Green Networking: Strategies to save network for Next-Generation

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Abstract- The current Internet usage, which was designed over 40 years ago, is facing unprecedented challenges in many aspects in the future. Our future Internet, though there will be more than 600 million users, the world is about 10% of the way there, and there is a lot of growth to come. As a result global internet traffic and mobile traffic will rise steadily and explosively over the next five years. These issues are usually referred to as 'green networking'. Despite some proposals for energy-efficient topologies most of the studies are focused on warning the world about this problem. Mainly as the unnecessary energy consumption is being reduced day by day, the proposed paper provides strategies to save network for future covering through many components such as; wireless networks, wired networks, hybrid networks and the current chemical evolution happening in the world. Furthermore, the proposed project hopes to identify a few strategies that are the key enablers of energy-efficient networking research. Since the proposed project mainly highlights greening the networks, when these strategies come to play approximately 30-35% of energy will be saved through networking for future usage.

Index Terms- Green networking, wired networks, wireless networks, chemical evolution.

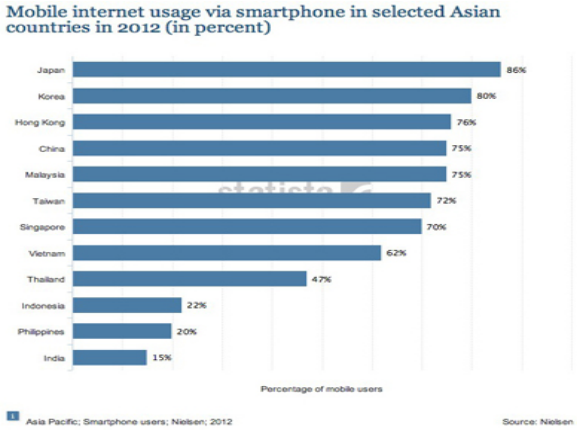
I. Introduction

Green networking is a component that is becoming very popular in this 21st century. Since the reduction of environment pollution and saving energy has become the key factors of this component. Green networking has a strong influence on both economically, environmentally and also mainly in networking field, in a time zone where the data storage and data processing is becoming more and more enormous. For a matter of fact, data-centers and networking infrastructure involve high-performance and high-availability machines which makes them rely on more powerful devices which require energy-consuming air conditioning to strengthen their operation. In recent years, many valuable efforts have been put in reducing unnecessary energy expenditure which is caused because of the massive data traffic growth. It is usually named as 'greening' of the networking technologies.

The topic of greening all the networks have been widely explored throughout these couple of years, because of the problem occurred due to the vast amount of data being collected every second of the day. Most of the greening work can be categorized into two groups in general. The most straightforward and successful way is designing energy-efficient topologies which can provide similar connectivity while using low-powered network devices.

As energy related networks are concerned, wired networks, wireless networks and hybrid networks are specifically discussed in this paper. The key research component is to explore widely about algorithm-based and natural strategies that can be used in order to reduce energy-consuming network usage. Also the major impact on nature because of the chemical revolution happening, based on high energy usage is also discussed throughout the rest of the paper.

When considering about wireless networks almost all the smartphones, tablets and laptops are taking over the world with the term of 'wireless' using only mobile networks to local Wi-Fi networks. And rest of the communication is done by wired network connections which also a reason in high network usage. This rapidly increasing usage of wireless and wired networks has become two of the main reasons to develop energy-efficient strategies with the concept of 'greening'. Wired and wireless networks differs in power consuming. In wired networks more than 70% of power is consumed in user premises whereas only 10% of power due to mobile user. The following Figure 01 shows the mobile internet usage by country in 2012.



(Source: http://www.asiabriefing.com/news/wp-content/uploads/2013/03/MobUsage.jpg)

Figure 01: Mobile traffic growth by country.

Since hybrid network contains network hardware and equipment or network infrastructure from multiple vendors, it also has a contribution on heavy usage of network. As hybrid networks are becoming popular day by day in this era, it is also an important component when considering about 'greening' the networks.

