM CPU powers the smartphone, it can only execute a limited number of programs. Laptops with various processors (i3, i5, and i7) are accessible. However, they are extremely expensive for mobile devices. If someone wants to update their mobile device's processor, they will be unable to do so. In the end, low Bandwidth, EDGE, GPRS, and GSM are examples of traditional technologies with limited bandwidth. Sophisticated technologies like 3G and 4G provide high bandwidth. However, they are only available in established cities and towns (Somula & Sasikala, 2018).

3.2 The Benefit of Mobile cloud computing

Mobile cloud computing offers several benefits to both end-users and organizations of all sizes. The obvious and significant benefit is that customers no longer need to care about infrastructure ore aware of its development and maintenance (Journal et al., n.d.). Mobile cloud computing offers a distinct advantage over other structures because of its architecture (Eshtawie, n.d.). So, MCC is responsible for:

1) Enhancing battery lifetime: Because data storage and processing occur from outside the phone and in the cloud with MCC, the device's battery performance is automatically extended. Any big processing speedily depletes the battery

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because it uses a lot of power (Arun & Prabu, 2017). MCC developed a scheme for saving battery life by transferring resource-intensive apps to the cloud, completing the operation and sending the results back to the mobile device (Somula & Sasikala, 2018).

2) Storage: Especially contrast to the personal computer, the cloud can handle and store much more data. There will be no further infrastructure expenditures or effort devoted to adding new servers. The cloud eliminates concerns about running out of data storage while also reducing the need for enterprises to replace their computer hardware, lowering total IT costs (Arun & Prabu, 2018; Journal et al., n.d.).
3) Enhancing processing power: Several applications, for example, transcoding, gaming, and streaming multimedia services, require a lot of processing power provided by shifting activities to the cloud (Arun & Prabu, 2017).
4) Disaster Recovery and Backup: Almost all cloud computing providers, depending on the type of service or technology, provide extensive, dependable, and adaptable backup and recovery services. The technique of backing up and restoring data is easier when using the cloud since the data is now stored on the cloud rather than on a physical machine. In certain situations, the cloud is utilized merely as a backup repository for data stored on local systems (Journal et al., n.d.).
5) Scalability: Mobile apps may be scaled up and down to accommodate new customers' requirements. Web scalability, Cloud scalability, and portable scalability in terms of mobile consumers and gadgets are the three elements of scalability (Mishra et al., n.d.).
6) Reliability: compared to a smartphone, the cloud always seems to be reliable. Protect applications that include virus detection and malicious software identification may be run in the cloud using cloud renders. MCC provides different authentication techniques to prevent unauthorized users from accessing cloud resources or private information to spare users from installing on local computers (Somula & Sasikala, 2018).

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4. Discussion

Cloud computing can interconnect various data and applications from different location to serve the users. Users benefited a lot from distributed cloud computing because distributed cloud computing can share data between multiple users in different locations. Also, mobile cloud computing provides extensive computing resources to mobile consumers because of its capabilities. Users can gain certain benefits from distributed cloud computing. Each benefit impacts how users utilize cloud technology and mobile computing because mobile computing combines cloud and mobile computing.

A crucial feature focused on more than one resource is the load balancing feature in CC. With load balancing, Users can distribute tasks between different servers to improve performance and balance them. Also, a load balancing approach can improve cloud computing performance while maximizing resource consumption.

Another feature that improves mobile devices' power efficiency and performance, both powerful servers and various mobile devices are employed. It is feasible to achieve two different goals through a new paradigm: increasing smartphones' lifetime and providing a new chance to speed up mobile apps.

Enhancing scalability is another aspect that has been discussed in several papers. This is accomplished by leveraging the use of multiple devices to conduct computation and allowing multiple devices to contribute compute requests without significantly raising request latency.

As indicated in Table 1 and Table 2, there are several benefits to adopting distributed cloud computing and mobile cloud computing. Each benefit impacts how both of them are used.

Table (1): Summary of Distributed Cloud Computing.

