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MOBILE CLOUD COMPUTING


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## ABSTRACT

This case study analyzes the use of Mobile Cloud Computing (MCC) in Facebook's mobile application to address the limitations of mobile devices. Mobile devices face constraints in processing power, storage, and battery life, which make it difficult to support data-intensive features such as multimedia sharing, live streaming, and personalized content. Through qualitative analysis of existing studies and system architecture, this research evaluates how Facebook offloads computation and storage to cloud infrastructure to enhance performance and scalability. The study highlights MCC as a key technology for modern mobile applications and underscores its relevance for future mobile social media platforms.

Keyword: Mobile Cloud Computing, MCC, Facebook

## 1.0 BACKGROUND

The advancement of science and technology has brought numerous benefits to human civilization, especially in the way information is created, shared, and accessed. Over the last few decades, there have been significant development in digital communication and information exchange. With the widespread adoption of smartphones among everyone, this further transformed how people stay connected, communicate, and access the information. This transformation led to the creation of social media applications, which have become an important medium for communication, content sharing, and community engagement regardless of physical boundaries in modern society today.

The existence of social media applications and the increasing reliance on mobile devices have contributed to the emergence of mobile computing, a computing paradigm that utilizes computing devices in a state of mobility where it enables users to access data and applications through mobile devices that are connected wirelessly to the network. This Mobile Computing encompasses a wide range of electronic devices, ranging from laptops, tablets, smartphones, and even wearable technology.

The technologies of mobile computing offer several advantages such as portability, flexibility and real-time access to application including the information via wireless networks. But despite these advantages, the mobile devices inherent several limitations such as resource scarcity like CPU and RAM, limited processing power, restricted storage capacity, high power consumption, frequent network disconnections, and scalability constraints [1]. These limitations become more evident and apparent when the mobile devices are used to support complex social media applications that require high computational power, large-scale data handling, intensive data processing, and continuous interaction [2]. As a result, these challenges show that the mobile devices alone are insufficient to handle modern social media applications today. Thus, this highlights the need for a solution that can extend the capabilities of the mobile devices

The modern social media applications have evolved beyond simple communication tools, and they are becoming more complex as more features are incorporated to meet user demands, like multimedia content processing, live streaming, and personalized recommendations. These feature-rich social media applications are designed not only to fulfill user needs but also to improve the user experience. However, deploying such complex social media applications on mobile devices places heavy demands on the performance and processing capabilities of mobile devices [1].

These issues introduce several challenges faced by social media applications operating in mobile computing environments. One of the primary challenges is performance limitation, as the advanced functionalities require substantial computational resources and processing power to perform well, which mobile devices often are unable to support these demands due to their constrained of mobile resources like limited CPU and RAM capacity [3]. Other than that, social media applications are known to produce and handle large volumes of data that require frequent access, such as user-generated data, images, videos, and live streaming media. This can pose a significant challenge to manage, store, and process the data locally as most of mobile devices are designed with limited storage capacity to support a high volume of data [2]. In addition, the data-intensive workload can lead to high power consumption, and mobile devices alone are not adequate to support the demand as it has limited battery capacity [1].

Furthermore, social media applications are often involved with real-time processing and continuous interaction to support services like instant messaging and live content streaming. These kinds of features in social media applications require low latency and continuous processing, which is difficult to achieve in a mobile computing environment only as it has limited computational resources and faces an unstable network [1]. As a result, mobile computing alone is not sufficient to support the demand for real-time performance required by modern social media applications today.

Moreover, scalability becomes another significant challenge as the number of media social application users continues to increase because supporting a large number of users at the same time requires computing resources beyond what mobile computing alone can offer [4]. Thus, this further shows the limitations of mobile computing in handling modern social media applications.

All of these challenges demonstrate that mobile devices are insufficient to support the increasing demands of modern social media applications. Henceforth, it highlights a need for an extended computing approach that can support and extend the capabilities of mobile devices[5]. These issues had led to the discovery and adoption of cloud computing in mobile environments, which is known as Mobile Cloud Computing (MCC). The MCC can provide and offer support such as computing power, storage, scalability, and other capabilities that mobile computing alone is insufficient to deliver, particularly for critical functions in social media applications [6].