When considering Green House Gases (GHG) reduction objectives, it mainly includes information and Communication Technology (ICT) sector. ICT sector alone has been produced approximately 2% of CO2 from the total man-made emissions [2].

Since previous researches have mainly focus on only alerting the world about this rapidly increasing problem, this research paper propose to discuss about various mechanisms to save network for the coming future. Therefore a research in green networking strategies can be mentioned as a successful solution to this expanding issue in the current century.

The rest of the paper is organized as follows. Section 2 has provides the existing related work through the Literature Review. Section 3 describes the methodology of this paper by providing strategies regarding the main topic. Also the conclusion of the proposed project has described in Section 4.

II. BACKGROUND AND RELATED WORK

Wang et.al states that the major objective of this research is to incorporate rate adaption into green data center networks in order to achieve energy conservation. They approached network-wide energy proportionality by routing optimization based on simulations which confirms that more than 40% of the energy can be saved while introducing very slight stretch on network delay. Wang et.al formalized the problem of high network usage with an integer program and propose an efficient approximation algorithm – Two-Step Relaxation and Rounding (TSRR). They solved the problem quickly while guaranteeing a constant performance ratio. In this paper rate adaption is considered as advantageous because of the better stability when applied in networks. Also this network-global routing optimization, which is discussed in this paper can bring up to 40% energy savings, even without switching off any network devices. But the major weakness of this project is network unsteadiness brought by the frequent change of the network topology when traffic move in a wavelike pattern very fast [1].

This book covers different forms of modeling, analysis, design, management, deployment and optimization of algorithms. Protocols and architectures based on green communication and networking. Those areas may include lots of points which are very important when considering present and future energy usage. Such as energy efficiency, resource management, relay techniques, cross-layer design and optimization, rate adaption etc. Neely presents a methodology for optimizing time averages in systems with variable length frames. Zhang and Cheng developed another new model for green communication called, Demanding-Based Resources Trading (DBRT). Also Attar st.al introduced a novel solution named, “Broadband Wireless Access with Fiber-connected Massively Distributed Antennas” (BWA-FMDA). The advantages of BWA-FMDA architecture are its’ flexibility of deployment, scalability of coverage from a few meters for indoor access and superior performance in terms of throughput as well as power efficiency [2].

In this survey article, the authors investigate the key research topics in the area of future Internet construction, challenges and usage. This aims to draw an overall picture of the current research development on the future Internet architecture. Future Internet architectures are required to provide extensible and flexible explicit interfaces among many stakeholders such as users, Internet service providers, application service providers, data owners, and governments. However, many technical and non-technical challenges have emerged during this process, which call for potential Internet usage. Technically, the current Internet was designed over 40 years ago with certain design principles. Its continuing success has been blocked by more and more sophisticated network attacks due to the lack of security embedded in the Internet architecture [3].

This research focuses on exploring the insights that the principles of network engineering and what architectural changes will be required to meet these new challenges in the future. It says that one recurrent theme in the debates over Internet policy is the claim that the Internet’s future success depends on preserving the architecture that has made it successful in the past. Identifying future trends is inherently speculative and in retrospect will turn out to be mistaken without any doubt in a number of important respects. According to this research wireless broadband market since 2008 and the emergence of wireless as the leading broadband platform in other countries both suggest that wireless broadband will become increasingly important in the years to come [4].

Bianzino et.al observed few techniques and categorized them as Adaptive Link Rate, Interface-Proxying, Energy Aware Infrastructure and Energy Aware Applications. Since a significant amount of CO_2 emissions are produced by the Information and Communication Technology (ICT) sector, they also mentioned that the massive Green House Gas emissions cause problems to the environment which are not limited. As solutions for CO_2 emission problem, researchers have stated four solutions; Recourse Consolidation, Virtualization, Selective Connectedness and Proportional Computing. They proposed to use the Benchmark methodology and metrics in handling this green networking research. In their Economical point of view, as a disadvantage there is a huge technological challenge lies in performing service migration without any service disruption, preserving fault-tolerance and data security. They concluded by mentioning as it is necessary to understand where the major energy expenditure occurs to pinpoint the place where the larger energy savings could be obtained [5].

