Advances inMobile Cloud Computing

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Abstract: *As advances in technology occur, mobile cloud computing is able to overcome the issue of resource poverty that occurs in mobile devices. Manufacturers now look at cloud computing as an asset because they can run their products better. The number of businesses and individuals that are investing in cloud computing services is anticipated to grow rapidly. Rapid growth of this nature will have a large impact in the IT industry. This study shows that cloud computing, including mobile computing, is a major contribution to the expansion of output and employment within the IT sector. An improvement in performance is making mobile cloud computing a better choice for consumers. In recent years, changes in the mobile cloud computing framework have enabled engineers to offload computational processing to other systems in the cloud that dramatically improve the mobile device experience.*

Keywords:*mobile cloud computing employment; advances in cloud computing; mobile cloud computing jobs; mobile cloud service; mobile cloud job growth.*

I.   Introduction

Csorny [1] states software developers and computer systems analysts are among the list of jobs cloud computing vendors employ to keep up with the increase in demand for cloud computing services. Furthermore, Csorny [1] notes that the application development field, in particular, is projected to grow fifty-seven percent from 2010 to 2020 due to the increased need for development of design software that is offered through mobile cloud computing. The rapid increase of smart mobile devices has given rise to a mobile app economy that brings new opportunities for employment. Fig. 2 presents the projected change in employment for years 2010 to 2020 in the computer systems design industry. In Information Week, LS Subramanian [2] noted that cloud computing can manufacture communication in a secure and simple way; he also noted that employees can maximize this potential by enhancing operations using their mobile devices.

Louis Columbus [3] from Forbes mentioned that SalesForce expanded manufacturing with their cloud platform automated ordering process. Columbus [3] thinks that manufacturers depend on their mobile devices more than past years. For manufacturers to benefit their mobile devices and take advantage of the automated process, they need to enter in the customer's personality on purchasing products into the system. Columbus [3] also states it is beneficial to figure out why the customer is purchasing such items.

Is mobile cloud computing growing enough to increase the demand for manufacturing jobs? Should businesses use more mobile devices to generate additional manufacturing jobs, or is it as simple as having more mobile devices built for sale by

those manufacturing mobile devices? Is mobile cloud computing growing fast enough to increase the demand for mobile devices to generate manufacturing jobs? Further study by Staten, Csorny, and Minnick show why advances in mobile cloud computing exists and the answer is businesses using more mobile devices as stated by Subramanian and Columbus. As a solution, more mobile devices may need to be manufactured in order to keep up with customer orders as mentioned by Columbus.

Mobile cloud computing is part of the expansion that is a leading contribution to the increased growth in output and employment in the IT industry. One avenue for mobile cloud computing is that rapid growth is expected to have high in-demand service in markets such as software, hardware, and IT outsourcing. The performance of mobile devices assists with the offload of heavy computer processing by the use of mobile cloud technology.

This study does not demonstrate exactly how people gain employment even if reliable Internet connections are available. This study also does not address how to provide access to cloud computing, or show how to maintain payment for subscription services of cloud computing, give investment tips for cloud computing, or resolve how security breaches are mitigated.

II. Mobile Cloud Computing Advances Increase Manufacturing And Employment

A. **Technology Leads To Growth**

The proposed avenue for mobile cloud computing is to have rapid growth as a high in-demand service in markets such as software, hardware, and IT outsourcing. Staten [4] states the cloud market has the potential of reaching $191 billion by the year 2020, from $58 billion in 2013. The expansion of cloud computing, including mobile cloud computing, is a leading contribution to the increased growth in output and employment in the IT industry. Csorny [1] mentions that output in computer systems design and other related services is on target to grow 6.1 percent from 2010 to 2020, while employment is expected to grow 3.9 percent annually. Fig. 1 presents the projected average annual percent change in output for 2010 to 2020.