Among existing social media applications, Facebook represents a prominent case for this project because it has a large user base and the application itself is equipped with data-intensive features [7]. Thereby, Facebook operates in a highly dynamic mobile computing environment as performance, data management, real-time interaction, and scalability are critical requirements for Facebook [1][4]. Thus, based on the scale and complexity of the Facebook application, it can clearly reflect the challenges faced by most modern social media applications

## 2.0 OBJECTIVE

The main objective of this case study is to analyse the use of Mobile Cloud Computing (MCC) by social media applications such as Facebook. This case study focuses on understanding on how MCC addresses the limitations of mobile computing by offloading tasks like computation, data processing, and storage to cloud infrastructure. Furthermore, this case study aims to investigate the application of cloud resources in Facebook's mobile architecture and evaluate the impact of MCC on Facebook. Additionally, this case study aims to identify challenges and limitations associated with the use of MCC in social media applications like Facebook.

## 3.0 METHODOLOGY

This case study uses a qualitative case study approach to examine the implementation of Mobile Cloud Computing (MCC) in social media mobile applications. This methodology approach is appropriate for this case study because it allows an in-depth analysis of a real-world application of MCC within a large-scale and widely used social media platform. In this case study, this approach focuses on understanding how MCC technologies are used, the problems they address, as well as their impact on user experience and system performance of the mobile application rather than focusing on numerical measurements.

The data utilized in this research was gathered from established literature and trustworthy online references. This encompasses scholarly journal articles, conference documents, technical reports, and authorized engineering blogs released between 2020 and 2025. Additionally, the perspective was also taken from well-regarded technology sites and official publications from Meta that outline Facebook's system design and cloud framework. These sources provide sufficient evidence to understand how Mobile Cloud Computing supports mobile social media applications.

Based on the comparison in Table 1.0, Facebook demonstrates the most comprehensive and complex implementation of Mobile Cloud Computing among social media applications. Unlike other platforms that rely on public cloud services for content delivery, Facebook operates a hybrid multi-cloud architecture where it integrates private data centres, edge computing, and cloud-based mobile augmentation [6] [7]. Its hybrid multi-cloud architecture allows Facebook to support its complex computation-intensive features such as real-time personalization, large-scale multimedia processing, and cross-device synchronization [??].

Henceforth, Facebook is an appropriate candidate for this in-depth MCC case study for a social media application. The characteristics of Facebook is suitable for analysing MCC architectures, challenges, and outcomes in large-scale social media environments. Another reason Facebook is selected as the primary case study because its Mobile Cloud Computing implementation is extensively documented through academic literature, engineering publications, and public technical disclosures. Unlike other social media applications, their architectural transparency is limited[8][9].

A general comparison was made between several popular social media applications such as Facebook, Instagram, TikTok, and Twitter. This comparison helps to understand how different platforms implement cloud computing in their mobile application environment and highlights the differences in scale, complexity, and MCC usage. The comparison table focuses on the aspects of cloud usage, computational offloading, multimedia handling, and scalability.

The goal of this comparison is not to analyse each platform in depth, but it to show that the Facebook platform operates at a much larger scale and requires a more advanced MCC architecture compared to other social media applications. Based on this comparison, Facebook

*Table 1.0: Comparative Analysis of MCC Adoption in Social Media Applications*

| MCC Aspect | Facebook | Instagram | TikTok |
|---|---|---|---|
| Cloud Used | Hybrid multi-cloud<br><br>(Combination of Private cloud and public cloud) | Use Private cloud from Meta | Public cloud |
| Ownership of Infrastructure | Owns and operates global private data centres | Relies on Meta shared infrastructure | Relies on third-party cloud providers |
| MCC architecture Type | Full MCC with Cloud-Based Mobile Augmentation (CMA) | Cloud-heavy MCC for media delivery | Cloud-heavy MCC focused on content delivery |
| Computational Offloading | Extensive offloading (feed ranking, AI, video processing, storage) | Moderate offloading (image/video processing) | Heavy offloading mainly for video streaming |
| AI/ML Processing | Cloud-based AI for feed ranking, ads, content moderation, recommendations | Shared Meta Cloud AI services (Use for share engagement ranking) | Cloud AI for video recommendation |
| Edge/CDN utilization | Use global CDNs, Edge Fabric, Points of Presence | Uses Meta CDN | CDN-focused mainly for streaming |
| Multimedia Scale | Extremely high (photos, videos, live streaming, stories) | High (images, short videos) | Very high (continuous video streams) |

was identified as the most suitable application for detailed case study analysis.