This research is about three issues that are relevant and possible of research in the field of green networking. They specifically focused energy efficiency in wireless networking. They stated that development of more energy-efficient hardware, the introduction of energy-proportional equipment and the adoption of sleep modes for the network elements can be used to achieve energy efficient in any type of networks. Marshan and Meo have mentioned three solutions for their three questions named as Base stations and hot spot, Sleep modes, Centralized and distributed algorithms. They considered a cellular network setting with an algorithm to state the importance of sleep modes and low-power modes for base stations. They have used centralized algorithms and distributed algorithm to identify the optimal network configuration. As a disadvantage there are some problems in sleep modes for base stations like identifying an optimum subset of element for traffic, choosing base stations to off and on and management of transients due to base station switch-off [6].

A measurement study of the energy consumption characteristics of three widespread mobile networking technologies; 3G, GSM and Wi-Fi and they develop through TailEnder module.

3G and GSM is the largest fraction (60%) of the energy; referred to as the tail energy and is take high power state after the completing for transfer. Energy for uploads it's nearly 30% more than that for downloads for 100 KB transfer. Wi-Fi had overhead tail energy and its transferring data itself is significantly. Wi-Fi composed of scanning, association and transfer for 50 k download. They show that the TailEnder scheduling algorithm is probably within a factor of the energy consumed by an optimal offline algorithm that knows the complete arrival pattern of alteration a priori. Furthermore, they show that no deterministic online algorithm can be better than 1.62 competitive than an optimal offline adversary. First, is the transmission energy that is enough capacity to the length of a transmission and the transmit power level. Second, is the Radio Resource Control (RRC) protocol that is responsible for channel apportion and scaling the power consumed by the radio based on inactivity timers [7].

Interconnect the large number of data center servers and provide efficient and fault-tolerate routing service to upper layer application. Fat-tree and BCube topology are represented to data center network. They using energy aware routing to save energy consumption in high density. It suffering from the problem of the low scalability high cost as well as single point of failure and they solve the problem through they own pseudo code algorithm. When the number of outflows is less than 1000, more than 20% energy are saved; and the amount increases to 80% if the number of outflows is less than 100. As expected, the energy-saving effectiveness degrades as the network load increases [8].

III. OUR APPROACH

A. *Wired Networks*

Traditionally, networking systems are designed according to the principles that are naturally in opposition with green networking objectives. Basically networks are dimensioned to sustain peak-hour traffic, with extra capacity to allow for unexpected future events. As a result during low traffic periods and over-provisioned networks are also over-energy consuming. Since the networks are also designed in a redundant manner for more flexibleness and fault-tolerance, many devices are added to the infrastructure with the exclusive purpose of taking over the duty when another device fails. These conditions revolutionary opposed to the environmental ones, make green networking an interesting and technically challenging, research field.

As one approach of this research, there are mainly three strategies to reach the green networking objectives named as resource integration, virtualization and selective connectedness. As the first category, resource integration regroups all the dimensioning strategies to reduce the global consumption at a given time since the traffic level in a given network nearly follows a well-known daily and weekly behavior. Since this strategy is already a popular approach in some other related fields such as data centers and CPUs, this can be simply achieved in networking by shutting down some lightly loaded routers and re-routing the traffic on a smaller number of active network equipment.

Virtualization comes to the play when considering about the improvement of hardware utilization. It regroups a set of mechanisms allowing more than one service to operate on the same piece of hardware which results in lowered energy consumption. This concept is also a well-known strategy in sharing servers in data centers in order to reduce hardware costs, improve energy management and reduce data center carbon footprint. Regarding green networks Virtualization can be applied to many kinds of resources including network links, storage devices, software resources, etc. The following Figure 02 shows the basic sketch of how the network virtualization happens currently.

