Need of Collaborative Work towards Emerging Issues Green Computing and Green IoT

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***Abstract*—Penetration of computer in our life is at tremendously high rate. So researcher should search different strategies and techniques to minimize the side effects of computer and its peripheral devices on an environment. Extremely rise in energy cost and growing awareness of global warming issues compel to pay attention on emerging topic 'Green Computing'. No doubt, advancement in technology is beneficial for us, but it also increases the carbon footprints. Now there is necessity to follow 3 R's principle of Reuse, Recycle and Replace to 'Go Green'. Growing realization of impact of hazardous material on environment and need of conservation of non-renewable resources, researcher insists to think about green cloud computing, IoT, Virtualization. Data centres are important part of any IT firm which emits CO_2 in environment. So government has also started to certify Data Centres as 'Green'. The Green Internet of Things (G-IoT) is predicted to introduce significant changes in our daily life and would help in realizing the vision of "green ambient intelligence". This paper emphasises on current trends, challenges of green computing. It also concentrates on need of collaborative work of people and implementation of all techniques and methods for healthy and clean environment.**

***Keywords*—Green computing, Carbon dioxide (CO_2), Green Cloud Computing, E-waste, Green IoT**

I. INTRODUCTION

Green computing is the environmentally responsible and eco-friendly use of computers and their resources. In broader terms, it is also defined as the study of designing, engineering, manufacturing, using and disposing of computing devices in a way that reduces their environmental impact [14].

'Going Green' means reducing the energy used and pollution footprints. Green computing is a term coined in official journal of the French republic on July 12th 2009. Green computing is an energy efficient and eco-friendly category of cloud computing. It increases energy efficiency by keeping low power consumption. There are various sources of green energy like solar, wind, geothermal, hydroelectricity and nuclear energy. Green energy is a source of wind and brown energy is a carbon intensive energy. The aim is to maximize green energy and minimize brown energy [9].

Energy efficient data gathering techniques play a crucial role in promoting the development of smart portable devices as well as smart sensor devices based on IoT [10]. Whilst data from 2014 to 2017 suggested global annual emissions of CO_2 had approximately stabilized. The most recent data from the global carbon project reported a 2.7 % increase in 2018. The main objective is to reduce the energy consumption of IoT application and create awareness in the society [11].

Green networks in IoT will contribute to reducing emissions, pollutions, exploiting environmental conservation, surveillance, minimizing operational cost and power consumption. The Green Internet of Things (G-IoT) is predicted to introduce significant changes in our daily life and it would help in realizing the vision of "green ambient intelligence". Within few years we will be surrounded by a massive amount of sensors, devices and "things", which will be able to communicate via 5G, act "intelligently" and provide green support for users in managing their tasks [15].

II. OVERVIEW OF GREEN COMPUTING

The Green Computing is the study of designing and practices of manufacturing, using and systematic disposal of IT equipments. There should not be any side effect on the environment or a very negligible effect. It saves energy and uses eco-friendly sources of energy. It reduces wastage and harmful effects on the environment. As the CO_2 and other toxic chemical increases in the climate it damages the environment. So 'Go Green' becomes the essential need of this safety environment. To decrease overall energy consumption, storage and communication five technologies are available that is *Green Data centre, Virtualization, Cloud Computing, Power Optimization and Grid Computing.*

III. NEED OF GREEN COMPUTING

As energy crisis deepens and the resources deplete, we need to seriously think about making substantial changes in our lifestyle for energy conservation. Green computing is one way of dealing with the energy crisis. It is possible to reduce carbon emissions, save energy and protect the environment as a whole with this approach. The traditional way of manufacturing computers involves the use of Lead, Cadmium, Mercury, and other toxic elements. According to environmentalists, the amount of Lead present in a computer could be anywhere up to 3 to 4 kg.

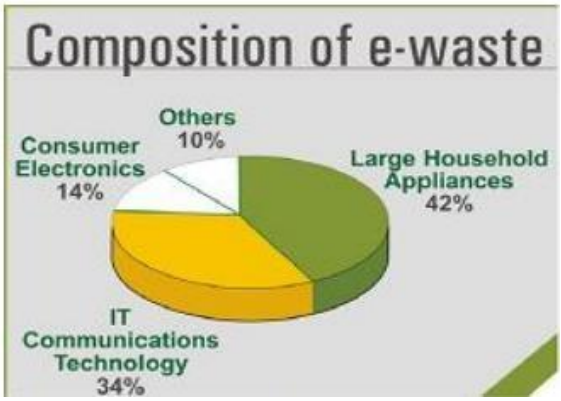

Fig-1. Composition of E-Waste[12]

Fig-1 displays the composition of electronic waste. The growing use of electronic devices among every strata of the society is resulting in unrestrained disposal of e-waste, posing a grave threat to the health and environment [12].