### 4.0 ANALYSIS

With the increase in complexity of social media applications and the use of mobile devices, as well as the success of Cloud Computing, the concept of Mobile Cloud Computing (MCC) technology has been introduced. This MCC technology is known as a new computing paradigm that incorporates Cloud Computing and Mobile Computing to alleviate the shortcomings of the mobile devices [5] [6]. It refers to an infrastructure where both data processing and data storage happen outside of the mobile devices.[10]. This means in MCC, computing resources such as memory, processing, and storage are not actually present at the device of the user. Instead, these resources are moved to a remote location known as the cloud, and it's typically owned by a service provider [11]. Thus, MCC was created specifically to overcome limitations of mobile devices like CPU, storage, and battery by offloading the computation and storage to the cloud infrastructure[1].

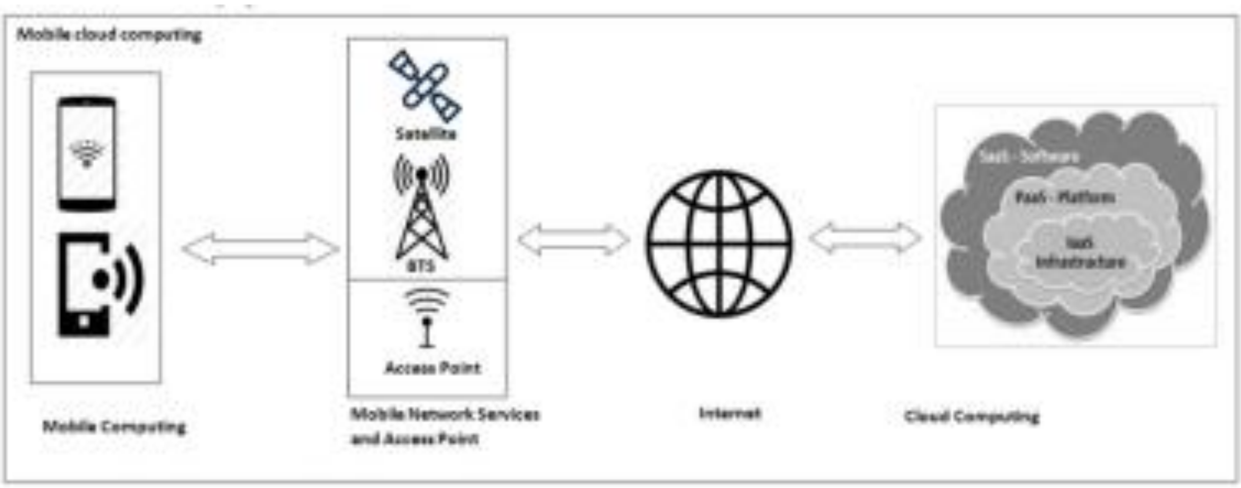


*Figure 1: MCC Architecture*

As illustrated in Figure 1.0 and stated by [10], the infrastructure of Mobile Cloud Computing (MCC) consists of heterogeneous mobile devices, networking infrastructure, and cloud computing resources. In this architecture, mobile devices such as smartphones, tablets, and laptops are connected to cloud services via wireless networks and the internet. This interconnected structure allows the mobile devices to transfer all intensive computation and data processing tasks from resource-constrained mobile devices to cloud servers[5]. As stated by [6], this MCC environment is typically supported by a software paradigm called Cloud-Based Mobile Augmentation (CMA). Through this approach, it allows mobile applications such as Facebook to focus on user interaction and lightweight processing at the mobile device, while the cloud helps by performing heavy processing and storage operations on its behalf [12].

Based on [13], cloud computing further provides mobile applications with several service models to support their mobile environments, which include Platform as a Service (PaaS), Software as a Service (SaaS), and Infrastructure as a Service (IaaS). These service models offer various scalable computing power, development platforms, and application services that can assist MCC-based applications in delivering their rich functionality, real-time interaction, and large-scale data to their mobile users more efficiently.

