

# Comparative Analysis of Power Consumption of the Linux and its Distribution Operating Systems vs Windows and Mac Operating Systems.

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## Abstract

Comparison and analysis of different operating systems by different aspects such as color schemes, resolutions, brightness, memory management, process management, scheduler tasks and other modules, and identifying why Linux kernel and Linux distributions consume more power and battery than Windows and Mac operating systems

**Keywords:** Power Consumption, Operating System, Linux, OS Comparison, Windows, Mac.

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## Introduction

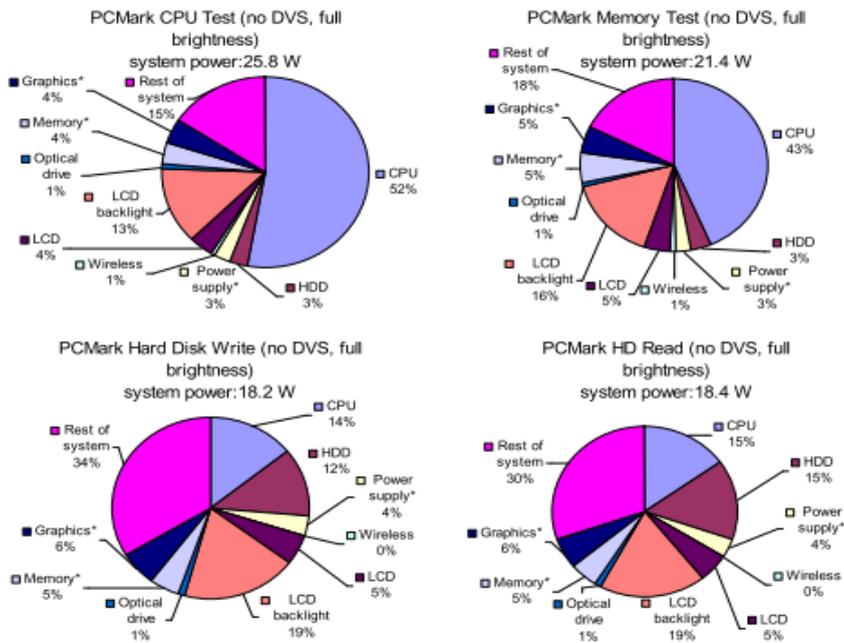
Here today we come to the topic which users had a quest and thirst to know the actual problem and to remove their confusion about the power consumption of different operating systems. Some said Windows is better than Linux and some said inverse, which many people have different opinions about it, so in this paper, we finally decided to overcome this problem and make it clear, which one is better, and consume less power or in other words which one is less efficient and consume more power and battery life. There are lots of things for the readers in this paper, readers will find this topic interesting because it is a query or topic of the years around to be solved and, to let people know what is it in reality, this topic holds important for both users and developers, and especially for Linux open-source developers, because they have more quest and passion to know and solve such problems to increase energy efficiency in Linux distributions, as we claim that, why Linux consumes more power and battery life than Windows and Mac, to prove this claim first we need a detailed comparison of components, modules, services of mentioned operating systems, which in this part a journal by the name of “Studying Main Difference between Linux and Windows Operating Systems” by (Al-rays, 2012) [1] will help us comparing their components and services with different levels, both programmers and users levels and also will help us telling pros and cons of both operating systems. And another paper by the name of “Power Consumption Breakdown on Modern Laptops” by (A. Mahesri, 2006) [2] will help us set an experimental setup and methodology for measuring different consumption benchmarks, which calculate both idle and workloads consumptions by different tools, which is a need to perform our task, many other sources are explored to help us do our task. This topic holds lots of significance for both

general operating system users and especially for Linux developers, by identifying the fact or dilemma which is created among the OS users, and also by identifying an exact area of the problem which will make things easier for users and developers, and will also solve running propaganda of power consumption between Linux and Windows, we will not discuss Mac in detail because usually, Mac OS runs on its environment; means on specially design mobile PC's which they improved it a lot, Windows and Linux will have a long journey to tackle down Mac Systems. In competing edge Linux and Windows are more questioned in many features and modules by its users, this paper will also make a window for future researches by identifying the problem and weak areas of the different operating systems, which will create a lot of new research opportunities.

