Go Green: A Case Study of Power Demand of Data Center and Technical Institutions in India

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ABSTRACT
Technology has grown rapidly with scientific advancement over the world in recent decades. Therefore, there is a need to redesign the educational system to meet industrial needs better. The advent of computers with sophisticated software has made it possible to solve many complex problems very fast and at a lower cost. Almost all studies in various disciplines use computers to solve their problems. Making computers available to all users, particularly students, is difficult in developing countries. This is one of the major problems in educational institutions arising from budget constraints. Cloud computing is becoming an attractive technology due to its dynamic scalability and effective usage of the resources; it can be utilized under circumstances where the availability of resources is limited. In this paper, two case studies are presented to know the power issues in Data Center and computer laboratories in educational institutions especially technical institutions. Attention is made to possible implementation of Cloud computing technology in the educational field, especially in engineering colleges where there is intensive use of computers and software.

1. INTRODUCTION
Energy costs related to IT is increasing from year to year and is expected to continue to increase in the years to come. This is affecting the use of IT equipment such as desktops, servers, switches, and storage systems. The duration of use of IT equipment in education institution is definitely more than the duration for which non-IT equipments are used. For example, in electrical machines laboratory, an electrical machine will be powered-on only for maximum of 30 minutes for a slot of 3 hours laboratory session. Whereas, in Computer laboratory, each student will be using a separate system and which will be ‘on’ for the complete 3 hours duration of the laboratory session. If we consider the total ratio of the power demand of the IT equipment to non IT equipment in any typical technical institution, we find the ratio will be always greater than one.

2. CASE STUDY 1
The power demand of IT equipment in technical institutions in India is depicted in the table below. The number of technical institutions in India [1] and the power demand is shown Table 1.1
The toatal power demand is approximatetly equal to the the total power generation from the Sharavathi Generating station of Karnataka, which is one of the largest power generating source in Karnataka.[2] . These copmuters will be used mostly for all the working dyas and in each working day, they will be used for two session each of 3 hours that is total 6 hopurs per day. Though it powered ‘on’ for 6 hours a day, it will not be effectively used for the complete duration. The actual usage of the systems may be only for 3 hours, because of various reasons like student will be listening to the explanation by faculty or sitting idle in between etc. We can assure an utility factor of 50%, during which the useful work is done. The students will be effectively using the computers for the 50% of the duration of the laboratory session time allocated which leads to the unnecessary power wastage. The electrical energy wastage will be approximately 1100 Mega Watt per hour, which is considerably large. These wastages can be reduced to some extent if some hardware and/or software approaches are used.

However, the operating system can be tuned to minimize this wastage by identifying the idle time and appropriately putting the monitor and/or CPU in power minimization mode like stand by and hibernate

- **Standby**: With standby mode, the PC uses very less power; but the power to items such as the monitor and hard drive is cut. When you come back to your PC, it will be up and running quickly, but the computer will be using more energy than the Hibernate mode.

- **Hibernate**: With hibernate mode, the PC is not using any power at all. Of the two, this mode definitely saves the most energy, but the time it takes to power up will be a bit longer compared to standby mode.

If these power saving modes are properly set, then the total power from the above said system will be definitely around 2.5MW, the standby mode will consume approximately about 2% to 3% of power and hence, still contribute to around 22MW which is quite considerable. The energy wastage can be reduced from 1100 M watt per hour to 22 M Watt per hour using standby mode.

Table 1.1 The technical institutions and the power demand

Sl No	Institute	Number	Average No of systems	Total No of systems	Approx. Power demand in Mega Watts
1	Engineering colleges	5000	500	2500000	625
2	Pharmacy colleges	1200	100	120000	30
3	Polytechnics	3500	400	1400000	350
4	Management	2500	150	375000	94
	Total			4395000	1099

3. POWER/ENERGY CONSERVATION MODES [3]

3.1 Power Management Driven by the Operating System

If suitable power management configuration settings in the Operating System are adapted, the energy dissipations can be reduced because of which battery life of the system can be prolonged or the energy conservation can be achieved in the PCs. When enabled, Operating System Power Management places the monitor, hard drives and computer into a low-power "sleep" mode after a period of inactivity. Touch the mouse or keyboard and the computer, hard drive and monitor "wake up" in seconds. Power management features are standard in Windows and Macintosh operating systems. To improve the power efficiency of your PC, the Climate Savers Computing Initiative recommends the following power management settings:

- Monitor/display can be put in to sleep: mode after 5 minutes or less
- hard drives/hard disk can be shifted to sleep mode after 15 minutes of idle.
- System can be moved to standby or sleep after 30 minutes or less
- Instructions for enabling power management vary by operating system.
- Instruction for power management can be checked according to your operating system.