IV. RELATED WORK

1. Dr.Pradeep Mittal et al., "Green Computing –Need and Implementation", IJARCET,vol 2,2013.

'Energy Star' is a program which is launched by U.S in 1992 by Environmental Protection Agency. It is an International standard. A label energy star is awarded to computers, electronic device, displays etc. Energy Star products minimises the use of energy and maximizes efficiency. Nowadays no one can work without computer, as it reduces time and effort of human. It results in increasing the number of computers which subsequently maximizes the power consumption, heat generation,CO_2 emission. It is very harmful to our environment. PCs are non biodegradable due to the defect in the manufacturing technique. Disposal of them is very difficult. As there are toxic chemicals in it it affects badly on environment. Disposing of it also produces harmful impacts. Now it is very necessary to take some efforts to save our environment. While using computer some tricks are discussed like setting sleep and Hibernate settings of computer, turn off the computer when not in use, set effective power plant, avoid screensaver, reduce the brightness of the screen, avoid informal disposal. Use LCD instead of CRT monitor, recycle hardware etc. Overall this paper spreads awareness in the society for future of good and healthy environment.

2. Sk.Fayaz Ahamad et.al., "Green Computing Future of Liveliness", IJCER, 2015.

Greening computing equipments reduces the cost and helps the environment. Global climate change causes environmental damage. To preserve our planet, we should take precaution. All we are responsible to find out the solution. Thin client is one solution over it. It has no disk drives or fans. It emits less heat which also saves cooling cost. Minimum energy and resources are used for it. Due to the light weight transportation is cheap and reduces disposal cost. Manufacture the product efficiently which require minimum energy. Any part upgrades and repairs whenever needed which reduces landfills. Increase the utilization of OLEDs (Organic light emitting diodes). Replace toxic material lead by copper or silver. In economic point of view, Green Computing groups uses 'Green computing philosophy' to save cost only not an environment but strategic leaders consider social and environmental impact of emerging technology. As there are different reasons like new revenue opportunity, fear of customer backlash, become a good citizen, IT vendors apply for green standards. Develop more and more green machine to save electricity. In software, try to write efficient algorithms to solve any problem which reduces the cost. Introduce virtualizations concept which reduces hardware, time, space etc. A fast GPU is also power consumer. CRT consumes more power than LCD monitor. LCD uses cathode fluorescent bulb. Instead of it use LEDs to save electricity. Some Green Computing applications are also discussed. Blackle is the best search engine introduced by Google search. When screen is white, computer consumes 74 W and when it is black it consumes 59 W. Now there is need to switch from Google to Blackle. It will save 750 MW each year. Different colours requires different amount of energy. Fit-PC, Sunray, thin client, portable PCs are also applications of it.

3. Ishrath Unnisa A, "Awareness Of Green Computing In Educational Institutions: A Review", ISBN, 2015

Green Computing is the emerging technology. It becomes more necessary for our environment. It reduces the IT waste. This paper creates an awareness of green computing among students and teachers. Design, manufacture, use and dispose of any product efficiently and cost effective way which will not affect on the environment. Follow the principles of sustainability i.e. to reduce, reuse and recycle.

In 21st century carbon emissions, global warming and climate change are hot issues. Turning to the green IT industry has to lead for computer manufacturing with 70% natural resources. Try to manufacture long life equipments. Upgrade RAM rather than purchasing new computer ACPT(Advanced Configuration and Power Interface) is an open industry standard. It allows an operating system to directly control power. It reduces heat produced and electricity consumed. Telecommunication technology reduces greenhouse gas, travelling and increases profit. Cloud Computing consumes computing resources. This paper focuses on hardware and infrastructure of an organization which will minimize cost and power. Excessive use of air conditioning in laboratory emits CO_2, which is very harmful for our health. So provide good ventilated laboratories to the students. Reduce the CDs and DVDs**,** paper printing, toner, energy and cost. Use draft mode to save ink. DVDs are better than CDs and USB flash drive is better option as it is reusable and faster than burning CD.

This paper tries to make aware the society about green computing through the students and teachers who can direct properly to the society. Students are our future. They can implement these ideas in better way.

4. Deepak Verma, "Protection of Environment By Green Computing : A Study", IJARCET,vol 4,2015.

Green Computing basically starts from design, manufacturing, using and disposing all operations in proper manner. "Energy star" labels are applied to refrigerator, A.C., television sets etc. For the implementation of Green Computing some steps should taken into consideration. We should manage energy efficient data centres. We should also use energy label to 'go green'. Old computers submit to those who are needy or to the municipal bodies. Try to recycle the parts of it. In telecommunication, people can work from home. Teleconferencing reduces greenhouse gas, travelling cost, office space, lighting etc.