**Main Results of this Study**

- 1) Total system power depending on workloads.
- 2) CPU power consumption for many applications.
- 3) Display power, which is affected mostly by backlight brightness and color schemas while the system is idle.
- 4) Graphics cards, wireless, optical drives, and other peripherals are major power consumers in specific workloads.

The figure below shows a pie chart for different consumptions.[2]



**Figure 1: Power Consumption under different workloads**

**Summary**

A detailed explanation could be, what we will do in this paper after this introduction we will discuss some literature review and systematic or tabular form literature reviews which will help us do our task, after that, we will discuss methodology for analysis and comparison, and then we will state test tools which

will generate results for different modules of OS's e.g. power consumption under workloads shown in below figure

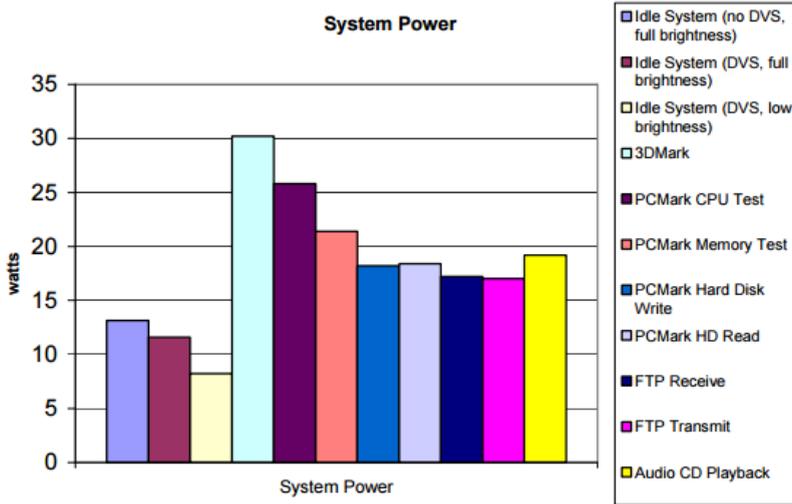


Figure 2: Power consumption of system under various workloads.

Example of a detailed module power consumption in a pie diagram below, while the system is idle, below in figure 2 shows the percentage of consumed power on every component

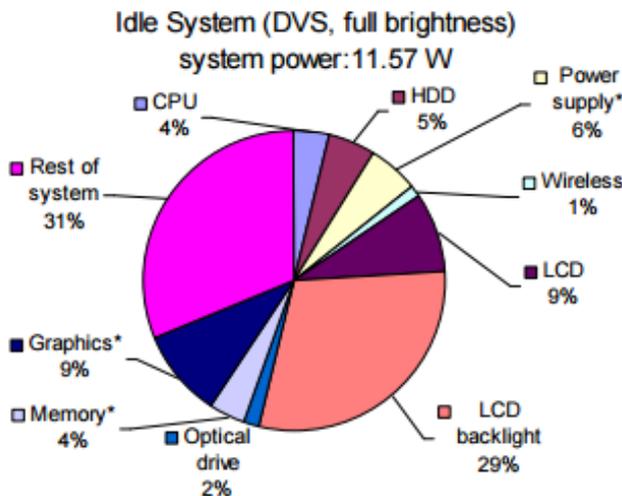


Figure 3: Idle system power usage of different components.

Based on these results which we will get from different sets we will conclude our topic, with the claim that we made. And at the end, we will discuss future research opportunities in this area.

Summary, after the introduction we will take related work into account with literature review and tabulated literature review which is also called a systematic

literature review, then methodology, analysis, comparison, test cases, and test tools and diagrammatically comparison of power consumption of various OS's and at the end future work and conclusion.