3.2 Practice

It has become a habit that if we want to put our television off, many a times unnecessarily, we spend 10 minutes looking for a misplaced remote instead of simply pressing the "off" button on the TV set. With computer also it happens. Practice to conserve the energy by manually putting the system to sleep mode before leaving the desk, For example, on certain computers, use (Fn + F4 keys) instead of using the more-complex Ctrl + Alt+ Delete + k function.

3.3 Use Power Efficient Screen Saver

Screen savers are not necessary on modern monitors, and studies show they actually consume more energy than allowing the monitor to less bright when it's not in use. Many a time, the screen savers will be using the monitor and the CPU time also to the fullest extent and dissipation of 100% energy similar to active mode. A black background screen will be always the best choice.

3.4 Turn Down the Brightness Setting on your Monitor

If the brightness of the computer is more it consumes twice the power used by the lightest setting. For example, on certain notebooks you can use the power brightness keys - Fn + Home (for up) or Fn + End (for down). Usually on a desktop computer, the brightness controls can usually be found on the front of the monitor.

3.5 Go on Standby

Switching to standby can also be a major-league power saver: a typical monitor consumes 30 watts to 140 watts while on, but around 3 watts while on standby. The recommended setting is for your computer to go to standby after no more than 30 minutes of inactivity.

3.6 Select to Shut Down the System if you are not going to use it for Longer Time

If it's not being used, shut it off. Keeping multiple applications open slows down your computer and sucks up the battery life. If you no longer need that application, tell it goodbye - for now.

Though the power saving modes are in place in the computer system, where as it is not widely used in the peripheral devices, considering the contribution of power wastage from all these devices. Similarly, if we consider the power demand of data centers, a large percentage of power is used in storing the data. A typical data center is given below:

4. CASE STUDY 2

We find many power hungry devices in the systems and the duration for which these systems are powered on over each day is more than 12 hours in case of desktops and other systems like servers, switches and data centers run 24x7 throughout its life time. The power and cooling in these systems are becoming more and more challenging. Under current efficiency trends, national energy consumption by servers and data centers could nearly double every five years [4].

4.1 Green Chips

A business with a network of 20,000 desktop systems running 24 x 7 drawing 200 watts will consume about 35 million kWh of electricity annually. Using the average cost of electricity at

4.00/kWh, this would cost this business approximately Rs. 14 Cr in utility charges annually. It is essential to device mechanism or techniques to control the power dissipated by these systems and open a new avenue called Green computing. Green computing can be implemented by designing greener ICs or greener chips i.e., the chips which are power efficient and/or by using algorithms which results in energy conservation. The greener ICs can be designed by using suitable technique at one or multiple levels of the following levels. The hybrid techniques involving both hardware and software techniques will yield better results.

Hardware level:

- Proper selection of materials for the construction of transistors (circuit level technique)
- Optimizing number of gates or size of the gate (gate level technique)
- Optimizing the register circuit or circuit layout (register level technique)

Software level:

System software level (using compiler or OS support)

- Application software level.

In the hardware level, many techniques involving static and dynamic methods are discussed in [5]. It is evidenced that cache and cache substructures are good candidates for the dynamic and leakage power control. As per the International Technology Roadmap for Semiconductors [13], leakage energy control is the short term and long term grand challenge for the architects of the future processors. By collectively using techniques suggested in [9,10,11,12], in i-cache, d-cache and BTB, it is possible to save the leakage power to the extent of 45-55% of total leakage power. The overhead involved is not exceeding 5% of power savings achieved through this technique.

4.2 Green IT

Green IT refers to IT's contribution to reduce carbon footprints, sustainability and regulatory compliance via managing electrical power used by the IT infrastructures, managing wastes and consumables used by IT and ITES and through IT sustainable practices. The green IT always yields greater profit for any organization. With emissions of $3.8x10^6$ metric tons of CO_2 in 2007, Intel Corporation knew it faced a long-term challenge to reduce its environmental footprint. Without taking action, overall emissions would increase due to the growth of the company and the increasing complexity of its design and manufacturing processes. Recognizing that addressing these challenges would be a strategic priority for any IT company in the coming years, Intel chose to develop significant capabilities and a reputation for leadership in the area of sustainability.

