EXPLORING RESEARCH AND INNOVATIONS

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# Application of Smartphone in Social Area Networks: An Initiative Towards Green Computing

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***Abstract*— The growth of the population of mobile devices such as smart phones and tablets provides huge amount of idling computing power. Smart phone technology drastically reduces the use of power for doing common internet applications such as chatting, send/receive mail, downloading music, video, data from internet. Smart phones now drastically replaces the normal cell phones. Smart phones can be used not only for audio conference but for video conference as well. Smart phones can be used to implement e-learning, MOOCs, video conference and so on. It is such a device which directly can reduces the power consumptions. Green computing is the universal term used for environment-friendly computing. It utilizes the computing resources in the most efficient way without causing harm to our habitat. Smart phones are the examples of green computing devices. Green computing goals include reducing the use of hazardous materials, maximizing energy efficiency during the products lifetime, and promoting recyclability of defunct products and factory waste. In the present paper the authors tried to explore the application of smart phone to introduce green computation and to save environment. In the present paper the authors tried to explore the applications of smart phone in implementing green computing.**

***Keywords*— Green Computing, e-learning, MOOCs smart phone, tablet**

## I. INTRODUCTION

The number of communicating devices are growing dramatically. During the last 10 years, there has been a rapid increase in the power and popularity of mobile devices. Most of these devices are smart phones with 2G, 3G,4G and WIFI that gives internet capability. The consumer enthusiasm generated by the latest devices has led to a dramatic shift in personal computing. This shift is characterized by consumers moving away from traditional desktop computers in favor of their mobile devices. The magnitude of consumer enthusiasm and the degree to which the personal computing shift can be felt are made tangible by observing the total volume of mobile devices sold around the world. For example, roughly one million units of the iPhone 3G models were sold worldwide in the first weekend. Similarly, over three hundred thousand iPads were sold the first day of its release (Lance, 2009).

This excitement inevitably means that the number of these devices is increasing extremely quickly. With the success of PC like applications on the smart phones, new constraints and challenges are introduced in design and implementation of these devices. Nowadays, mobile devices such as smart phones and tablets are becoming increasingly powerful and rising quickly in popularity. According to International Data Corporation (IDC)'s statistics, 722 million smart phones were sold worldwide in 2012, surpassing the 350 million total sales of PCs (desktop and portable). From 2011 to 2014, the sales of smart phones reached an annual growth of 40% and in 2017 it assume that it will reach up to 80%. These comparisons are illustrated in Fig. 1.With the continuous growth of annual sales and the evolution of technology, it is reasonable to expect that in the near future there will be enormous amount of computing power available from smart phones and tablets all over the world.

