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A Study of Improving the Energy Efficiency in Distributed Network systems Using Computer Peripherals

Natesan Sundaram and Lokman Erzen

Regent University College of Science and Technology, Accra, Ghana.

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ABSTRACT

The Large- Scale Computing and network systems consume more amount of power and computer components like Mother Board, Processor, RAM, Hard Disk, VGA (Video Graphics Adapter), AGP (Accelerated Graphics Port), Network ports, data centers and supercomputers. Most of the places like schools, colleges, and IT Industries people work with computer. Day by day the energy consumed by these computer peripherals all over the world is high. Trying to reduce these high energy consumption a study and survey techniques have been analyzed. This survey techniques and solutions will improve the energy efficiency in computing devices and network resources. This method discusses to evaluate the maximum power consumed by the resources and explains the techniques that operate at distributing systems, trying to allocate resource for scheduling, network management. This study aims about the art of energy efficiency in computing resources and network components.

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1. Introduction

In all the computing systems, power consumption is the key design factor like sensor networks and battery backup-constrained devices. Currently the other systems like data centers, supercomputers in business, schools, IT industries, and factories have good computing performance. Increase in performance is also appreciated but the power consumption is high. In most of the companies like large scale computer and network system are constructed near power stations to reduce the power transmission loss. In general around 95,000 LAN switches and 3,257 routers were deployed and they consumes 3.2 Tera watts hour and 1.1 Tera watts hours per year respectively [Gupta and Singh 2003]. In power grids and data centers, energy is often wasted by leaving computers and networking components like switches, routers, and servers powered on, even if they are idle. At certain period it is observed that an average 10% of servers are never utilized.

The energy consumed by these servers can be saved if all the other components were switched off or put into low consumption modes when the computers are not in use. The power consumptions are categorized in to two main parts like static and dynamic. Static depends on the mother board size, configuration, computing time, data storage capacity and network components. In this static mode the power consumption is included with leakage power present in computer systems. A dynamic mode depends on the usage of computer peripherals, data storage, network resources during the computer active stage, change in clock speed, will reduce the energy. Performance of the computer also increases in dynamic mode and hence becomes active in research and development area. Decreasing the power consumption in a large scale distributed computer system is a highly challenging and it can be identified and addressed in many ways by reducing the size of the nodes in network environment and hardware components by implementing the

high infrastructure techniques. This survey techniques and solutions aim to improve the energy efficiency in computing and also wired network resources. Infrastructure level techniques will be improved by supporting the power saving capabilities of an individual hardware and also software components.

2. Literature Study

[1]Rihab Maaloul, Lamia Chaari, Bernard Cousin, Energy Saving in Carrier-Grade Networks: A Survey. Computer Standards & Interfaces, Elsevier, 2018, 55, pp.8-26 Energy consumption of large-scale networks has become a primary concern in a society increasingly dependent on information technology. Novel solutions that contribute to achieving energy savings in wired networks have been proposed to mitigate ongoing and alarming climate change and global warming. A detailed survey of relevant power-saving approaches in wired networks is presented here. They give a special focus on carrier-grade networks. At first we perform a comprehensive study of communication infrastructures regarding energy saving. Then, we highlight key issues to enable green networks, ranging from network design to network operation. After that, we present the major contributors to power consumption in cable networks. Afterwards, survey, classify, and compare the main energy aware methods and mechanisms that are the most appropriate for improving the energy efficiency of carrier-grade networks.

[2]S.A. Nesterenko, Prof., J.S. Nesterenko, DOI.10.15276/opu.2.49.2016.10.A in 2016 the Authors. This is an open access article under the CC BY license. Costs Evaluation Methodic Of Energy Efficient Computer Network Reengineering. A key direction of modern computer networks reengineering is their transfer to a new energy-saving technology IEEE 802.3az. To make a reasoned decision about the transition to the new technology is needed

a technique that allows network engineers to answer the question about the economic feasibility of a network upgrade. Aim: The aim of this research is development of methods for calculating the cost-effectiveness of energy efficient computer network reengineering. Materials and Methods: The methodic uses analytical models for calculating power consumption of a computer network port operating in IEEE 802.3 standard and energy-efficient mode of IEEE 802.3az standard. For frame transmission time calculation in the communication channel used the queuing model. To determine the values of the network operation parameters proposed to use multi agent network monitoring method. Results: The methodic allows calculating the economic impact of a computer network transfer to energy-saving technology IEEE 802.3az. To determine the network performance parameters proposed to use network SNMP monitoring systems based on RMON MIB agents.