The IT sustainability program has allowed Intel IT to increase the performance of its computing environment while reducing the overall IT carbon footprint. This has resulted in energy cost savings of $5.8 million in 2010 (up from $4 million in 2009) and the avoidance of more than 60,000 metric tons of CO_2 emissions. The program also helped the wider company to reduce its carbon impacts. For example, in 2010 and 2011 new videoconferencing facilities resulted in cost savings of over $114 million and the avoidance of more than 87,500 metric tons of CO_2 emissions. In recognition of Intel IT's sustainability achievements, Intel was included in Computerworld's 2010 and 2011 lists of "Top Green-IT Organizations". The Intel IT statistics of three years from 2009 to 2011 is given in table 1.2 below, from which it evidenced that good IT practices always yields a better performance.

Table 1.2 Statistics of IT practices for three years

Intel IT	2009	2010	2011
Intel data Centers	95	91	87
Storage capacity (peta bytes)	18.6	24.9	38.2
Percentage of applications virtualized	12%	42%	64%
Number of Employees	80K	82K	100K
IT spending (in million)	$1264	$1308	$1404
Saving from travel avoidance due to videoconferencing ($, Million)	$14	$27	$73

4.3 Factors Affecting Data Center Energy Efficiency

Data centers are found in nearly every sector of the economy: financial services, media, high-tech, universities, government institutions, and many others use an efficiency of a data center goes beyond server refresh and virtualization. Data centers generate heat and must be cooled; the required equipment can be a significant consumer of power.

Data center facilities are heavy consumers of energy, accounting for between 1.1% and 1.5% of the world's total energy use in 2010[4]. The energy used by the United State's servers and data centers is significant. It is estimated [5] that this sector consumed about 61 billion kilowatt-hours (kWh) in 2006 for a total electricity cost of about $4.5 billion. This estimated level of electricity consumption is more than the electricity consumed by the nation's color televisions. Power usage effectiveness (PUE) measures how much power is actually used by IT equipment vs. cooling, and other non-IT equipment. PUE is the ratio of total amount of power used by a computer data center facility to the power delivered to computing equipment.

$$PUE = \frac{Total\ facility\ Power}{IT\ equipment\ Power}$$

Intel IT actively tracks PUE measurements within its data centers to optimize cooling. Geographic location is also a key factor in cooling; a data center in a cool climate such as Ireland requires less cooling power than a data center in a warm climate such as Mexico. Location is also an important factor for the CO_2 intensity of the power consumed by the data center. A gas or coal fired power utility creates much more CO_2 than a hydro- or wind-power utility. For this reason, many new data centers (e.g., Google's) are located near low-cost and environmentally friendly power sources.

There is significant potential for energy-efficiency improvements in data centers. Although some improvements in energy efficiency are expected if current trends continue, many technologies are either commercially available or will soon be available that could further improve the energy efficiency of microprocessors, servers, storage devices, network equipment, and infrastructure systems. For instance, existing technologies and design strategies have been shown to reduce the energy use of a typical server by 25 percent or more. Even with existing IT equipment, implementing best energy-management practices in existing data centers and consolidating applications from many servers to one server could reduce current data center energy usage by around 20 percent. Energy-efficiency strategies could be implemented in ways that do not compromise data center availability, performance or network security, which are essential for these strategies to be accepted by the market. The future trends in energy-efficient technologies beyond current trends:

4.3.1 Improved Operation:

Includes energy-efficiency techniques essentially operational in nature and require little or no capital investment. It can be harvested simply by operating the existing capital stock more efficiently. Server consolidation, elimination of unused servers or legacy applications, adoption of energy-efficient servers to modest level on all the applicable servers may yield good results. Improved airflow management may contribute to about 25%-30% improvement in energy efficiency.

4.3.2 Adoption of best practices:

Represents the efficiency gains that can be obtained through the more widespread adoption of the practices like consolidation of servers and storage to the modest extent and use of best transformers, UPS and cooling systems may yield highest improvement in infrastructure energy efficiency.

It is estimated that electricity cost saving could amount to approximately 700 million dollars per year if the above suggested methods are implemented to the fullest possible extent [5].

5. CONCLUSION

There is an immediate future scope to prepare the skill set to design, develop strategies and manage Green IT and convert the IT to Green and Greener IT. Similar to the universities abroad [6,7,8], the Indian universities have to immediately act in this direction and design the curriculum to focus needs of Green IT. All the stake holders in the educational institutes have to get educated about the Energy conservation and take up necessary steps to check increase in energy dissipation by the IT equipments and global warming.

All organizations in the private and public sector would like to reduce both the capital and operational cost of IT. Yet they are becoming more dependent upon it all the time. Making these two ends meet has always been a challenge the cloud promises to make it possible to massively and rapidly increase IT capacity, without any significant capital outlay and reduce the overall cost of IT.

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