Mobile devices are designed to run on batteries with slower and less powerful processors than traditional computers. Applications that demand high computation and graphic manipulation need more processing power than is usually supplied by a mobile device. According to Ali et al. [5], mobile devices that run these high computation applications tend to heat up and drain the battery power sooner. In recent years, Kovachev&Klamma [6] note that mobile cloud computing framework has enabled engineers to offload computational processing to other systems in the cloud, dramatically improving the overall mobile computing experience. By allowing mobile devices to offload heavy computer processing using mobile cloud technology, mobile device designers are able to mimic traditional computer performance. This in turn enables mobile devices to use less battery power and increase uptime.

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With rapid growth and advancements in mobile cloud computing, there may be a need to increase the production of mobile devices that could generate manufacturing jobs. This circumstance rises from an increased use of mobile cloud computing by consumers and businesses. A solution to the growing need for greater access to such mobile devices is to manufacture more of these products. In an interview with Manufacturing Business Technology conducted by Minnick [7], Sanjay Rav, Director of Manufacturing at Microsoft, notes that manufacturers are implementing cloud computing into their products to run high quality models for their product development rather than emphasizing on manual sources for testing purposes.

Improved performance with mobile devices, including the offloading of computational processing to the cloud, accommodates the need for more reliable devices and results in an improvement in the entire mobile computing experience. Kovachev&Klamma [6] notes this offloading method overcomes the limitations of mobile devices in relation to computation, memory, and battery power and is essential to the expansion of mobile cloud computing. By permitting mobile devices the ability to offload large amounts of computer processing by the use of mobile cloud technology, the designers of mobile devices are able to imitate the conventional computer performance. This technique expands the capabilities of the existing mobile device, and as a result, making it a more sought after product, proving the need for greater manufacturing. According to Ali et al. [5], a technical survey shows that offloading mobile device code execution to the mobile cloud is a very promising technique to increase overall mobile device performance.

Projected average annual percent change in output and employment in selected industries, 2010−2020
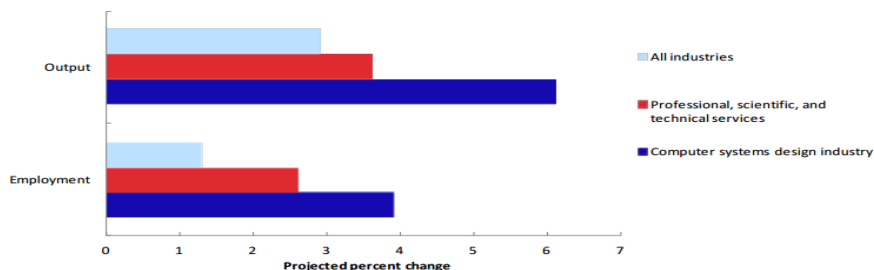
Source: U.S. Bureau of Labor Statistics, Employment Projections Program

Figure 1. Growth of output and employment in the computer systems design industry. Adapted from "Careers in the growing field of information technology services", *Beyond the Numbers: Employment and Unemployment; U.S. Bureau of Labor Statistics*, by L. Csorny [1].

B. Review

       Smart mobile computing devices have limited processing capabilities and power supply resources. According to Kumar et al. [8] in the 2012 study, A Survey of Computation Offloading for Mobile Systems, researchers are focusing on ways to offload mobile device processing to other systems. According to Kumar et al. [8], this research timeline goes back to the mid 1990's, but it was not until around 2010 when mobile cloud offloading algorithms started to be commonly used. Kovachev&Klamma [8] state offloading processing proved to increase processing performance 20 times and increase device battery life greatly. In addition, with the 2007 announcement of the Apple iPhone, DeGusta [9] mentions there was an explosion of smart mobile device manufacturing. According to Boston Consulting Group [10], improved mobile computing processing sparked an increase in employment opportunities related to this technology. As Boston Consulting Group [10] states that in 2014 global tablet sales are estimated to surpass 260 million units, mobile cloud computing offloading technology may have supplemented a significant impact in the number of new mobile cloud computing related jobs.