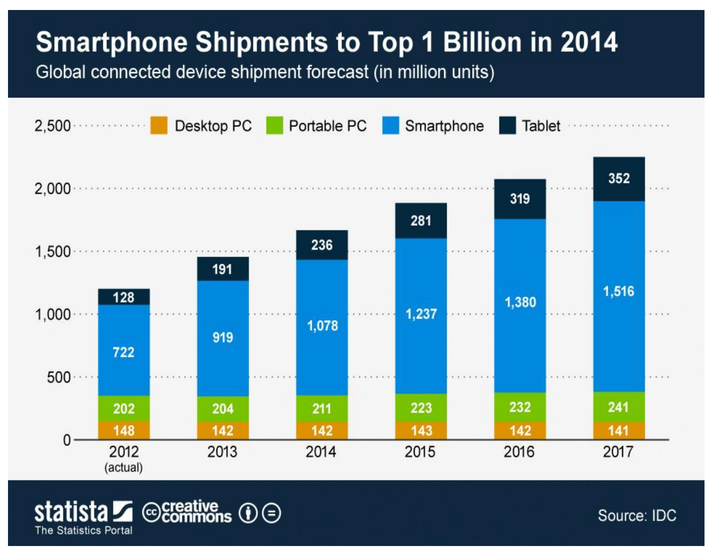


**Fig1:-PC and non PC components sales.**

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## II. EVOLUTION FROM CELL PHONE TO SMART PHONE

Cell phone gives users game-playing capabilities and can send and receive e-mail messages, images, sounds, and text. Many cell phones have speakerphones and voice dialing, and some can even take pictures. Nowadays it is clear that traditional cell phones are being replaced by their more advanced counterparts. Thus, it is likely that these advanced counterparts will dominate the future cell phone market. Traditional cell phones that are currently in circulation or will be in circulation in the future will gradually be removed from the market altogether. Among cell phones, smart phones are the fastest growing subset in terms of popularity. A smart phone, in its current manifestation, is a cell phone with highly advanced telecommunication features and computational power comparable to a desktop computer created in the last decade. They usually run complete operating systems that allow software developers to produce a wide range of applications for the smart phone platform. The large library of advanced applications that consumers can run and install on their smart phones sets this particular type of phone apart from other subsets of cellular phone. Smart phones are not to be confused with feature phones. Feature phones are now considered to be those low-end mobile phones with a few special features tacked on (i.e. a limited browser, a game or two, etc.). As smart phones became more sophisticated over time, consumers began to replace traditional cell phones with smart phones. The rate of growth of the smart phone market is much greater compared to the overall cell phone market. Thus, it is not surprising that smart phones, the next step in mobile phone technology, have been taking over the cell phone market there, as well. Similar data detailing the growth of the smart phone market of a particular region can be found for many more regions.

## III. THE COMPONENTS INSIDE A SMART PHONE

Smart phones are composed of many different kinds of hardware components. Though the specifications of these components may differ from model to model, much of the same type of hardware is used. Components common to current smart phones include random access memory, embedded processors, internal data storage space, display screens, sensors batteries and cameras. Each one of these components, as found in smart phones, have been steadily evolving since their introduction.

The rate at which each component improves in quality can vary significantly depending on the hardware demands of software developers and consumers as well as the technological ability to meet those demands at any given time.

*Memory:* - The amount of memory on smart phones has been growing as smart phones become more complex. More memory on a phone provides the opportunity for better software services. The amount of memory on smart phones has been on the order of hundreds of megabytes for some time now and is steadily making its way towards the gigabyte realm. Smart phones of particular model lines often receive an increase in memory with each new generation that gets introduced. RAM, which is short for random access memory, is one of the critical components of the smart phone along with the processing cores and dedicated graphics. Without RAM in any sort of computing system like this your smart phone would fail to perform basic tasks because accessing files would be ridiculously slow. This type of memory is a middle man between the file-system, which is stored on the ROM, and the processing cores, serving any sort of information as quickly as possible. Critical files that are needed by the processor are stored in the RAM, waiting to be accessed. These files could be things such as operating system components, application data and game graphics; or generally anything that needs to be accessed at speeds faster than other storage can provide. RAM that is used in smart phones is technically DRAM, with the D standing for dynamic. The structure of DRAM is such that each capacitor on the RAM board stores a bit, and the capacitors leak charge and require constant “refreshing”; thus the “dynamic” nature of the RAM. It also means that the contents of the DRAM module can be changed quickly and easily to store different files. The advantage of the RAM not being static is that the storage can change to cope with whatever tasks the system is trying to perform. If an entire operating system was, say, 2 GB on disk, it wouldn’t make sense or be efficient for the RAM to archive the entire thing, especially when smart phones with low amounts of RAM (like 512 MB) can’t afford to do that. RAM is different to the flash-style ROM storage on the device in that whenever power is disconnected from the RAM module, the contents are lost. This is known as volatile storage, and it partially helps the access times to the RAM to be so fast. It also explains loading screens: information from the slower ROM must be passed to the faster RAM, and the limiting factor in most cases is the read speed of the ROM.

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When the system is powered off, the contents of the RAM is lost and so at the next boot, the RAM needs to be filled once more from the contents on the slower storage.

*Storage:-*

*Internal storage and rom:* - Like RAM, internal storage is critical to a smart phone's operation; without any place to store the operating system and critical files there would be nothing for the phone to do. Even if a phone has no storage accessible to the user, there will also be some form of internal storage that stores the operating system. Depending on the operating system loaded on the device, and the device itself, there are multiple storage chips inside the device. These chips may then be partitioned into several areas for different purposes, such as application storage, cache and system files. Normally the chip that stores the system files is called the ROM for read-only memory; Some devices have a multi-ROM set-up. One memory chip is smaller around 512 MB, but faster, and stores the main system files, cache and application data in separate partitions. The second chip is larger, and is usually a 1-2 GB partition of the user storage that is slower but allows for storage of applications. In these systems having a full 2 GB of fast access memory may be too expensive to include, so lowering the size to just accommodate the operating system and using the cheaper user storage for the remaining non-user-accessible data is a better option. It creates a good balance between performance and cost for the manufacturer.