Feature	(Z. A. S. A. et al Najat Z, 2019)	(Miguel Castanheira Sanches, n.d.)	(Salem, n.d.)
process a batch or a stream of data		✓	
support scalability		✓	
reduced latency times	✓	✓	

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achieve high performance			
high resource utilization			
performing huge processing	✓		✓
utilizing power via cloud domain	✓	✓	
reduce a huge amount of processing power	✓	✓	✓

Table (2). Summary of Mobile Cloud Computing

Feature	(He et al., 2018)	(Z. A. S. A. et al Najat Z, 2019)	(Borcea et al., n.d.)	(Salem, n.d.)	(Mishra et al., n.d.)
solve a long-standing problem			✓		
identity-based signature scheme	✓				
less computation time	✓				
Fewer communication costs	✓				
parallel computations	✓	✓			
better performance	✓	✓			
power saving		✓			
Improve performance		✓		✓	
Huge Computation saving				✓	
Increasing Scalability					✓

5. Conclusion:

From the discussion details and comparison tables illustrated in section 4, it can be concluded that for distributed cloud computing, the previous works focused on: reducing the latency time, performing massive processing, utilizing power via cloud domain, and reducing a considerable amount of processing power. However, the researchers contributed to the processing stream of data and supported the scalability. But they didn't go in deep to achieve high performance and resource utilization. In contrast, mobile cloud computing focused on parallel computations and enhanced the system's performance. These achievements contributed to solving a long-standing problem, identity-based signature scheme, less computation time and

communication costs, huge computation saving with heavy loads, and increasing scalability. The main goal of this paper is related to MCC, which MCC incorporates cloud computing into the mobile environment, allowing users to access resources as needed. MCC concerns include security to ensure that unauthorized individuals do not access critical data and information stored in the cloud. Future work that has to be considered carefully while developing a mobile cloud is security.

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دابەشکردنی سیستەمی هەوری و سیستەمی هەوری موبایل: پێداچوونەوە

پـوخـتـە:

هەڵگرتن و کۆکردنەوەی زانیاری لەڕێی تەکنەلۆژیای هەورەوە ناوبانگێکی زۆری دروستکردوە، بەهۆی توانای ئەم تەکنەلۆژیا نوێیەوە بەسەر هەموو بوارەکانی کۆمپویتەر و دابینکردنی سیکویریتی بۆ هەموو بوارەکان. لە جیهانی زانستی کۆمپیوتەردا سیستەمی هەوریی بیرۆکەیەکی تازەیە. بەکارهێنەرەکان لە ئامێرەکانیاندا سەرچاوەیەکی کەمتر بەکاردەهێنن و زیاتر پشتدەبەستن بە سەرچاوەی هەوریی. سیستەمی هەوریی و سیستەمی موبایل لەگەڵ وایفای تۆڕەکاندا بەیەکەوە کاردەکان بۆ پێکهێنانی سیستەمی هەوری موبایل. لە لایەکی ترەوە موبایلەکان توانای دەستکەوتنی سەرچاوەیەکی زۆری زانیاری هەیە بۆ بەکارهێنەرانی موبایل بەهۆی توانا و گونجاویان. سیستەمی هەوری هەموو ئەو سەنتەری زانیاریانە دەگرێتەوە کە بەردەستە بۆ هەموو بەکارهێنەرەکان لەڕێی ئنتەرنێتەوە. ئامانجی ئەم پێداچونەوەیە بریتیە لە پێناسەکردنی پوختەیەک دەربارەی سیستەمی هەوری بۆ کومپیوتەر لەگەڵ سیستەمی هەوری بۆ موبایل. ئەم پێداچونەوەیە چۆنیەتی گەیاندن و پێکهاتەی هەوری دەگرێتەوە لەگەڵ خزمەتگوزاریەکانی سیستەمی هەوری موبایل.

الحوسبة السحابية والمتنقلة الموزعة: مراجعة

الملخص:

ازدادت شعبية تخزين البيانات المستندة إلى السحابة في الآونة الأخيرة بشكل ملحوظ ؛ نتيجة لمرونتها ومخاوفها بشأن الأمان والسرية في عالم علوم الكمبيوتر ، تعد الحوسبة السحابية مفهومًا جديدًا نسبيًا. يستخدم المستخدمون القليل من مواردهم الخاصة مع زيادة اعتمادهم على موارد السحابة. يتم الجمع بين الحوسبة السحابية والحوسبة المتنقلة والشبكات اللاسلكية في الحوسبة السحابية المتنقلة (MCC)من ناحية أخرى ، تتوفر في الهواتف المحمولة

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موارد حسابية هائلة للمستهلكين المتنقلين نظرًا لقدراتهم. ومن ناحية أخرى ، تشير الحوسبة السحابية إلى مراكز البيانات التي يمكن الوصول إليها عبر الإنترنت لعدد كبير من الأشخاص. ام الغرض الاساسي من هذه الملخص هو تقديم لمحة عامة عن الحوسبة السحابية والحوسبة السحابية المتنقلة. لتغطي الدراسة نماذج التسليم والنشر للحوسبة السحابية ، فضلاً عن السمات الرئيسية للحوسبة السحابية المتنقلة.