### **Literature Review and Related Work**

The above-mentioned claim is not that easy to prove with no knowledge and background readings so while claiming this topic, I discovered and reviewed many journals to help us in our work, the first paper I reviewed was "Studying main differences between Linux and Windows operating systems" [1] 2012 by Hadeel Tariq Al-Rayes in which he discusses both in detail. A revision that, I did was that comparison between these two OS's was a long-running discussion topic, which throughout this period Windows retained retail market while Linux capture open source world, both OS's differ in philosophy, versatility, cost, and stability with each seeking to improve their weaker areas comparison of these two reflects their historic user base distribution modules, and it also provides a concrete comparison of both OS's modules, services and levels of usage by both users and programmers aspect. Another paper which I reviewed was "A review of Energy Measurement Approaches " 2013 [3] by some researchers which in their paper they discuss approaches for energy management, efficiency reducing usages of software and hardware where not necessary, and also some compiler optimizations which shows approaches for measurement which I vital help for our task. Another paper which I reviewed was "Green Mining, Investigating power Consumption across versions" 2016 [4] by some researchers of the University of Alberta in this paper they state that power consumption is not only electrical engineers concerns but also software engineers concern as well, because of increasing power limited contexts such as mobile computing, smartphones, and cloud computing, software changes can change power consumption behavior and cause regression in power efficiency so in this paper they provide modules and develop tools for consumptions analysis which is a demanded help for our task. Another paper which I reviewed was "Linux vs Windows: A comparison of application & platform innovation incentives for open source and proprietary software platforms" [5] actually in this paper the compare the level of investment in open source software's and proprietary software platform which give us a detail overview of Linux and Windows Software platforms and investments which a give us knowledge about software platforms which will help us while analyzing these OS's, I went through many papers and reviewed them here are the names of the papers and short reviews, a paper on "Power Consumption Breakdown on a Modern Laptop" [2] 2006 which researchers provide a component wise break down of power consumption analysis, another paper on "Power Consumption Analysis of OS's for wireless Sensor Networks" [6] 2010 in which researchers take into account wireless power consumption on micro kernels and small devices, another paper on "Measuring Software Energy Efficiency" [7] 2016 which researchers present a methodology for power consumption of software which is helpful for our research work, another paper on "Operating System Selection Using AHP on the basis of security, Cost and Boot time" [8] 2014 some researchers in this paper compare three different aspects of three different operating systems and conclude the best one according to the aspects mentioned above which a very helpful process for our task of improving our claim and comparison of Linux, Windows and Mac, another paper on "Saving Energy in Network Desktops using virtualization" [9] 2014 some researchers I this

paper reduce the energy wastage of idle desktops in network which are not frequently used by providing two option one for shutting it down and other to sleep it , which is helpful for our task, another paper “A Complete Picture of the energy consumption of portable computer” [10] an old paper which give us an insight of power consumption on old PC’s another old paper by the same writer “Energy Consumption of Apple Macintosh Computers” [11] 1997 it actually compute power consumptions of different machines by different workloads from users and compute its power consumption with built in tools which is really helpful and informative paper which one can understand how to analyze a system with different workloads from user and there is another paper which I surveyed was “The Model is not Enough: Understanding Energy Consumption in mobile devices” [12] 2011 which in this paper writers discuss power models and made a module to compute power consumption of mobile devices another paper which I surveyed was “The Case for Energy-Proportional Computing” [13] which writers discuss the proportional consumption of computing to be improved and tried to enhance the consumption of computing proportionally, another paper which I read was “Managing Energy Consumption Costs in desktop PCs and LAN Switches with proxying, split TCP connections, and scaling of link speed” [14] 2010 actually writers talk about the expenses of power on modern society which is increasing day by day so they decided to manage these consumptions and make an efficient way to control it figure below shows an image of the idea, which will help us finding our future work.