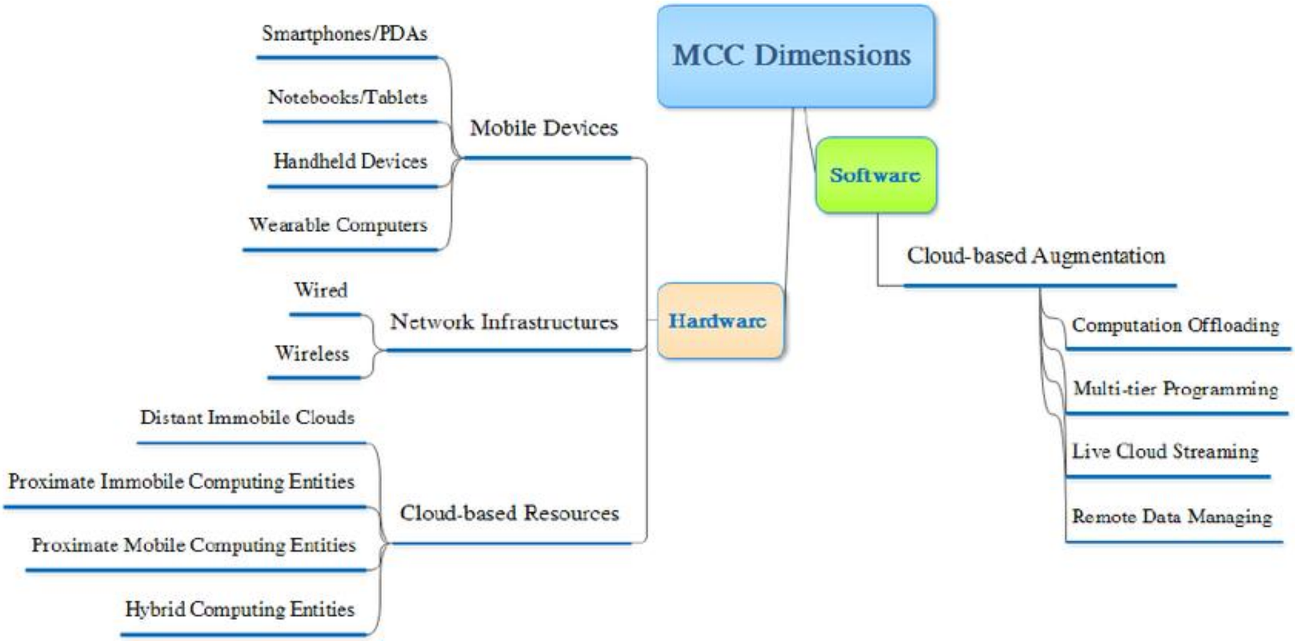


*Figure 2: Internal Dimensions of MCC*

As illustrated in Figure 2.0, the Mobile Cloud Computing (MCC) framework can be further explained through its internal dimensions, which consist of mobile devices, network infrastructures, cloud-based resources, and software-based augmentation mechanisms. This framework shows that mobile devices such as smartphones and tablets function as access points for user interaction, while the network infrastructure allows connectivity to happen between mobile devices and cloud resources through wired and wireless networks [10].

Furthermore, this architecture it highlights the role of Cloud-Based Mobile Augmentation (CMA), where the limitations of mobile devices are addressed by augmenting them with external cloud computing resources[6]. This approach shows that mobile devices can offload their computation-intensive tasks, manage remote data storage, and support live cloud streaming via stable network connectivity[5]. Additionally, the MCC dimensions demonstrate how software-level augmentation techniques enable applications to dynamically utilize cloud resources such as distant immobile clouds, proximate computing entities, and hybrid cloud environments. Henceforth, this architectural model provides the foundation for scalable, high-performance mobile applications that require intensive computation, real-time processing, and large-scale data handling beyond the capabilities of mobile devices [12].

The Context

*Figure 3: Facebook Application*

The context of this case study involves user of the Facebook application who often access the application through their mobile devices, such as smartphones and tablets, as part of their daily routines. According to [14], Facebook was the first social network that surpass one billion registered accounts, and as of 2025, there are more than three billion active users. This shows that Facebook is a large-scale global social media application with its users coming from diverse types of backgrounds, age groups, and geographical locations. For this reason, the Facebook mobile application must be capable of supporting a wide range of devices while making sure that the application can deliver consistent performance for all users, as those people experience varying device capabilities, network bandwidth, and latency conditions. In addition, mobile device users often alternate between different network types such as Wi-Fi and cellular data, which can result in unpredictable connectivity [1]. This further highlights the importance of using MCC architecture in Facebook's mobile application.