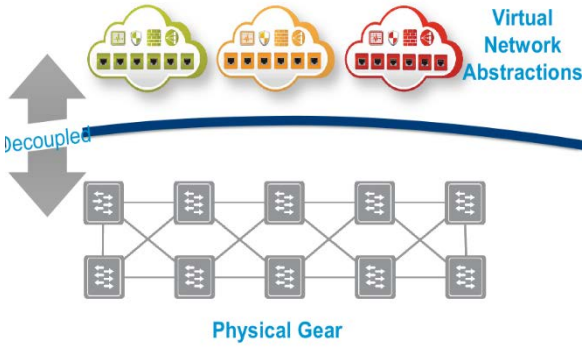


Figure 02: Network Virtualization (Source:http://www.techopsguys.com/wp-content/uploads/2013/08/network-virtualization.png)

In networking, selective connectedness can be concerned as a most trustworthy connection base, which will provide direct access to people's own career interests. Rather than connecting all the devices which may be or may be not useful at the time, connecting only the devices which are most important at the time will help in reducing unwanted energy waste. Also when considering about 'greening' the networks, this strategy can be simply used where routers can turn-off or turn-on depending on their usage and the group of multiple processes and services using above mentioned virtualization in the same hardware. This strategy is specially proposed because a single device working at a full capacity, wastes less power than running several devices simultaneously.

B. Chemical Damages

The Climate Group, GeSI Report says, the emission of Carbon dioxide from PCs, peripherals and printer is 57% (820m tons CO_2), Telecoms infrastructure and devices is 25% (360m tons CO_2), Data centers is 18% (260m tons CO_2) in 2007. And it is expected to grow by 4% by 2020. The traffic growth in the internet is doubling every two years. The traffic of internet videos is higher than the traffic of wireless data and wireless voice. As the following Figure 03 shows current usage of energy, for cooling down the data centers.

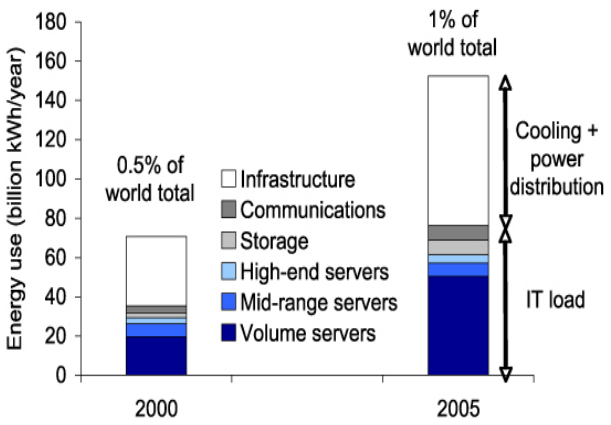


Figure 03: Energy consumption in data centers (Source: lukenotricks.blogspot.com2010_05_01_archive.html)

Server farms and cellular networks together consume much electricity. The energy consumes by the internet, the wireless and wired communication is comparatively less than the quantity if electricity consumption by ICT systems in houses and offices especially laptops. This causes a huge amount of CO_2 emission every year. The major effect of CO_2 emission is climate change. The use of high temperature electronics, avoid air conditioning in server farms and cellular networks are some reasons for energy consumption. Round half of the electricity usage in ICT goes to centers to cool systems inside. It mixes the hot and cold air. Servers utilize nearly ¾ of power usage for no useful works. These servers are inefficient.

Therefore energy improvements can be done in several areas. By using Ultra-efficient power amplifiers for transmit signals with large point to average power ratio, Active antennas and self-organizing networks in Mobile and passive cooling everywhere, dynamic energy usage and Network Virtualization and Programmable, application specific, highly parallel, power productive digital baseband processors which consume less power per function can be used to improve the energy efficient.

Air cooling represents an important share of the energy expenditure in data centers and cold climates may loosen this dependency. Liquid cooling or fresh air cooling will be a better solution which uses air from outside to cool for data centers. For example, Google does locate the server farms near the river to get energy hydroelectric power plants. The water flow provided by the river may in addition be used within the cooling systems. Microsoft leaves their servers in the open air to cool. Amazon does geographical delocalization to save energy consumption. Virtualization is a technology which allows the applications to run on many servers which reduces the wastage of energy by servers and redundant servers will be removed.