[3]Bolla, R., Khan, R., & Repetto, M. (2016). Assessing the Potential for Saving Energy by Impersonating Idle Networked Devices IEEE Journal on Selected Areas in Communications, 34(5), 1676 – 1689 the idea of proxying network connectivity. Has been proposed as an efficient mechanism to maintain network presence on behalf of idle devices, so that they can “sleep. The concept has been around for many years; alternative architectural solutions have been proposed to implement it, which lead to different considerations about capability, effectiveness and energy efficiency. However, there is neither a clear understanding of the potential for energy saving nor a detailed performance comparison among the different proxy architectures. In this paper, they estimate the potential energy saving achievable by different architectural solutions for proxying network connectivity. Our work considers the trade-off between the saving achievable by putting idle devices to sleep and the additional power consumption to run the proxy. Our analysis encompasses a broad range of alternatives, taking into consideration both implementations already available

[4]Guilherme C. Januario, Carlos H. A. Costa, 2013 IEEE Evaluation of a Policy-Based Network Management System for Energy-Efficiency, Energy efficiency features are being integrated in network protocols and management systems. Simulations can provide input on how a particular algorithm would perform in different network conditions. However, building an environment that is able to comprehensively account for interactions between different network functions is difficult. A combination of emulation and implementation of major energy efficiency features provides a view closer to what may happen in a real deployment. Previously, this study described a policy-based network management system that optimizes network paths with respect to energy efficiency. In this paper, they evaluate the system using software routers for emulating network equipment functionality. The developed and trade-offs of employing a state-of-the-art Linux distribution to emulate an energy efficient router. The article then presents results from the evaluation of the management system and argues about the benefits of the emulation environment.

[5]Anne-Cecile Orgerie, *Acm Computing Surveys*, Vol. TBD, No. TBD, TBD 2013, Pages 1{35, A Survey on Techniques for Improving the Energy Efficiency of Large Scale Distributed Systems. The great amount of energy consumed by large-scale computing and network systems, such as data centers and supercomputers, have been a major source of concern in a society increasingly reliant on information

technology. Trying to tackle this issue, the research community and industry have proposed a myriad of techniques to curb the energy consumed by IT systems. This article surveys techniques and solutions that aim to improve the energy efficiency of computing and network resources. It discusses methods to evaluate and model the energy consumed by these resources, and describes techniques that operate at a distributed system level, trying to improve aspects such as resource allocation, scheduling and network track management. This work aims to review the state of the art on energy efficiency and to foster research on schemes to make network and computing resources more efficient.

[6]Anne-Ccile Orgerie, Laurent Lefevre and Isabelle Guerin-Lassous, paper was peer reviewed at the direction of IEEE Communications Society subject matter experts for publication in the IEEE Globecom 2011 proceedings, On the Energy Efficiency of Centralized and Decentralized Management for Reservation-Based Networks. Reducing the energy consumption of wired networks has become a key concern for manufacturers of network equipment and network providers. In this paper, we propose an energy-efficient data transfer framework that uses advance bandwidth provisioning and on/off algorithms to put unused nodes of wired networks into sleep mode. This framework is termed as High-level Energy-aware Model for bandwidth reservation in End-to-end networks (HERMES). We explore centralized, decentralized and clustered approaches for managing network resources and bandwidth reservations in this framework. By applying these approaches to HERMES, we evaluate via simulation their efficiency in terms of performance and energy consumption.