This paper concludes with implementing very little tricks like don't keep PC on when not needed, use sleep, hibernate mode, blank screen savers to save energy. Apply 3 R's principle of Reuse, Replace and Recycle to 'Go Green'.

5. Khushwant Kaur, "Green Computing: An Eco-friendly Approach to Manage E-Waste",IJSRCSEIT,vol 3,2018.

This paper suggest about the management of e-waste. First it discusses why there is a need of green computing. Concerning with the manufacturing process, lead is used for soldering purpose on circuit boards which effect on the central nervous system, kidneys etc. Cadmium is used in

semiconductors, mercury is used in batteries and switches. All are harmful for human beings. There is vast increase in e-waste and disposal of it is very big issue. There is greater need to 'Go Green'. To promote his term different approaches are taken into consideration i.e. green design, use, and Green disposal. In green design, maintain product longevity e.g. upgrade RAM.

6. Rina Mishra et al., "An Emerging Technology : Green Computing", International Research Journal of Engineering and technology IRJET ,vol 2,Issue 02, 2015.

Green computing is the study and practices of IT equipments. IT equipments should be efficiently and effectively disposable. It should not affect on environment. Classification of Green computing has two factors : "Green IT" and "IT for Green". Today there is need of minimum energy consumption, E-waste recycling, Virtualization, Green Cloud, developing Green machines. This paper concludes with up- gradation of computer parts, set Blackle as home page instead of wallpaper.

7. Ibtehaj AlMusbahi, "Survey on Green Computing : Vision and Challenges",vol 167, 2017.

Human utilizes computers and related technology effectively, efficiently and an eco-friendly manner is known as Green Computing. It minimizes carbon emissions. It is a study of Designing, manufacturing, using and disposing of computers, server and peripheral devices. It focuses on power management techniques. According to environmental protection agency 32- 40% computers kept on after office hours and 90% computers are Idle at week end. To save power, activate hibernate mode over them. Virtualization process runs multiple computers on single physical hardware. Execute several operating systems on one computer. It reduces hardware space and cooling of them. Make improvement in repairing, reusing, recycling and disposing of computers. Use 'eco-label' products. In data centre pay serious attention to power consumption. Think about the major challenges and find out the solutions to overcome the problems.

8. Kancharana Nitin Kumar, "A Novel Scheme of Computing: Green Cloud Computing", IJSRCSEIT, vol 3, 2018.

Greenhouse gases are responsible for global warming. To reduce energy consumption we should adopt green technologies. Goal of green technology is manufacture or usage of it should not affect on an environment. Now IT companies have been realised that green technology are helpful to decrease the cost of the system and it also saves the environment. In cloud computing using remote server in internet, we can store, manage and process data. Now users of cloud computing are increasing. For providing efficient services cloud computing service providers compelled to open data centres. It increases high energy consumption which results in high operational cost. It also affect on an environment by emission of CO2 gas. So there is need to make cloud computing as 'green cloud computing'. This paper discusses the merits and demerits of green cloud computing. Virtualization, green data centres, green cloud computing, power optimization and grid computing are core concepts it. Green cloud computing is quite costly. Rapid change in technology affects on usage of green cloud computing. But it has more advantages than disadvantages so it is negligible. As the business grows suddenly it becomes difficult to handle their data storage and manual processing. So the businessmen moved to cloud computing. In 2005, cloud computing became popular. It has very bright future. In few years everything will work through cloud computing. Now use the available resources in well-utilised manner and make it more environmental friendly.

9. Hsing-I Wang , "Constructing th Green Campus within the Internet of Things Architecture", International Journal of Distributed Sensors Networks, 2014.

IoT revolution promises to enhance the smart environment so that users can take benefit of it. Governments around world take lot of efforts to minimize carbon production as well as emphasize on the reduction of energy consumption. This research adopts the concept of IoT to construct a green campus environment which will realize the idea of energy saving. Author has conducted experiment on computer labs and air condition devices and proved that sensor network saves energy. Finally author concluded that this research will be carried out in university campus and make this campus smart green campus.

V. APPROACHES TO GREEN COMPUTING

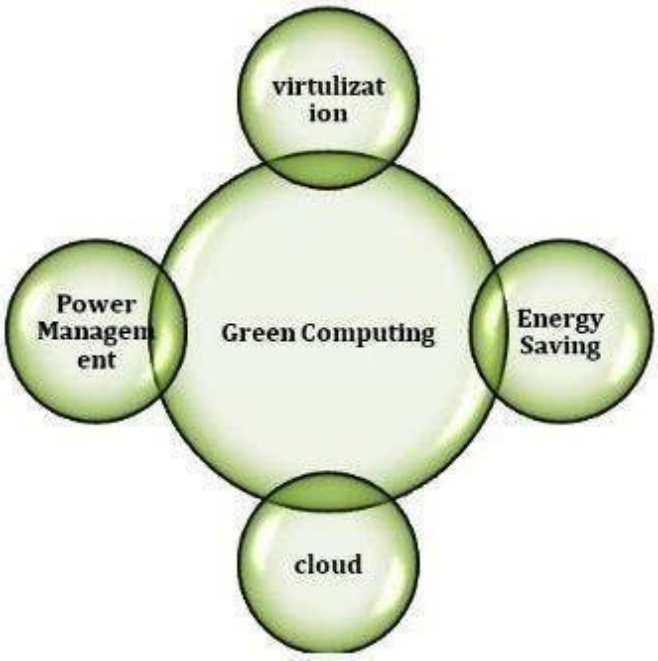

Fig.2 Fundamental Techniques of Green Computing [6]