       The convenience and accessibility of mobile cloud computing is quickly becoming an essential part of everyday life for many consumers and businesses. According to Dinh et al. [11], mobile cloud computing provides users with extended battery life with computation offloading, improved data storage capacity and processing power with wireless networks, and improved reliability with data and applications stored and backed up on the cloud. Dinh et al. [11] states mobile cloud computing also inherits other advantages such as dynamic provisioning, scalability, multi-tenancy, and ease of integration, which makes available the use of mobile applications including mobile commerce (m-commerce), mobile learning (m-learning), mobile healthcare, mobile gaming, and other practical applications. By providing optimal services for mobile users, mobile cloud computing is swiftly becoming a top trend as a profitable business option. ABI Research [12] predicts that cloud platforms revenue is capable of generating $3.6 million in mobile enterprise applications by the year 2019. With increased use of mobile devices, including smart phones and tablets, by consumers and businesses, it is no surprise that mobile cloud computing has the capacity to impact the growth in employment concerning the IT industry.

       Boston Consulting Group [10] notes that approximately 3 million people in about 13 countries had jobs created which included manufacturing of mobile devices in Asia. As stated in the Information Management Journal by Frost & Sullivan [13], increased contact with cloud technologies may lead to wider adoption. Has wider adoption of cloud technologies in manufacturing spurred employment growth to create new jobs? As additional findings in the next section provide insight into employment, manufacturing, and mobile devices, read on to see what the findings are.

Projected percent change in employment in selected occupations in computer systems design and related services, 2010–2020
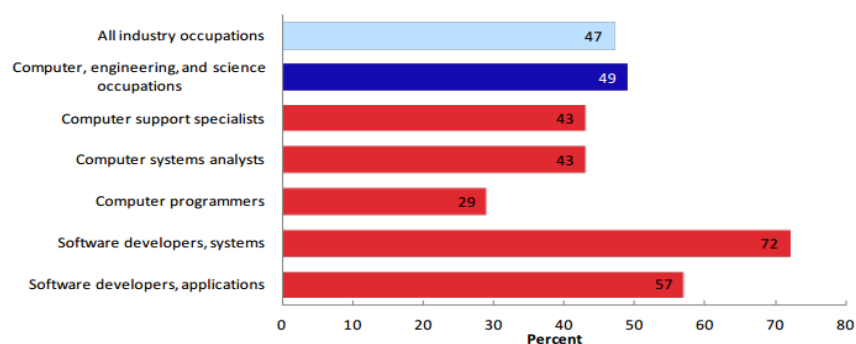
Source: U.S. Bureau of Labor Statistics, Employment Projections Program

Figure 2. Projected percent change in employment, 2010-2020. Adapted from "Careers in the growing field of information technology services", Beyond the Numbers: Employment and Unemployment; U.S. Bureau of Labor Statistics, by L. Csorny

III. Improved Technology Leads To Job Growth

       As Mestchersky [14] mentions that mobile applications are aiding in the transformation of all business operations, another part that is associated with the digital revolution is both energy to fuel an economy such as Europe and the jobs delivered by such energy. At present, Mestchersky [14] notes that 1.8 million European

jobs exist in 2013 with revenue reaching €17.5 billion by the end of the year and the growth expectation is 300%, which is €63 billion by the year 2018.
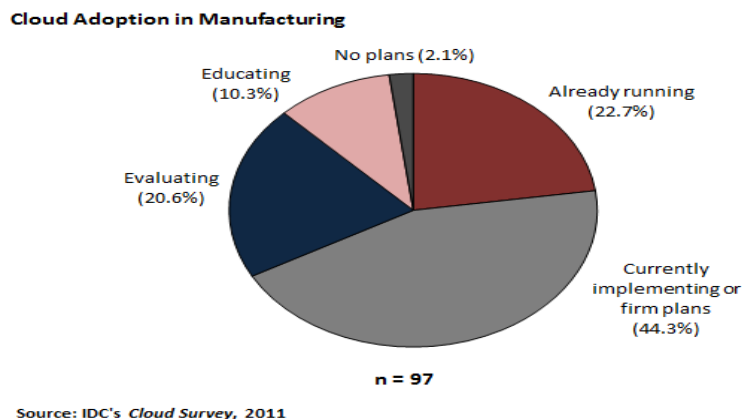
In 1964, Manyika et al. [15] noticed the economy worldwide registered at $14 trillion dollars. Five decades later, Manyika et al. [15] mentioned it has jumped up dramatically by $70 trillion to $84 trillion dollars. According to Manyika et al. [15], transitioning from the West of Europe and the United States to Asia caused this economically. In addition, Manyika et al. [15] noted a jump of how many people have employment and productivity especially with the people employed caused the GDP to rise for the past 50 years.