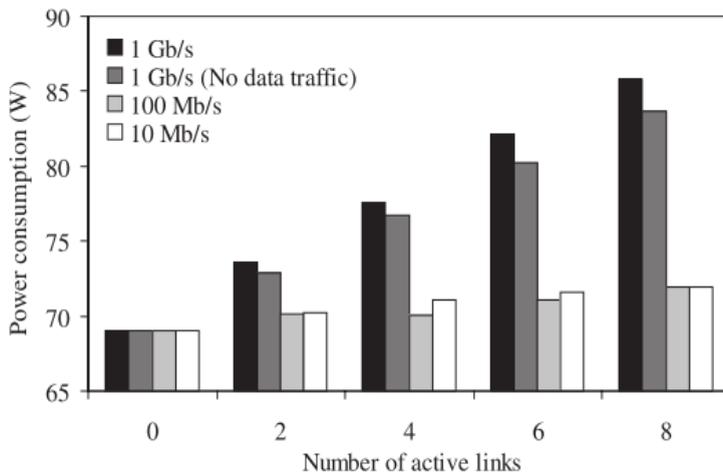


Figure 4: LAN Switches power consumption.

Another paper by (Tao Le 2003) “Run-time modeling and estimation of operating system power consumption” 2003 [15] which they described the increasing constraints of power consumption in many computing systems, that it needs for modeling and estimation of power for all components of the system, which in their paper writers give a detailed estimation of power consumption of different OS components a figure below shows a full picture of the paper.



virtualization techniques which he compared different virtual guests as the figure below show.

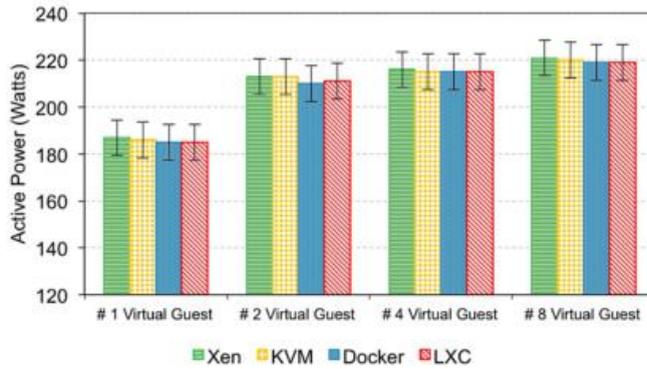


Figure 6: CPU power consumption with eight active VMs/containers.

Another paper by Afifa Sajid and some other researchers “An Analysis on Host Vulnerability Evaluation of Modern Operating Systems” 2016 [17] which in this paper they discussed the security of different operating systems and examines and estimate the vulnerabilities and attacks of different operating systems and also show the usage of operating systems around the globe, which below figure shows the usage of their operating system.

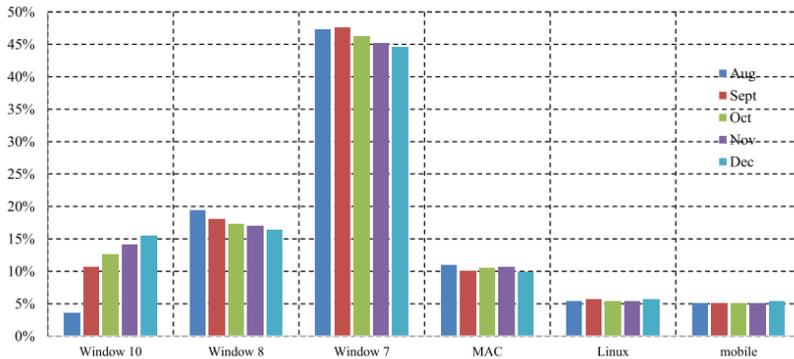
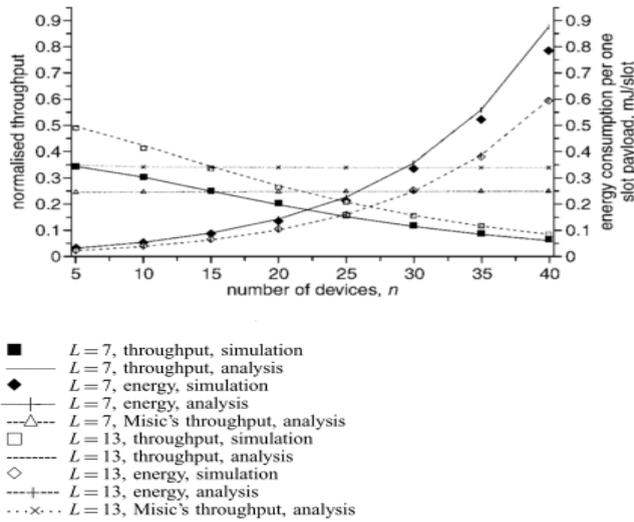