*User removable storage:* **-** Sometimes user removable storage is called "external" storage due to the fact that it can be removed, but this is somewhat silly as the card inserted into the device is more internal than it is external. Nowadays all smart phones that have user removable storage use micro SD cards, with a few tablets offering full-sized SD card slots. The most important thing to consider when purchasing a micro SD card for smart phone is the speed, which is stated as a "Class" on the packaging. Luckily the class number is very easy to understand as it directly corresponds to the minimum write speed of the card in MB/s. A card that is rated as Class 4 will be able to be written to at a minimum of 4 MB/s, and Class 10 at 10 MB/s. Classes can go as high as the manufacturer wishes within the specifications of the card, and generally a higher class means the card will be more expensive but a better performer. For micro SD cards the best you can get is a 32 GB Class 10, these cards will often outperform the internal storage of your device assuming it can handle 10 MB/s write speeds to the removable storage.

*Processor:* - The processor is the central hub of any smart phone. It receives and executes every command, performing billions of calculations per second. The effectiveness of the processor directly affects every application, whether it's the camera, the music player, or just a simple email program. Pick the wrong one and you could experience sluggish, stuttering apps and limited network performance, regardless of carrier, manufacturer, or operating system. When you swipe your way down a web page, you're commanding the processor to make billions of simultaneous and instantaneous interactions. When you do something more complex, like playing an online multiplayer game with 3D –intensive graphics or capturing 1080p video, the load put on a processor can be quite immense. The ability of the processor to coordinate efficient communication between the wireless data, graphics, and memory is essential to smooth operation. The CPU, GPU, audio and video engine, connectivity features (GPS, WiFi, FM), and 3G/4G modem are the major components of a processor that control the operation of smart phone. Let's take a look at what they do, and how they work together with the processor to make every action so seamless.

*CPU, or Central Processing Unit***:-** This is the "brain" of your smart phone. The CPU receives commands, makes instant calculations, and sends signals throughout your device. There are multiple ways to gauge the performance of a CPU, including checking the Gigahertz (GHz) speed under the processor specs. This tells you how many instructions the chip can complete in one second. A 1 GHz processor can process roughly 1 billion cycles-per-second. In the past, the CPU handled the visuals that were sent to the screen in addition to its other duties, but the demands of high quality graphics led to the development of another component to lighten its load— the GPU.

*GPU, or Graphics Processing Unit***.:-** The GPU assists the CPU by handling the visuals. By adding a dedicated GPU chip, your phone does a much better job handling a multitude of graphics-related chores than the CPU could alone. The GPU frees up the CPU, allowing it to conserve or redirect its resources.

*Camera ISP (Image Signal Processor):-* An integrated Image Signal Processor provides the "oomph" for many of your smart phone's camera functions. It is designed to deliver a tightly bound image processing package and enable an improved overall picture and video experience. An integrated ISP can also be invaluable when it comes to things like instant image capture, high-resolution support, image stabilization, and other image enhancements.

*Radio & 3G/4G Modem:* - These components control your connection to the world. Broadly speaking, the radio receives and transmits voice connections and the modem enables your phone to send and receive digital signals. When enabled with 4G LTE, the radio and modem have a high-speed cellular wireless network at their disposal, capable of speeds that mimic WiFi connection. When working closely with the CPU and GPU, a 4G LTE modem can deliver seamless, fluid access from your LTE network to applications.

*Memory Controller:-* A memory controller integrated into the processor plays an important role, as it provides a direct link to your phone's memory. It ensures an instant connection to frequently used files and applications.

*Audio and Video.* A good processor will also have dedicated processing units that handle audio and video. So the next time a smart phone is playing back favorite music track or a 1080p video clip, a well-designed processor will have a component dedicated to each task.