David Greenfield [16] projects that cloud computing is projected to grow immensely within two years in an attempt to improve capabilities and concentrate less on budgeting for not just hardware, but also software in IT. Greenfield [16] states according to ninety-seven respondents who participated in a survey as demonstrated in Fig. 3, provided by IDC Manufacturing Insights, forty-four percent believe that manufacturer firms now evaluate either deploying clouds or implementing those clouds. According to Greenfield [16], twenty-three percent of the ninety-seven respondents claimed that they have previously implemented cloud computing.

IDC Manufacturing Insights took another survey according to David Greenfield [16] and Fig. 4 notes that private clouds project expansion from 9.4 percent to 14.6 percent within the next two years. In addition, Greenfield [16] notes that public clouds are capable of growing amid manufacturers and public clouds and expand from 9.5 to 12.7 percent within the next two years.

Chunlin Li and Layuan Li [18] stated mobile cloud computing helps to combine cloud computing and wireless access service; this allows the performance of mobile applications to improve. As Darrell M. West [19] discusses mobile revenues in relation to mobile devices, he mentions that businesses that provide applications and services are listing potential revenues to rise above 1.6 trillion to $2 trillion by 2017. Another reason for the growth is that West [19] mentions mobile technology has sparked growth in new industries and has created opportunities for billions, which were facilitated by breakthroughs in research and development. One of the most important findings that West [19] states is mobile technology adds to the overall economic growth every year in a significant manner.

As advancements in mobile technology continue, Gartner [20] predicts that mobile data traffic will grow to 59 percent this year; the key driver of this growth on a global scale is mobile applications. To keep up with the growing need for mobile application platforms, cloud based development solutions have evolved and according to ABI Research [12],

Figure 3. IDC's Survey in 2011. Adapted from "Cloud Computing in Manufacturing" by Bob Parker, 2011 [17].

Cloud Share of Infrastructure Wallet in Manufacturing

Internal - we own and manage the hardware, software, and IT staff

Outsourced - a third party owns hardware and runs IT staff

Private cloud architectures (dynamic resource pools managed in-house)

Private cloud architectures hosted/managed by a third party, dedicated to my company

Public cloud services subscription, delivered over the Internet)

(% if respondents)

n = 86
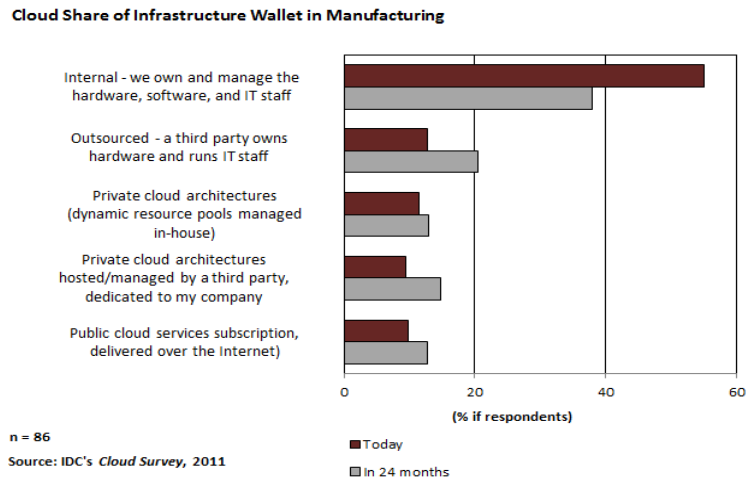Source: IDC's *Cloud Survey*, 2011

■ Today
■ In 24 months

Figure 4.IDC's Survey about Private and Public Cloud.Adapted from "Cloud Computing in Manufacturing" by Bob Parker [17].

cloud deployments will grow faster than on-premise solutions with a compound annual growth rate (CAGR) of 42.5 percent from 2014 to 2019. This year, Gartner [21] expects the mobile phone market to total 1.9 billion units and grow 3.5 percent, and the ultramobile market, which include tablets, to total 237 million units and grow 4.3 percent.