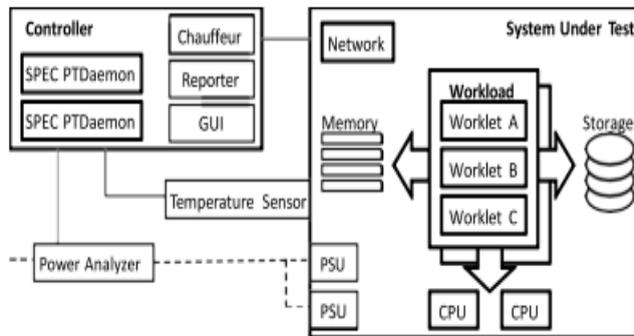
Figure 7: Operating systems usage in 2015

And there is another paper on IEEE 802.15 devices “Throughput and energy consumption analysis of IEEE 802. 15.4 slotted CSMA/CA” 2005 [18] by T. R. Parkin this paper a new analytical model has been purposed from which throughput and energy consumption in saturated conditions, and then the analytic results are validated by a simulator below figure shows how it's done.



**Figure 8: Saturated throughput and energy consumption**

Another paper on “Analysis of the Influences on Server Power Consumption and Energy Efficiency for CPU-Intensive Workloads” 2015 [19] by Kistowski, Jóakim, and Beckett, John which in their paper they discussed and solved energy efficiency of servers and said “as server energy consumption varies depending on multiple factors, such as server utilization and workload type. Server energy analysis and estimation must take all relevant factors into account to ensure reliable estimates and conclusions.” And they benchmarked multiple server configurations using CPU worklets in a SPEC’s Server Efficiency Rating Tool (SERT), and the researchers also documented the usage of power from servers in governments in these past decades, bringing efficiency can save a huge amount of energy wastage. The below figure shows their SERT architecture.



**Figure:9 SERT Architecture**

And these following figures show consumption and efficient graphs.