### *A. The All-In-One Design*

Sometimes these components exist as different chips in a device, but the exceptionally powerful and power-efficient processors have all of them situated on a single chip. When they're grouped together onto the processor, it's referred to as "integrated." Bringing them closer together provides advantages for the operation of smart phone, like faster communication and reduced power consumption. Old-style, un-integrated processors and their scattered circuitry simply can't keep up. The pinnacle of the integrated design, though, is the "all-in-one" processor. An all-in-one processor brings all smart phone's major components together, improving performance and efficiency across the board by reducing the distance signals and data need to travel. Integrated processors that bring together some components but leave others isolated do not maximize communication speeds like an all-in-one.

*Screen:* - Details on the elements and compounds involved in the manufacture of touch screens were in fact the easiest to track down. A description of the evolution of display screens on is more feature-centric than the numeric trends discussed for previous hardware components. The display screens on cell phones used to be for visual output only. The screens found on current smart phones do much more than that. Now, consumers use their screens as the primary input device for their phones. are often set up such that selecting applications, changing settings, typing, etc. are all done via the touch screen.

On top of being used for visual output and primary input, touch screens are now capable of understanding and responding to different gestures made by users. This feature is called multi touch. Display screens have evolved by way of acquiring new features. These features are centered on improving the I/O experience of a user. It is not clear how display screen features will evolve, however. It is more than likely that display screen technology for smart phones will continue to advance alongside other hardware components. Very recently, AMOLED (Active-Matrix Organic Light Emitting Diode) display panels have begun to replace conventional LCD (Liquid Crystal Display) technology in mainstream smart phones. Compared to LCD, AMOLED offers much better display quality and higher power efficiency because of its unique lighting mechanism. This unique property has led to much research involving the power evaluation and modeling of AMOLED as well as the performance variance among different AMOLED panel designs. However, due to the large variety of AMOLED panel designs and the fast pace of smart phone software development, most of this research only aims at a particular smart phone device or application. It is not clear whether there is any significant power efficiency improvement between different generations of AMOLED display technology or if it is possible to obtain an overview display power efficiency under different applications. Smart phone hardware is projected to take a technological leap in the near future. Processor manufacturers are moving towards chips with multiple cores. These processors will allow software developers to make certain applications run much faster. Memory and clock frequency should continue to grow in size at the same rate they have been until the power wall for smart phones has been reached. As is typical for batteries, advances in the capacity of smart phone batteries will occur slowly. This is consistent with the trend observed in advances in battery technology of other devices. Phones will also receive a boost in the amount of storage space available to users. As consumers abandon traditional computers in favor of their mobile devices, inevitably, they will want to store more data on their phones. Furthermore, more powerful smart phone hardware could lead to larger applications. This would necessitate the increase in the amount of storage space available on smart phones. The next popular innovation in smart phone displays will likely be a new I/O feature. Perhaps displays will incorporate 3D display technology on top of their multi-touch capabilities. Finally, the cameras found in smart phones should improve steadily over time.

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At some point, smart phones will have camera resolutions exceeding ten mega pixels. Phones with camera resolutions exceeding ten mega pixels already exist but they are not widespread.

*Battery:* - Battery life is a key aspect of user experience of battery-operated and mobile devices, and even more so with smart phones given their widespread use and compact form factors. The battery capacity of a smart phone determines to some extent how long a phone can function without recharging. Battery life is the amount of time a phone can run on a single charge for a given "usage pattern." The usage pattern is key since this can have a huge impact on battery life. The usage pattern can sometimes be comprised of a single use case, such as video playback or web browsing, which somewhat corresponds to the specifications advertised with smart phones (e.g., 10 hours of video playback), or a complex set of use cases that try to mirror a certain type of usage profile. To truly determine how long a phone can go without recharging, one must have a model for typical user activity and a hardware profile for a specific phone and also it must be known at what rate power will be consumed. It is not well known how the battery capacity of will evolve in the future. Advances in battery technology are much slower than in other hardware components. Therefore, smart phone manufacturers are much more likely to design more power efficient phones before incorporating a battery with a longer life.

## IV. SMART PHONE LIFECYCLE ASSESSMENT

To understand the impact of the fast increasing market of smart phones to the world, it is critical to quantify the resource been used during different stages of smart phone life cycles. Computing the resource requirements and environmental impacts of a product system is often carried out through Life Cycle Assessment (LCA). LCA is a standardized methodology for computing environmental burdens based on the network of processes that lead to a product being produced, delivered, and disposed at the end of life. Often an objective of a life cycle study is to compare the resource and energy requirements of the production phase (raw material extraction, manufacturing, and distribution) to the use phase and end-of-life disposal phase. A life cycle assessment leads to two main types of quantitative results. The first is a Life Cycle Inventory (LCI), which describes resource requirements and environmental emissions due to the product system. Subsequently, a Life Cycle Impact Assessment (LCIA) is then performed to estimate the potential environmental impacts due to the inventoried emissions.