Mobile cloud computing is giving rise to new business opportunities. According to McKendrick [22], Cisco Corporation, a leading computer networking company, reports, "As many business models emerge with new forms of advertising, media and content partnerships, and mobile services including M2M, live gaming, and augmented reality, a mutually beneficial situation needs to be developed for service providers and over-the-top providers. New partnerships, ecosystems, and strategic consolidations are expected as mobile operators, content providers, application developers, and others seek to monetize the video traffic that traverses mobile networks".

IV. Applications Of Mobile Cloud Computing

Mobile cloud computing has a large number of application [14] in various fields and a wide range of potential mobile cloud applications have been recognized in the present literature. These applications are fall into different areas including natural language processing, image processing, sharing GPS, sharing Internet access, sensor data applications, crowd computing, querying and multimedia search.

4.1 Image Processing

In the authors try to experiment with running GOCR and an optical character recognition (OCR) program on a collection of different mobile devices. A similar scenario is given in [15]. If user/subscriber visit foreign museum, he can't perceive the language written in each object of the museum. He can take picture of the object and using mobile cloud computing can understand the language written over the object.

4.2 Natural Language Processing

Language translation is one possible application for mobile cloud computing. Translation is a viable candidate for language processing since different sentences and paragraphs can be translated independently, and this is experimentally explored in using Pangloss-Lite

4.3 Sharing GPS/Internet Data

Through local-area or peer-to-peer networks data can be share among a group of mobile devices that are near each other. It is faster as well as cheaper

4.4 Sensor Data Applications

Now-a-days almost every mobile devices are built with sensors which are used to read data. Some sensors such as GPS, accelerometer, thermo sensor, light sensor, clock and compass may be time stamped and associated with other phone readings. In order to gather precious information in different situation different queries can be executed.

4.5 Multimedia Search

Mobile phones may store different types of multimedia content such as videos, photos, and music. To illustrate, Shazam is a music identification service for mobile phones that searches for similar songs in a central database. In mobile cloud, the searching could be executed on the contents of nearby phones easily.

4.6 Social Networking
Since sharing different user content is a popular way and we can interact with friends on social networks such as Facebook.

V. Mobile Cloud Computing Security

In mobile cloud computing applications security and privacy are the key issues and still face some enormous challenges [18]. User's privacy and integrity of data or applications is one of the key issues in securing mobile cloud computing. It is the combination of cloud computing and mobile networks. For this the security related issues are then divided into two categories: cloud security and mobile network user's security;

5.1 Mobile Network User's Security
A large number of security vulnerabilities and threats such as malicious codes are known to the different mobile devices such as cellular phones, Smartphone's, PDAs , laptops etc. Some of the applications to these mobile devices can cause privacy issues for users [21]. There are the two major issues concerning the subscriber's security.

5.1.1 Security for Mobile Applications
The easiest ways to find security threats will be installing and running security software and antivirus programs on mobile devices. All the mobile devices are fixed with processing and power limitations. To protect devices from these threats could be more difficult compared to regular computers. To find threat detection and security mechanisms in the cloud several approaches have been developed. Before using a certain mobile application on mobile, it may go through some level of threat evaluation. First it will be verified and if malicious are not detect, file are sent to the user mobile devices. Mobile devices are performs only lightweight activities such as execution traces transmitted to cloud security servers instead of running anti-virus software or threat detection programs logically.

5.2 Securing Information on the Cloud
For storing large amount of data or applications individuals and enterprises may take advantage over the cloud. However, integrity, authentication, and digital rights of data or application have to ensure during processing
.
5.2.1 Integrity
The entire mobile cloud user must ensure the integrity of their information stored on the cloud network. All access must me authenticated and verified. In order to preserving integrity for one's information that is stored on the cloud is being proposed by giving different approaches. For example, entire information stored by each individual or enterprise in the cloud network is tagged or initialized to them wherein they are the only one to move, update or delete information.