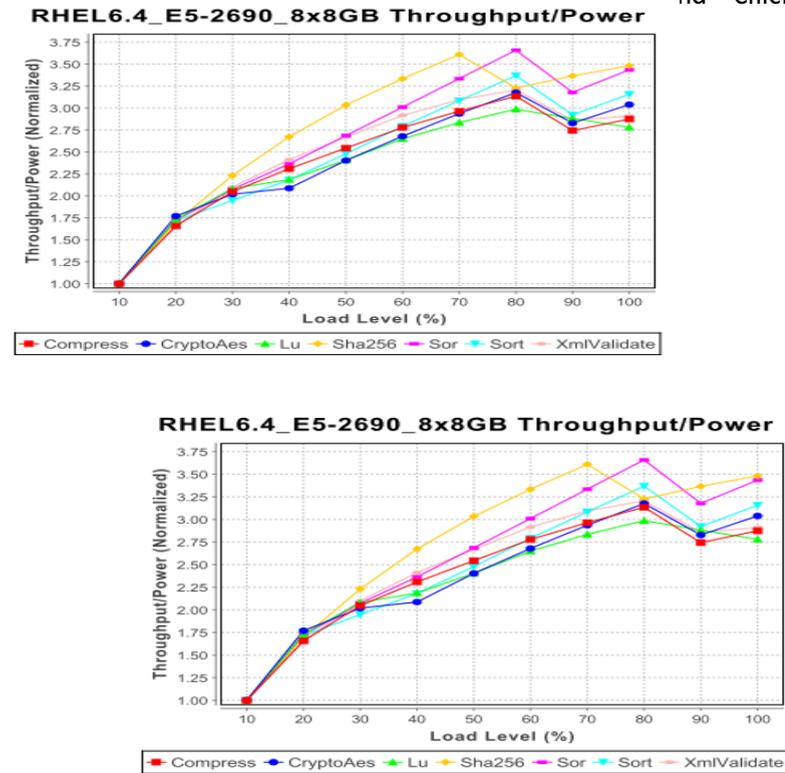


Figure 10: Power consumption and energy efficiency on baseline server

### Systematic Literature Review

Table 1: Systematic Tabular LR

Paper	TITLE	Study Characteristics	Power Consumption Analysis	Summaries
Al-Rayes (2012)	Studying Main Differences Between Linux & Windows Operating Systems	Differentiating between Linux and Windows	Concerning performance and power.	Compared and discussed different characteristics such as OS markets, performances, and weaknesses.
A Mahesri, S Vibhore (2004)	Power Consumption Breakdown on a Modern Laptop	Module and Services Comparison	Concerning different components and modules	Showing power consumption of different system modules and different workloads on the system and showing its percentages of usage.
Noureddine, Adel Rouvoy (2013)	A review of energy measurement approaches	Measurement and Comparison	Analysis up to 35 % done	Energy modeling of different workloads on servers, and estimation of energy consumption of different servers.

Abraham Hindle. (2016)	Green Mining: Investigating Power Consumption across Versions	Comparison across different Linux versions	Analysis was done on Linux based systems, not on Windows or Mac	Optimizing the power consumption to make Operating Systems greener.
N. Economides (2006)	Linux vs Windows: A Comparison of Application and Platform Innovation Incentives for Open Source and Proprietary Software Platforms	Application Platforms	No consumption 0%, just information about operating system platforms.	Compares different platforms for software innovations, both for open source and proprietary software.
Aqeel Mahesri (2004)	Power Consumption Breakdown on a Modern Laptop	Breakdown on power consumption	50 % Analysis done based on performance	It breakdown the components of the OS and then estimate the energy consumption of every component and module it.
Juan J Perez Solnao. (2010)	Power Consumption Analysis of Operating Systems for Wireless Sensor Networks	Analysis and comparison based on networks	Analysis was done based on networks	This paper discusses four wireless sensor network operating systems that are compared in terms of consumption.
Albert henkel. (2016)	Measuring Software Energy Efficiency	Energy consumption of different software's	20 % comparison done based on efficiency and consumption.	Discusses methodologies that how to measure the energy consumption of different software's which is mainly focused on DNS resolver software.
Padeep Padala (2014)	LiteGreen: Saving Energy in Networked Desktops Using Virtualization	Optimizing, comparison	Comparing network desktops using virtualizations.	In this paper, writers discussed that while a PC is not in use should be put on sleep to save energy.
JR Lorch (1995)	Apple Macintosh's Energy Consumption	Comparison done on Portable PC's	90 % consumption analysis of one operating system	Optimizing power consumption on desktop environments such as mac books and other Apple-based desktops.
Tao Le (2003)	Run-time modeling and estimation of operating system power consumption	Modeling and estimation of power consumption	70 % consumption analysis and modeling of operating system	Described the increasing constraints of power consumption in many computing systems, that it needs for modeling and estimation of power for all components of the system, which in their paper writers