LCIA results are generally reported in terms of a quantitative indicator of the potential effects in a category of interest. For instance, potential contribution to climate change is reported in units of the equivalent amount of $CO_2$ (kg $CO_2$-eq) emitted to the atmosphere as a consequence of the product system's operation. Other categories of environmental impacts are reported in appropriate equivalencies (atmospheric acidification may be reported in units of $SO_2$-equivalent; human toxicity may be reported in units of arsenic-equivalent; and so on.) Because the resource requirements and emissions associated with manufacturing processes are proprietary and often closely held by industry participants, it can be difficult to obtain adequate data to perform an LCA, particularly of high-tech products such as smart phones.

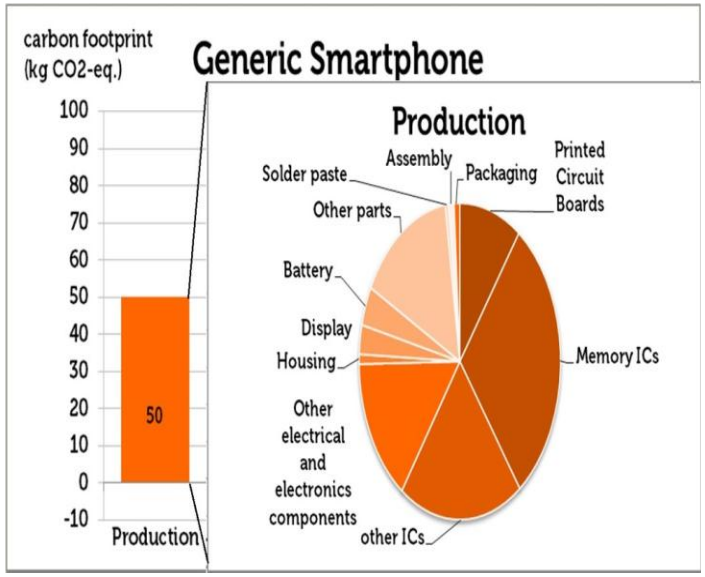


**Fig2:- carbon footprint is created from the many aspects of the production process.**

## V. TOWARDS GREEN COMPUTING: SMART PHONE REUSE

One natural reuse of mobile handsets would be the formation of a robust and self-maintaining environmental monitoring infrastructure. As the smart phone industry consumes more and more energy and affects a greater environmental impact, it is critical to think Green for every stage of the smart phone life cycle. Although it is also important to apply new technologies to reduce the energy and materials used during the manufacturing process of smart phones.

- *Smart phone reuse:-*

Smart phones degrade while being used. Although we imagine that typically when a smart phone is discarded after 1 or 2 years of normal use, it remains mostly functional. Even if certain components break or wear out, the phone might still be reusable as long as its key components are still working. Yet, what defines "key components" in smart phones is highly dependent on what kinds of applications are the targets of reuse. The following components are generally considered as important: the screen, processing unit, storage (internal and external) and battery.

To make smart phone reuse feasible, it is important to first understand how smart phones evolve in terms of technology and how to design mobile applications with such knowledge in mind. To analyze potential benefits of reusing mobile devices by comparing the energy cost of manufacturing mobile devices with their lifetime energy, concluding that there is, indeed, a compelling environmental benefit to repurposing used smart phones. However, the environmental impact of the increasing number of smart phones has been a pressing problem. More toxic chemicals are generated, and the disposal cost is increasing. To achieve sustainable computing, discarded smart phones have to be either reused or recycled. Reuse in the broadest sense means any activity that lengthens the life of an item. Recycling, on the other hand, is the reprocessing of an item into a new raw material for use in a new product. Recycling has been used for a long time and benefits from regaining the materials for manufacturing. However, reusing achieves the goal of sustainable manufacturing more efficiently than recycling due to the fact that recycling will always generate waste regardless of the recycling technology, and it also costs money and energy to recycle. Hence there is a high incentive of reusing mobile devices into other purposes. In addition, when the phone becomes too old for educational use, it can still be recycled.