5.2.2 Authentication
To secure the data access suitable for mobile environments using cloud computing large number of authentication mechanisms has been proposed. Some uses the open standards and supports the integration of deferent authentication methods. Such as illustrating the use of access or log-in IDs, password or PINS, authentication request etc.

5.2.3 Digital Rights Management
Piracy of various digital contents such as image, audio, video, and e-book programs becomes more and more popular day by day. A numerous solution has been proposed to protect these contents from illegal access are implemented such as provision of encryption and decryption keys to access these digital contents. Before accessing such digital contents on mobile devices coding or decoding platform must be done.

VI. Mobile Cloud Computing Advantage

There are many reasons including mobility, communication, and portability cloud computing is known to be a promising solution for mobile computing. Advantages of the consolidation of both mobile computing and cloud computing are combined by mobile cloud computing, thereby providing mobile user the optimal services [23]. These advantages are:

6.1 Extending Battery Lifetime

There are several solutions have been proposed to increase the CPU performance and organizes the disk and screen in an intelligent manner to reduce power consumption. In order to fulfill these solutions may require changes in the structure of mobile devices or require advance hardware that results in an increase of cost. But these changes may not be feasible for all mobile devices. In order to execute the large computations and complex processing from resource-limited devices like mobile devices to resourceful machines such as servers in clouds several computations offloading technique is proposed. Mobile cloud computing avoids taking a long application execution time on mobile devices which may results in large amount of power consumption.

6.2 Improving Reliability

By storing data or information on clouds is an effective way to increase the reliability whereby the data and application are stored and backed up on a number of computers. Hence the chance of data and application lost on mobile devices is reduced and ultimately reliability is increased. Moreover mobile cloud computing can be designed as a significance and compressive data security model for both service providers and users.

6.3 Improving Data Storage Capacity and Processing Power

Data storage capacity is also an important constraint for mobile devices. Mobile cloud computing is developed to enhance the mobile users to store/access the large data on the cloud network through wireless networks. There are several examples which are mostly used i.e. Amazon Simple Storage Service (Amazon S3) to provide file storage on the cloud network.

6.4 Dynamic Provisioning

Dynamic provisioning of resources is a flexible way for service providers and mobile users to run their various applications without advanced reservation of resources. Without storing data in mobile device it be stored in cloud and

VII.   Conclusion

As Frost & Sullivan [13] mentioned that increased contact with cloud technologies could lead to wider adoption, adoption of cloud technologies occurred by the spurred employment growth from manufacturing more mobile devices. Furthermore, Mestchersky [14] noted that growth expectation is 300% by the end of 2013. As the economy worldwide had revenues go from $14 trillion dollars to $84 trillion dollars, Manyika et al. [15] noted that there was a jump in productivity and employment that impacted the GDP to increase during the past 50 years. From the study, our group agrees with Chunlin Li and Layuan Li [18] when they stated that mobile cloud computing has helped to combine cloud computing and wireless access service; it truly has allowed the performance of mobile applications to be improved.

Mobile cloud computing has proven to be a very active computer science field. Over the past decade, mobile cloud computing went from experimental to everyday use. Most of the growth of mobile cloud computing has occurred over the last five years. Improvements in offloading processing of mobile devices to cloud servers have helped to make mobile device applications comparable in performance to traditional computers. This makes resource starved mobile devices much more desirable for personal and business use. Offloading also improves mobile device battery life, which can give the user a better experience. Along with improved performance, mobile cloud computing has contributed to major job growth worldwide.

According to Greenfield [16], cloud computing has seen a surge in technology because it has helped the expenses of infrastructure decrease thanks to improving its power in the cloud when it comes to manufacturing. As the data presented in this study has shown how growth in the manufacturing of mobile devices has helped to create jobs, Mestchersky [14] noted that at least 1.8 million jobs came from Europe and had revenues towards €17.5 billion by the end of 2013. Minnick [7] noticed that not only cloud computing created jobs created in manufacturing of mobile devices, but also mobile cloud computing had rapid growth occur as well as advancements, which occurred partly due to implementation of cloud computing during manufacturing.

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