				give a detailed estimation of power consumption of different OS components.
Lorch, Jacob R(1995)	A Complete Picture of the energy consumption of the portable computer.	Power consumption on portable computers	80% consumption analysis done	Described the internals of operating systems that how it consumes power and how can we optimize it and telling the importance of power for the future.
Afifa Sajid (2016)	An Analysis on Host Vulnerability Evaluation of Modern Operating Systems	Operating systems vulnerabilities.	Model to show vulnerabilities of different operating systems	Compares different operating systems and platforms vulnerable parts and models it according to the point.
Roberto Morabito (2015)	Power Consumption of Virtualization Technologies: an Empirical Investigation	Consumption on virtualization	Techniques for power consumption in a virtual environment	Describing different types of virtualization and their energy consumptions, which type of virtualization consumes less energy.
Gunaratne, Chamara (2005)	Managing energy consumption costs in desktop PCs and LAN switches with proxying, split TCP connections, and scaling of link speed	Managing Energy Consumption	Usage of electricity and energy consumption	Showing the wastage of electricity on desktop PCs and LAN switches, that should be managed and controlled by the governments.

## Discussion

As battery usage of operating systems is a long-running discussion among the different users of different operating systems platforms. There are users with complaints of battery life while using any of these operating systems, below are some examples of discussion and complaints of the users.

A question post in StackExchange.com [20] saying that “Why does Linux have poor battery life by default compared to Windows?” which is very identical to our topic, many users answer it with different aspects, answering the “Why” of the question as one of the users answered an exact problem which he said “Thus good power management requires well-written drivers. Hardware manufacturers are very cagey about giving out details about their hardware to people who write drivers. Even people who write closed-source drivers under a non-disclosure agreement often lack detailed documentation — and people who are writing open-source drivers for an operating system that the manufacturer doesn't care much about have it a lot worse.” So from this answer, we can smell some issues in device drivers of Linux, not the native drivers but the propriety drivers which are sustained and maintained by third parties, another comment on the same question a user replied that “Someone brought it to my attention that there were (maybe still are?) Driver issues to do with power management on some GPUs. That could easily be the case -- it's using the GPU at full power all the time; also, if you have two graphics cards, it favors the fancy battery-draining one and does not conserve

energy by using the smaller one as Window would do.” And many other advanced users add comments on the above question and said, “This answer is too generic, “I blame the kernel, reinstall it” will usually install the very same kernel.” [21] This indicates that many versions of the Linux kernel have the power management issue which is a series and important module of any modern age kernel because nowadays many personal computers and handheld systems use battery, which makes power management very important and many Linux kernels are still Desktop oriented in case of power management, which in that case performance was the target, but now the trend has changed, so should Linux kernel development should also change according to requirement and needs of people and society. On Quora.com another discussion says that “By default, Linux consumes more battery power than Windows, especially Fedora and Ubuntu. Linux beginners who use the default configuration of Fedora or Ubuntu, they always wonder why their battery becomes empty so fast compare to windows. They don't know anything about power consumption in Linux. Most Hardware supporters don't care about Linux too much, Lack of proper driver configuration is one reason to consume more battery in Linux.” So one can see that many power consumption problems in Linux systems are caused by improper drivers and lack of driver configurations, and also. Where comparatively Windows and Mac have a proper power managment tools in place and also an efficient drivers for operating the hardware's in a way to consume the power economically.

### **Future Work**

As in this paper, we compared different OS's power consumption costs with Linux, which gives us the information about weak areas in which Linux lacks, and needs to be optimized. To make pace with other competitors, so our future work will be to optimize that resulted weak area which we got from this comparison and analysis of the power consumption which showed that improper drivers for devices such as Wifi, network and video drivers, Lack of drivers configurations and inefficient power management modules, so these above-mentioned problems are to be solved in future. This paper also explores many different research topics which are hidden within this paper, which need to be explored.

### **Conclusion**

As we discussed that how and why windows operating systems consumes less power and battery life than modern Linux distributions such as Ubuntu, Fedora, Debian, Red Hat, and other leading flavors of Linux distributions, which we reached the point to conclude that Linux power management requires well-written drivers, which Linux is lacking because, hardware manufacturers are unwilling about giving out details about their hardware to people who write drivers, even for those who write deriver for closed-source under an unclear agreement often lack documentation, and people who are writing for open-source operating systems manufacturers do not care much, in this case, it gets worse, which consumes more battery life. And there are some versions of the Linux kernel in which the power management module is not properly optimized and up to work for mobile systems because many of them are designed for desktop platforms, so in this case, choosing the best performing and optimized kernel can solve the problem.