As the usages of mobile phones have increased the need of energy efficient is high. The energy consumption can be reduced by having IP-Based Base Transceiver Stations and Radio-over-Fiber technologies.

C. Wireless Networks

Mobile phones are any ware today with an estimated cellular subscription of more than 4 billion worldwide. Most phones presently used more than one of 3G, GSM, and Wi-Fi for data transformation. For example, the insertion of 3G is estimated more than 15% of cellular contribution worldwide and more than 70% in some countries. How do the energy utilization attribute of network activity up 3G, GSM, and Wi-Fi on mobile phones analyze with each other? How can we cut down the energy consumed by frequent applications using each of these three technologies? To consider these questions, we first conduct a detailed assessment study to quantify the energy consumed by data transmission across 3G, GSM and Wi-Fi. We find that the energy utilization is informally related to the characteristics of the workload and not just the total transmission size, e.g., a few hundred bytes transferred intermittently on 3G can obsess more energy than transferring a megabyte in isolated. Below is a summary of the key findings of our analysis study, which remain dependable across three variance cities, diurnal variation, mobility patterns, and devices. The following chart presented in Figure 04 shows the evolution of wireless networks with mobile data and wired networks.

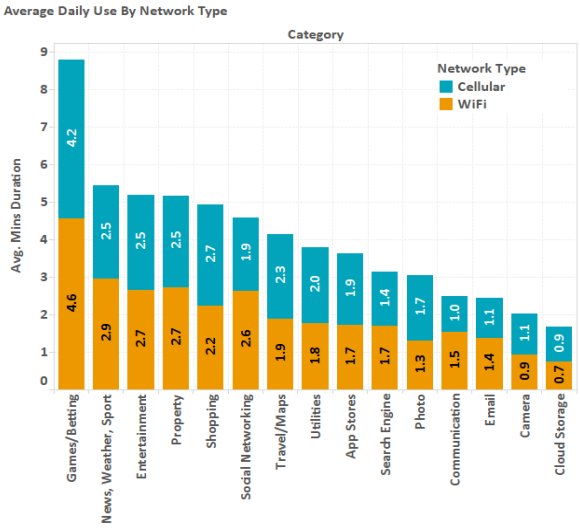


Figure 04: Usage of wireless networks. (Source:http://www.realitymine.com/wp-content/uploads/2013/08/Average-Daily-Use-By-Network-Type.png?f29246)

As a way of closing the hole among the special-purpose and general-purpose devices, the proposed project suggest accommodate the notion of requirement-specific energy scales down at all levels of the system. Namely providing for the design and use adaptively in hardware and software to exploit mismatches between system functionality and workload/user requirements. Specifically, the proposed paper suggest considering each component in the general-purpose device and comparing it to the requirements of the applications using that device. Ideally, each general-purpose component should be capable of scaling down its energy use to connect the design view used by the application with the lowest requirements. There are two substitute for achieving this: gradation-based scaling, where the component has a wide range of adaptability, or

plurality-based scaling, where the device chooses bitwise multiple components with different properties. Below, the scale-down expansion in the context of the display, wireless, and processor components of the system that attempt to use adaptively improve the efficiency of energy use in the device.

D. Data Centers

Present data centers, containing thousands of switches and servers, run data-intensive applications from cloud services such as search, web email, to infrastructural calculation. (GFS, CloudStore, and MapReduce) The goal of Data Centre Network (DCN) is to combine the huge number of data center servers, provide productive and fault-tolerant routing service to over layer applications. It is well known that the current practice of tree architecture in data centers suffers from the problems of low scalability, high cost as well as single point of failure. Hence, recently a lots of advanced network architectures are proposed to restore the tree topology, represented by Fat-Tree, BCube and etc.

As a solution for that, BCube (BN, BL) topology, where BN indicates the number of ports in a switch and BL denotes the number of levels, where there are different values of BN and BL to vary the topology scales. Similarly, it varies the couple of ports in switch in Fat-Tree, denoted as FP. It can be assumed that the network capacity of all links in these topologies are 1Gbps. The number of flows in a topology can be changed to simulate different network load, and the traffic matrix is one of normal way generated upon servers.