- *Device recycling :-*

A smart phone consists of tens or even hundreds of components and some of the parts such as PCB(printed circuit board),LCD(liquid crystal display),batteries may be poisonous. recycling processes used materials into new products in order to reduce or prevent materials or energy wasted.

- *Mobile green computing:-*

Most smart phones are uses lithium ion batteries .this kind of batteries can only last for few hours of operations before needing to be recharged. extending time of operations is not only urgent need for users, but also is good for the environment, because batteries of this nature fail after hundreds of times recharging them .one way to extend battery life is to use efficient algorithms, one of the methods of green mobile computing. many methods are used to improve the algorithm efficiency some of them are as follows:-

1) *Scheduling:* - some mobile operating system allows multithreading programing. Scheduling means to distribute the system resource, such as cpu time and memory to processes effectively in order to make the maximum out of the resource.
2) *Picking the right algorithms:-* to accomplish a task, it is more important to pick the right algorithm than to use a more powerful device or acquire more money.
3) *Caching:-* instead of waiting for the request, the system is able to pre-fetch or cache the data based on previous experience or predictions.

- *Reducing energy consumption by smartphone:-*

The four components that consume the most energy in smart phones are: the screen, CPU, GPS service, and network connection. Although the energy consumed by the network connection could vary substantially when the network interface changes from cellular service/3G to Wi-Fi or Bluetooth, the average energy consumption is high in general.

Nowadays smart phones are using commodity general purpose processors. Hence, most of the existing techniques to improve the energy efficiency of general purpose processors would also benefit smart phones, such as Dynamic Voltage and Frequency Scalding (DVFS) which has been widely applied to embedded systems and architectures. Two streams of approaches exist in the context of reducing energy consumption; particularly for smart phone CPUs. One popular technique to reduce the energy needs of mobile devices is *computation offloading*: Applications can take advantage of the resource-rich infrastructure by delegating code execution to remote servers. Such approaches either rely on programmers to partition the program, or rely on full process migration.

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Another way to optimize the computational energy efficiency is to *utilize the computational power of other components in the smart phone*; specifically, the Graphics Processing Units (GPU).Mapping parallel computation to GPUs is nothing new, but it is still challenging for smart phones. The limited graphics memory resource in smart phones prevents the migration of most, existing algorithms into smart phone GPUs.

Next another popular trend towards reducing the energy consumption of screens is to *adjust the brightness of the screen in a smarter way*. The current screen brightness adjustment strategy does not match with user behavior perfectly. Energy is wasted due to long screen intervals when users are not using their phone. New scheme of reducing the brightness of the screen slowly over time demonstrates 10.6% total system energy savings with a minimal impact on user satisfaction.

A smart phone today typically uses a cellular (3G) network or Wi-Fi for network connections. It is well known that Wi-Fi consumes much less energy compared to a 3G network. Hence, using Wi-Fi as much as possible is the key to achieving more energy efficient smart phones. The main challenge for this is that a Wi-Fi network is not always available, and the delay could be intolerable if one always tried to wait for Wi-Fi connections.

## VI. Conclusion And Future Scope

With recent technological advancements, the average person’s day-to-day life in the developed world has become busy with smart phones. Traditional phones have replaced by smart phones and become the most pervasive and popular handset devices. The increasing demand of smart phones leads to the fast expanding of the smart phone market. The dark side, however, is that smart phones become out-of-date so quickly that their average lifetime is only 1.5 years.

Billions of used smart phones are discarded every year, among which most devices are still functional. There are significant energy and resource requirements associated with the manufacture of mobile handsets and the operation of access networks. Device manufacture accounts for a large share of device life-cycle impacts, driven mostly by the high-energy cost of semiconductor technology. Lengthening device life times would have the effect of spreading manufacturing impacts across a longer useable period. This would reduce the generation of waste as well as the intensity of environmental impacts from smart phone use. More research work is required in the area of smart phones. The traditional PCs will be replaced by mart phones in the coming days. One smart phone device can be used to do multidimensional work. More use of smart phones will less use of electricity and less generations of $CO_2$ . Hence reusing those smart phones is a key approach towards green computing. There are many different ways of reusing smart phones. However, many more challenges are still there to be explored in smart phones.

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