[7]P. Reviriego, Member, IEEE, K. Christensen, Senior Member, IEEE, J. Rabanillo, IEEE communications letters, vol. 15, no. 5, may 2011, An Initial Evaluation of Energy Efficient Ethernet. In September 2010, the Energy Efficient Ethernet (IEEE 802.3az) standard was officially approved. This new standard introduces a low power mode for the most common Ethernet physical layer standards and is expected to provide large energy savings. In this letter, for the first time, Network Interface Cards (NICs) that implement Energy Efficient Ethernet (EEE) are used to measure energy savings with real traffic. The data presented will be useful to better estimate the energy savings that can be achieved when EEE is deployed. Existing analysis of EEE based on simulations predict a large overhead due to mode transitions between active and low power modes. The experimental results confirm that transition overheads can be significant, leading to almost full energy consumption even at low utilization levels. Therefore traffic patterns will play a key role in the energy savings achieved by EEE as it becomes deployed in the field.

3. Problem Identification

Identifying the usage of power and power consumption in all the computer accessories in working places like data centers, business, schools, IT industries, and factories also in research projects. The power consumption in a large computing infrastructure can be improved at various levels, depicting the power consumed by individual components and it is generally a difficult task. But it is important to the design and evaluation of energy efficiency using architectures and algorithms. Once the power consumption of all individual computing resources is known, researchers can design and implement new techniques to reduce the power consumed by all individual components.

4. Measures and Models in Energy Consumption of Computing Resources

The power consumption of can be measured by energy sensors like wattmeter. Wattmeter is external equipment or components embedded in Power Distribution Units (PDUs) and also work as temperature sensors. Installing sensors like wattmeter is costly. An alternative tool is to install less expensive system to use energy models to estimate the consumption of components.

Table. 1 Power Consumption components in CPU.

Sl.NO	Name of the components	Power consumptions by the components
1.	Mother board	30W-60W
2.	processor	65W-130W
3.	memory	15W/1GB RAM
4.	Hard disk drive	15W-30W
5.	Optical drive	20W-30W
6.	Video card(AGP)	30W-70W
7.	PCI video card	30W-150W
8.	PCI add in card	5W-10W
9.	USB device	5W
10.	CPU FANs/case	2W-3W

Good models should be lightweight and should not interfere in the power consumption. Microsoft's Joule meter is also an example of software tool that estimates the power consumption of a computer by tracing information on many hardware components. The power consumed in a processor can be identified as the sum of the static power.

$$P_{dynamic} = A * C * V * (2f)$$

Where A is the percentage of active gates, C is the total capacitance load, V is the Supply voltage and f is the frequency. Several solutions have been projected in this study to evaluate at various levels the power processors consumes, including cycle level estimation where the energy consumes in each processor unit is estimated at each clock cycle. Several measurements and metrics have been proposed for infrastructure like computer data centers and servers. The most commonly used matrices is the Power Usage Effectiveness (PUE), Introduced by the Green Grid.

$$PUE = \frac{\text{Total Available Power}}{\text{Power Consumed by Peripherals}}$$

Another popular metric used in computer Data Center Infrastructure Efficiency (DCiE) expressed as:

$$DCiE = \frac{1}{PUE} = \frac{\text{Power Consumed by Peripherals}}{\text{Total Available Power}} \times 100\%$$

These two measurements and metrics will calculate how much power is used by an overall infrastructure and hence, it is proved that how efficient the cooling system and other non-IT resources are. Other metrics also evaluate the performance per watt, for instance, the compiled evaluating the Floating Point Operations per Second (FLOPS) per watt achieved by the estimated systems.

4.1. Node optimizations

A computing node comprises of many components, each of which can be optimized to save energy. Figure 1 illustrates what components can be switched on and off or put in lower power-consumption modes.

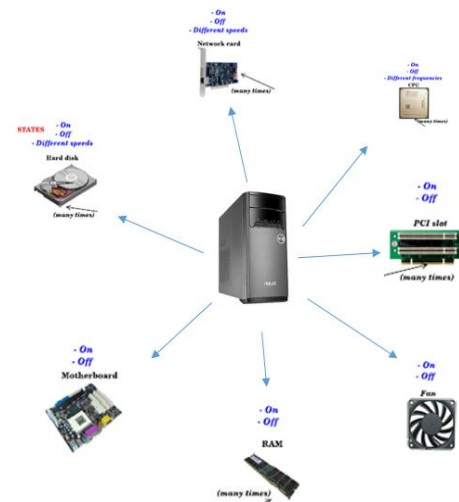


Figure 1. Possible states per node component.