1. **Energy consumption** : Servers, cooling and lighting are main sources of saving energy.
2. **Recycling** :E-waste, recycling includes equipments such as computers, peripherals, laptops, mobiles, hard disc, batteries, circuit boards, monitors and other electronic utilities. Recycling of E-waste protect human and environmental health. The *reuse* of equipments saves energy.
3. **Virtualizations**: Using virtualization, system administrator combines several systems into virtual machines on single server to run multiple operating systems. By minimizing power

and less electricity consumption, energy efficiency can be achieved with less physical equipment plugged in.

4. Cloud: Now a day organization moving from ordinary server to cloud server for energy efficiency and sustainability goal. Cloud providers make their system green by using renewable energy sources such as wind, solar or hydroelectricity. Combining all these resources can improve utilization and provides more space, power and cooling capacity.

VI. GREEN INITIATIVES

Key points	How to implement
Energy Star	Use product of label "Energy Star"
Sleep mode	Activate sleep mode on PC to save electricity
Hibernate mode	Activate hibernate mode on PC to save electricity
Brightness of screen	Minimize to save energy
Screen saver	Avoid it to save power
Computer	Switch off when not needed
Blackle	Use best Green search engine
Virtualization	Combine several systems into virtual machines on single server to run multiple operating systems
Smart sensor	Based on IOT
Recycle	Recycle the part of computer
Reuse	Donate to those needy people of any part
Reduce	Reduce e-waste
Product longevity	e.g. Upgrade RAM
LCD	Use LCD's to consume less power than CRT
OLED	Use OLED's to save power
CD	Use DVD better than CD
USB flash drive	Reusable, faster than burning CD
Algorithm	Write efficient algorithm to save energy and cost
Wallpaper	Set Blackle as home page instead of wallpaper

Table No.1 Green Initiatives

VII.CHALLENGES

Now a days the use of computer increases tremendously so there is need to focus on reducing IT infrastructure and equipment associated cost. Concentrate on the term services and computing efficiency.

In information technology industry the big challenges are,

- To convince the companies and stakeholders for investment in eco-friendly computing. It takes too much time to show the real benefits and advantages of it.
- Try to use eco-friendly material in manufacturing process of computers and chips which would be helpful for easy disposal of it.
- Focus on generating higher efficiency IC chips which will give high performance with minimum power. This is very skilful job and requires high level skilled engineer.
- People need to prefer high processor to increase in energy requirements.
- Improvement is needed in organizing Green computing awareness program [7].

Challenges in Networking

Green communication is the largest energy consuming issue in sensor based networks. There is growing need to reduce the energy consumption in communication. It can be achieved through:

Use asynchronous sleep/waking working mode: Try to reduce energy consumption of nodes. As the sensor node rotate from sleeping to waking state try to keep that node maximum time in sleeping state. Only in the waking state, node can communicate to save energy. To reduce data transmission there is need to increase duty cycle which increases energy consumption of the node. Balancing of delay and energy consumption is a major issue.

Effectively reduce consumption in Data Fusion: Data fusion means to fuse multiple information which reduces data and energy consumption. To minimize redundancy, data packets should be fused. Most of the routing strategies have not been applied to sensor networks. 'Alarm' message is required whenever necessary to take instant action which reduces energy consumption effectively [10].

VIII. CONCLUSION

In this paper we discussed briefly about environmental issues, global warming and need of green computing. CO_2 emissions from Data centres are responsible for global damage**.** We also covered how to make IoT environment as green, green initiatives and challenges in green computing. By adopting green computing practices globally, we can contribute positively to environmental stewardship and protect the environment by reducing brown energy and paper cost. By ever increasing research in the field of science and technology, we can tackle the problems.

IX. FUTURE WORK

Sleep mode, hibernate mode, standby mode are effective ways to consume power. Many governments tried to take initiatives like "energy star" label for products. This standard should adopt to save energy, emission of CO_2, air pollution and toxic materials. Recycling of e-waste and scrap computer also helps to keep environment healthy. Improve the overall network efficiency for various network topologies. Improve Green IoT based applications efficiently and effectively is a big challenge.

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