E. Milimeter wave radion access

(1) *Wireless and mobile internet access*

Green networking is a expeditiously expanding area of research. It is the practice of selecting energy-efficient networking technologies and products, and decreasing resource usage whenever possible [9].

Wireless and mobile internet access recently became an integral part of human lives. Consumers now access the Internet more on mobile devices than on PCs such as smart phones, tablets and etc. A wireless internet infrastructure with the capacity for fast data transfer is used in all areas from education to e-state and e-commerce. According to a recent Cisco report, the most recent data show that the overall internet usage is 60% via mobile devices. Last year's wireless data traffic was nearly 30 times the size of the entire global Internet in 2000. The following Figure 05 shows the approximate mobile data traffic growth that will be happening within next 3 years.

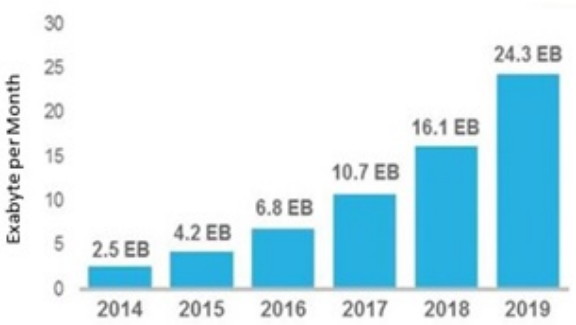


Figure 05: Global Mobile Data Traffic Growth (Source: https://www.mvnodynamics.com/wp-content/uploads/2015/02/screen01-ash.png)

(2) *Video Streaming*

Video streaming is becoming much more widely used by end users for both work and leisure. With the increasing number of personal and home devices, increased data created, and the resulting contentrich applications, video streaming in particular, has become the application that requires the highest amount of bandwidth [10].

Because of above incident future of wireless internet is in a danger. If this continues like this future internet usage will be limited. A solution for above problem is Milimeter wave radion access (mm- Wave) [11]. One major factor that is driving Internet bandwidth utilization is the move to from wired networks to wireless (WiFi and mobile services). So mm-wave radio access will increase wireless bandwidth.

The uncrowded, license-free mm-wave frequencies can provide 50 to 100 times more user capacity than that is readily available. When combined with other optimizations, mm-wave is expected to increase wireless bandwith by a factor of up to 1000 than current 4G within the next few years [12]. According to recent measurement, current mm-wave already supports a bandwidth of at least 1 Gbps, the bandwidth that can sustain the most demanding applications such as high-definition video streaming.

IV. CONCLUSION

Currently since the world has faced a critical problem in terms of power consumption it is indeed important to start saving energy in the networking perspective. High use of internet can be effected in internet loss in the near future. As the internet is an essential part of lifestyles, using it efficiently is a solution than limiting the usage. This research paper introduces some strategies towards greening the networks based on wired networks, wireless networks, chemical environment and data centers. Furthermore, in this paper, some startegies are applyied to save network which are currently being used in different sections other than networking. As the main objective, this paper has presented many strategies to save network for future generations by greening the networks efficiently.

V. FUTURE WORK

The main limitation of the proposed project is, that this research does not provide any specialized algorithms on reducing the network power consumption regarding green networking. (E.g. Distributed Algorithms) Many strategies that are currently using in related fields (E.g. data centers) are discussed within the research. This research can be elaborated furthermore by providing new algorithms regarding the discussed strategies. Since this research project mentions about saving network for future generations, it can also be more elaborated by providing strategies through hybrid networks. Not introducing new strategies regarding the topic of reducing unnecessary energy consumption through hybrid networks can be pointed as a drawback of this project.

ACKNOWLEDGEMENT

It is with great pleasure that we express deep sense of gratitude and profound feeling of admiration to our project supervisor Mr. Dhishan Dhammearatchi for guiding and advising through the entire project work.

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