Different studies focuses on reducing the consumption of specific components, like Network Interface Cards (NICs), hard disks, motherboards, VGA cards and CPUs , with varying results. Table 2 shows the power consumed by various components.

A CPU can have power on state and several on states that correspond to different operating frequencies and voltages.

Table 2. Peripherals Power Consumption.

Sl.NO	Computer components	Peak power	Count Rate	Total power in watts	Power consumed in %
1.	Central processing unit(cpu)	40W	2	80W	37.6%
2.	PCI slots	25W	2	50W	23.5%
3.	memory	9W	4	36W	16.9%
4.	Mother board	25W	1	25W	11.7%
5.	Disk drives	12W	1	12W	5.6%
6.	Fan	10W	1	10W	4.7%

Because of some potential benefits of turning Components on, this technique has limitations. The motherboard is one of the high power consuming components that can be turned on only if the entire node is in sleep state.

5. Wired Network Resources

The Internet has become one of the most essential and important part in communication likes private companies, governments, institutions and other organizations. Also, the number of Internet users increased every day. The devices also keep on increasing to get connected to the Internet calls for high performance end-to-end networks, and in turn increases the topology complexity; the number of core components is to ensure performance, reliability and consequently.

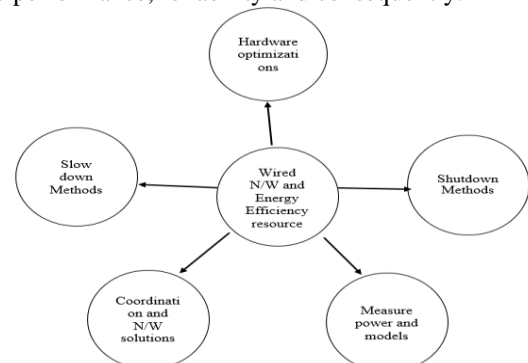


Figure 2. Network and energy resources.

The energy measurements and models allow the researchers to verify and to validate the new frameworks and algorithms. As for computing resources, energy efficient techniques targeting networking resources can be divided into different levels from hardware optimizations to network-wide solutions.

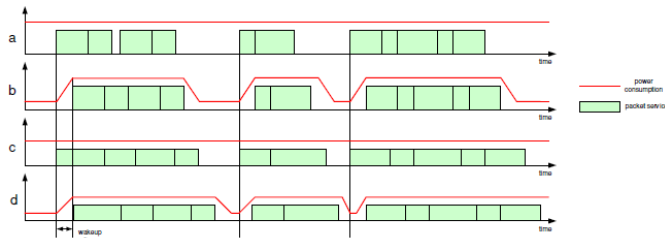


Figure 3. Packet service times and power consumptions in the following cases: (a) no power-aware optimizations, (b) only idle logic, (c) only performance scaling, (d) performance scaling and idle logic.

6. Conclusion

This technique is used for improving the energy efficiency in computing and networking resources, and key components of large-scale distributed systems. In wired networks, shutdown techniques have been extensively analyzed and evaluated to limit the number of resources that can remain idle and consume power unnecessarily. There are also other techniques for adapting the performance of network, computing resources, and their energy usage to the needs of applications and services. These approaches are often combined and applied in a coordinated way in large-scale distributed systems.