## References

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- [1] L. H. T. Al-rayes, "Studying Main Differences Between Linux & Windows Operating Systems," no. 4, 2012.
- [2] A. Mahesri, "Power Consumption Breakdown on a Modern Laptop," pp. 1–10.
- [3] A. Nouredine *et al.*, "A review of energy measurement approaches To cite this version :, " vol. 47, no. 3, 2013.
- [4] W. E. B. Edition, "Green Mining : Investigating Power Consumption across Versions," pp. 1–6.
- [5] N. Economides and E. Katsamakos, "Linux vs . Windows : A Comparison of Application and Platform Innovation Incentives for Open Source and Proprietary Software Platforms," 2006.
- [6] R. Lajara, J. Pelegrí-Sebastiá, and J. J. Perez Solano, "Power consumption analysis of operating systems for wireless sensor networks," *Sensors*, vol. 10, no. 6, pp. 5809–5826, 2010.
- [7] A. Hankel and E. Hoekstra, "Presenting a Methodology and Case Study on DNS Resolvers," no. April, pp. 18–20, 2016.
- [8] V. Chaudhary and R. Mishra, "International Journal of Advanced Research in Computer Science and Software Engineering Operating System Selection using AHP based on Security, Cost and Boot Time," vol. 4, no. 5, pp. 1016–1020, 2014.
- [9] T. Das, "LiteGreen: Saving Energy in Networked Desktops Using Virtualization," 2013.
- [10] J. R. Lorch, "A Complete Picture of the Energy Consumption of a Portable Computer," 1995.
- [11] J. R. Lorch, "Apple Macintosh's Energy Consumption Much of a Portable Computer's Utility Depends on How Long It Can Consumption ( and How Much of That Power Goes To Each System," 1998.
- [12] A. Carroll and G. Heiser, "An analysis of power consumption in a smartphone," *Proc. 2010 USENIX Conf. USENIX Annu. Tech. Conf.*, pp. 21–21, 2010.
- [13] L. A. B. and U. Hölzle, "The Case for Energy Proportional Computing," no. April, pp. 33–36, 2000.
- [14] C. Gunaratne, K. Christensenf, and B. Nordman, "Managing energy consumption costs in desktop PCs and LAN switches with proxying, split TCP connections, and scaling of link speed," *Int. J. Netw. Manag.*, vol. 15, no. 5, pp. 297–310, 2005.
- [15] T. Li and L. K. John, "Run-time modeling and estimation of operating system power consumption," *ACM SIGMETRICS Perform. Eval. Rev.*, vol. 31, p. 160, 2003.
- [16] R. Morabito, "Power Consumption of Virtualization Technologies : an Empirical Investigation," no. 607728, 2015.
- [17] A. Sajid and M. Kamran, "An Analysis on Host Vulnerability Evaluation of Modern Operating Systems," vol. 7, no. 4, pp. 245–254, 2016.
- [18] T. R. Park, T. H. Kim, J. Y. Choi, S. Choi, and W. H. Kwon, "Throughput and energy consumption analysis of *IEEE 802 . 15 . 4* slotted CSMA = CA," vol. 41, no. 18, pp. 10–11, 2005.

- [19] J. Kistowski, J. Beckett, S. Kounev, and J. A. Arnold, "Analysis of the Influences on Server Power Consumption and Energy Efficiency for CPU-Intensive Workloads."
- [20] "Why does Linux have poor battery life by default compared to Windows." Available: [stackexchange.com](http://stackexchange.com).
- [21] "Why does my computer get less battery life with Ubuntu compared to Windows" Available: [AskUbuntu.com](http://AskUbuntu.com).

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