According to [15], the average mobile user spends over 2 hours and 24 minutes every day on social media applications. Furthermore, based on [16], Facebook user spends approximately 19.42 hours per month, which is equivalent to 35 minutes daily on the platform in 2025, ranking it as the third most engaging social media application globally. Additionally, hundreds of millions of photos are taken daily, and billions of videos are uploaded and viewed worldwide, creating an enormous volume of multimedia data that must be stored and processed. About 98.3 percent of Facebook users choose to access the platform on their mobile devices [17]. These usage patterns demonstrate that Facebook's mobile user base is both extensive and highly active, which emphasizes the necessity of a robust Mobile Cloud Computing architecture.

## Research Outcomes

The implementation of Mobile Cloud Computing (MCC) by Facebook in its mobile application has shown significant positive outcomes in terms of performance, scalability, and user experience. One of the positive impacts of the application's implementation can be seen in [1] is that Facebook can deliver a responsive and feature-rich application to users, even on users' mobile devices who have limited processing power and memory. All the computation-intensive tasks like content processing, feed ranking, recommendation generation, video rendering, and data storage of Facebook that are offloaded to cloud infrastructure enable mobile applications to achieve faster content loading, smoother scrolling, and reduced application latency [18]. For this reason, mobile devices that have limited CPU and RAM can run Facebook efficiently without performance degradation. Thus, this MCC implementation in Facebook improves overall performance and responsiveness of Facebook's mobile applications.

In addition to performance improvements, [10] shows another positive impact of the MCC implementation on the Facebook mobile applications which is the MCC allow Facebook to dynamically scale its backend resources to accommodate billions of concurrent users across different geographical regions. The use of distributed cloud data centres and content delivery networks (CDNs) by Facebook, the Facebook able to efficiently manage its own peak traffic demands effectively while delivering content with low latency, regardless of its user location.

In [1] , it stated that one of the key benefits of MCC implementation in Facebook is that MCC can help Facebook support its data-intensive multimedia ecosystem, where there are massive volumes of photos, videos, and live-streaming content that are uploaded and consumed daily in the Facebook mobile application store and processed in the cloud. For this reason, Facebook can minimize local storage consumption and ensure rapid content retrieval as well as ensure seamless playback for a user experience.

Additionally, [19] stated that the use of cloud to process complex computation artificial intelligence for Facebook's mobile application allows Facebook to deliver personalized news feeds, targeted advertising, and automated content moderation effectively to all its users. These advanced features require large-scale computational resources, which are not suitable for execution on mobile devices solely. Therefore, MCC implementation for this can significantly enhance the relevance and quality of user interactions. Coupled with this, the use of MCC in Facebook's mobile application enables Facebook users to switch seamlessly between different types of mobile devices while preserving session continuity, preferences, and content states for the users through cloud servers[10]. This allows users to continue their activities and experience smoothly across smartphones, tablets, and desktops without interruption. Hence, this MCC implementation in Facebook improves user experience and accessibility.

Even though MCC can significantly improve performance, scalability, and functionality, it can also introduce several challenges and negative outcomes for mobile applications. This includes heavy dependency on network connectivity, increases in power consumption, latency, and security issues. Despite the advantages offered by MCC, the MCC architecture heavily depends on stable network connectivity to compute data processing and deliver it to mobile devices. If the mobile users experience weak or unstable connections, as a result, the user can experience delays in content loading, interruptions in live streaming, or failure in data synchronization [1].

Therefore, mobile applications that require consistent interaction and synchronization, like Facebook, can be highly affected by network quality and bandwidth activity. Besides, [??] stated that the mobile application, like Facebook can still be affected by latency, even though the MCC helps enhance processing capabilities for mobile applications. This latency can affect real-time features of Facebook such as live video streaming and instant messaging. Network congestion and the server distance from mobile devices will introduces delayes that can impact time-sensitive interaction. Hence, mobile application like Facebook may face potentials delays in real-time communication and inconsistent quality for user experience.

Whereas continuous communication of a mobile device with cloud servers can substantially increase power consumption due to frequent real-time data processing, continuous network communication as well as background synchronization processes. Activities such as video streaming, real-time updates, and background synchronization will lead to faster battery depletion on users' mobile devices [6]. Hence, this approach for mobile applications can negatively impact battery life especially during prolonged usage of Facebook's multimedia features.