References

- [1]. Agarwal, Y., Savage, S., and Gupta, R. 2010. Sleep Server: A software-only approach for reducing the energy consumption of PCs within enterprise environments. In USENIX Annual Technical Conference (ATC). USENIX Association, Berkeley, CA, USA.
- [2]. Bolla, R., Bruschi, R., Christensen, K., Cucchiatti, F., Davoli, F., and Singh, S. 2011. The Potential Impact of Green Technologies in Next Generation Wireline Networks - Is There Room for Energy Savings Optimization? IEEE Communications.
- [3]. Costa, C., Amaral, M., Januario, G., Carvalho, T., and Meirosu, C. 2012. SustNMS: Towards service oriented policy-based network management for energy-efficiency. In Sustainable Internet and ICT for Sustainability (SustainIT 2012). 1
- [4]. S. Chaudhari, S. Nottath, M. Subramanian, and H. Murthy, "Green-IT: An approach to energy savings using energy aware network management system," in Communications (NCC), 2012 National Conference on, Feb. 2012, pp. 1–5..
- [5] Kim, K.J., Jin, S., Tian, N., & Choi, B.D. (2013). Mathematical analysis of burst transmission scheme for IEEE 802.3az Energy Efficient Ethernet. Performance Evaluation, 70(5), 350–363. DOI:10.1016/j.peva.2012.12.001
- [6]. Meng, J., Ren, F., Jiang, W., & Lin, C. (2013). Modeling and understanding burst transmission algorithms for Energy Efficient Ethernet. In Proceedings of 2013 IEEE/ACM 21st International Symposium on Quality of Service (IWQoS) (pp. 1–10). Piscataway, NJ: IEEE. DOI:10.1109/IWQoS.2013.6550278
- [7]. Herreria-Alonso, S., Rodriguez-Pérez, M., Fernández-Veiga, M., & López-García, C. (2012). Optimal configuration of Energy-Efficient Ethernet. Computer Networks, 56(10), 2456–2467. DOI:10.1016/j.comnet.2012.03.006
- [8] R. Bolla, M. Giribaldi, R. Khan, and M. Repetto, "Network connectivity proxy: Architecture, implementation and performance analysis," IEEE Systems Journal, vol. PP, no. 99, pp. 1–12, June 2015, pre-print.
- [9]. B. Urban, V. Shmakova, B. Lim, and K. Roth, "Energy consumption of consumer electronics in use homes in 2013," Fraunhofer USA, Tech. Rep., June 2014.
- [10] B. Nordman, S. Lanzisera, and R. E. Brown, "Energy efficient digital networks," Lawrence Berkeley National Laboratory, Tech. Rep., January 2013, chapter 3: Network Presence Proxy.
- [11]. Nareen Karnati, Ben Kent and Erik D. Engeberg Human Finger Joint Synergies for a Constrained Task Applied to a Dexterous Anthropomorphic Hand Bled, Slovenia, October 26-28, 2011
- [12]. R. Bolla, R. Bruschi, M. Giribaldi, R. Khan, and M. Repetto, "Smart proxying for reducing network energy consumption," in Proceedings of the 2012 International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS2012), Genoa, Italy, Jul. 8–11, 2012.



Dr. Natesan Sundaram M.E., Ph.D. has completed his Doctor of Philosophy in Computer Science and Engineering, OPJS University, India in 2017 with First class, Master of Engineering degree in Computer Science and Engineering, Mahendra Engineering College, India in 2011 with First class, Bachelor of Engineering degree in Computer Science and Engineering, Annai Mathammal Shella Engineering College, India in 2002, First class with Distinction. He has over 13 years of experience in teaching. Added to that he has experience in hardware and networking. Presently he is working as Lecturer and Head of the Department in Regent University College of Science and Technology, Accra, Ghana. West Africa. Prior to the present he worked as Lecture in Academic City College, West Africa, Accra, Ghana. His area of research includes Computer Network, Software Engineering, and Medical Image Processing.



Dr. Lokman Erzen B.Sc., M.Sc., Ph.D. has completed his Doctor of Philosophy in Electric Power Engineering, Rensselaer Polytechnic Institute, Troy, NY USA in 2003, Master of Science degree in Electrical and Electronics Engineering, Gaziantep University, Gaziantep, Turkey in 1993, Bachelor of Science in Electrical and Electronics Engineering, Middle East Technical University, Gaziantep, Turkey in 1990. He has more than 20 years of experience in academic. Presently he is working as Associate Professor, Head of the Department and Vice Dean in Faculty of Engineering, Computing and Allied Sciences, Regent University College of Science and Technology, Accra, Ghana. Prior to the present he worked as a Lecturer for several colleges in Turkey. His area of research includes electric power systems in the areas of analysis, reliability, monitoring, control and protection. Optimal operation of power systems. Power quality and diagnostics of power apparatus. Artificial intelligence applications for distribution automation.