Next, Based on the author in [20], the MCC architecture raises a concern related to data privacy and security in the cloud since large volumes of personal users' data are transmitted and stored in the cloud. For this reason, the data transmitted and stored within the cloud are always in the risk of unauthorized access, data breaches and privacy violations. Although Facebook employs encryption and security mechanisms, concerns regarding user data protection and compliance with regional data protection regulations remain an ongoing challenge, especially given Facebook's global user base [??].

## 5.0 DISCUSSION & SUGGESSTION

The success of MCC implementation in Facebook's mobile platform lies in it ability to deliver a smooth, responsive, and feature-rich experience to all its users across a wide range of mobile devices. It can be seen that overall, the implementation of Mobile Cloud Computing (MCC) in Facebook's mobile application can be considered successful in supporting both its large and diverse user base as well as its large-scale social media services.

From a user perspective, Facebook performs consistently well across different types of mobile devices, and its users also benefit from the MCC implementation. Through MCC, every user is able to access the most advanced version of the platform at all times without requiring manual app store updates, as heavy-demand processing is not done on their mobile devices [1]. This also contributed to more efficient battery usage, as offloading resource-intensive operations to the cloud can prevent the device from overheating during prolonged interaction of the user with the application [1]. This is mainly because Facebook's computation-intensive tasks, such as content ranking, multimedia processing, and personalization, are handled by its global data centre (cloud environment) rather than users' mobile devices. As a result, the Facebook mobile application can ensure users are able to experience faster loading times, smoother scrolling, and fewer performance-related issues even when using lower-end devices.

However, the MCC in Facebook also introduces several challenges that can affect the overall user experience. Since most application functionalities rely on cloud processing, Facebook's mobile application depends on stable network connectivity to deliver a smooth experience to its users[3]. In addition to that, as large volumes of personal user data are continuously transmitted, stored, and processed in the cloud, it raises concerns among users related to their data privacy [4]. Although Facebook applies security measures such as an encryption mechanism to protect user information, some users remain cautious about how their data is handled in the cloud. Therefore, even though Facebook considered success in delivering a scalable and high-performance mobile application experience to its users, the overall user experience is still influenced by external factors such as network reliability and user trust in cloud-based data handling.

## 6.0 CONCLUSION

In conclusion, this case study has demonstrated that Mobile Cloud Computing (MCC) plays an important part in modern social media applications today. Through the analysis of Facebook as a representative case, it's proven that MCC effectively addresses issues related to inherent mobile device limitations such as limited processing power, storage capacity, battery life, and scalability in mobile computing environments. The analysis of this case study shows that traditional mobile computing alone is insufficient to support the performance, scalability, and real-time interaction required by a social media platform.

However, Facebook is capable of delivering a responsive, feature-rich rich and scalable mobile application experience to its users across a wide range of mobile devices by offloading intensive computation tasks like data processing, multimedia handling, and artificial intelligence operations to cloud infrastructures. Hence, this successfully demonstrates that MCC can effectively enhances both system performance and user experience in a large-scale mobile social media environment.

However, the findings also highlight several challenges that are faced by social media applications like Facebook when implementing Mobile Cloud Computing. This includes heavy dependence on network connectivity as Facebook's reliance on the cloud for storing and processing means that network instability can negatively affect the application performance. Moreover, continuous cloud communication and data synchronization between mobile devices and the cloud can increase the power consumption on mobile devices. While the storage and processing of large volumes of personal data in the cloud raises ongoing concerns among users related to data privacy and security. These challenges indicate that even though MCC enhances functionality and performance, the overall user experience is highly influenced by external factors.

The findings of this study not only applicable to social media application like Facebook but it also provides valuable insights for other large-scale mobile applications that require real-time processing, multimedia handling, and global scalability. As mobile networks, edge computing, cloud security technologies, and artificial intelligence continue to evolve, the MCC is expected to become even more efficient, reliable, and remain as a key computing paradigm in future mobile systems. The rise of artificial intelligence in every aspect of life, the MCC paradigm expected to reach beyond individual device performance. Overall, the Facebook case study proved that a mobile phone doesn't need to be super powerful as long as it has a strong connection to a super powerful cloud.

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