Maximizing Power Efficiency with Dell Optimizer: A Case Study

This Dell Whitepaper investigates the performance and power impacts of the four thermal power modes within Dell Optimizer. Illustrations of best tuning for performance and efficiency are provided, and recommendations are given for those customers focused on general productivity versus digital content creation.

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INTRODUCTION

In today's operating environment power efficiency is as critical as ever. At Dell Technologies we are determined to provide our customers the ability to scale in their compute needs by providing raw performance when desired and power efficiency when required. In this paper we will focus on performance per watt of productivity applications by utilizing the PCMark 10 benchmark and how custom tuning through Dell Optimizer (DO) impacts power efficiency. As a case study we will investigate the use of DO on the Dell Latitude 7430 utilizing the Intel® Core™ i7-1265U series CPU, and we will illustrate an average savings of 2.4W of power may be saved further by using Quiet Mode over the default Optimized Mode with even greater sub score efficiency.

As Moore's law has slowed and transistor size approaches the limits of the silicon atom (0.2nm), CPU and GPU providers have focused on increasing power to provide ever higher frequency ranges to drive performance and response time. Names for this control strategy all vary, but in general the purpose is the same; to drive higher CPU frequency for a short period at high power to maximize response time. A good illustration of this control capability can be observed on the Intel® Core™ i7-1265U series class of CPU. This hybrid 8 efficient core and 2 performance core CPU has a base power of 15W and a maximum Turbo power of 55W. The CPU can burst up to 4.8Ghz for a few seconds at 55W of power to provide very snappy performance of opening and closing applications, but at steady state can reduce performance to between 1.3Ghz to 1.8Ghz at 15W for sustained performance. This range of power and frequency scaling provides Dell the opportunity to tune for both performance and efficiency. In this study we will discuss Dell Optimizer and how to specifically tune for energy efficiency, while providing additional benefits such as lower noise or skin temperature.

DELL OPTIMIZER AND THE IMPACT ON PERFORMANE PER WATT

Today's CPUs are advanced compute devices that can significantly scale in performance and efficiency through multiple internal controls. From Hardware Pstate Control (such as Intel® Speed Shift technology), dedicated CPU power limits such as Power Limit 1,2 and Fast/Slow PPT to OS level controls such as Energy Performance Preference (EPP) and Quality of Service (QoS), Dell has simplified the complex through enablement of our Power PC experience to allow for customer optimization as illustrated in Figure 1.

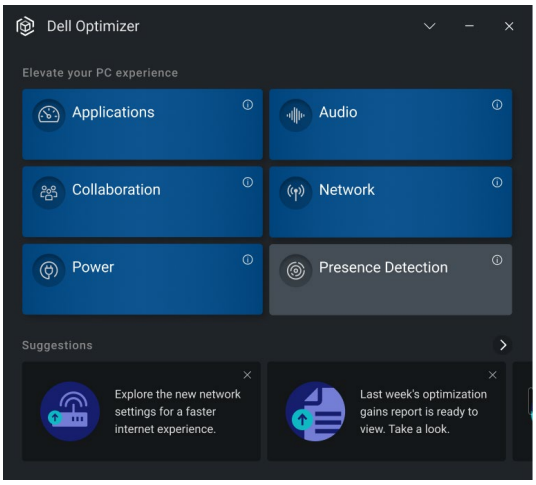


Figure 1: Dell Optimizer Experience Panel

Within the power experience the four defined Thermal Management Modes, as illustrated in Figure 2, allows our customers custom tuning opportunities that directly impact power efficiency. All modes use the same tools to optimize the system experience by managing power dynamically, as well as the temperature and fan speed settings. To understand the impact of thermal management modes on the power we have utilized PCMark 10 and the subset tests to provide guidance to our customers in particular, we will focus on Quiet mode and determine if this is the right tradeoff for a customer focused on efficiency.

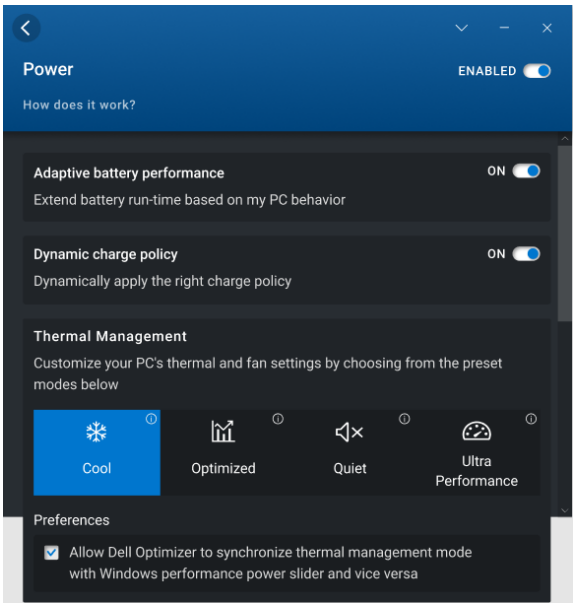


Figure 2 DO Power pane and access to Thermal Management settings

For this study we ran the standard PCMark 10 benchmark which is categorized by three sub test domains as follows;

- Essentials – focused on typical customer activities such as Web Browsing, Video Conference, and Application Start up
- Productivity- targets office application-based workloads including spreadsheet and writing
- Digital Content Creation (DCC) – which is a heavier based loading focused on Photo Editing, Video Editing, Rendering/Visualization.

The Dell Latitude 7430 was utilized and PCMark 10 was ran through each various Thermal Management Modes, and the results for each individual run are illustrated in Table 1.

	PCMark 10 7430				
	Overall	Essentials	Productivity	DCC	Average Power (W)
Performance Mode	5259	10447	6997	5399	13.5
Optimized Mode	5231	10388	6964	5369	13.24
Quiet Mode	4783	10317	6815	4223	10.85
Cool Mode	4952	10297	6972	4590	11.21

Table 1: PCMark 10 Scoring and Power

As can be observed from Table 1, the best overall performance is obtained with the system unconstrained for thermal, acoustics, and power, while the most power-efficient mode was quiet mode. A power savings of 2.44W(18%) is obtained on average by moving from the default Optimized Mode to Quiet Mode in the control pane. While it is possible to reduce overall power, we also need to consider the impact of that reduced power on productivity. As such power or raw performance is not enough to make a determination in isolation on which mode is most power efficient. By utilizing the overall performance illustrated in the second column of Table 1 and the average power we can now look at the impact in Performance/Watt (avg) and the overall impact in efficiency. Figure 3 illustrates the overall Performance per Watt for the various modes tested.

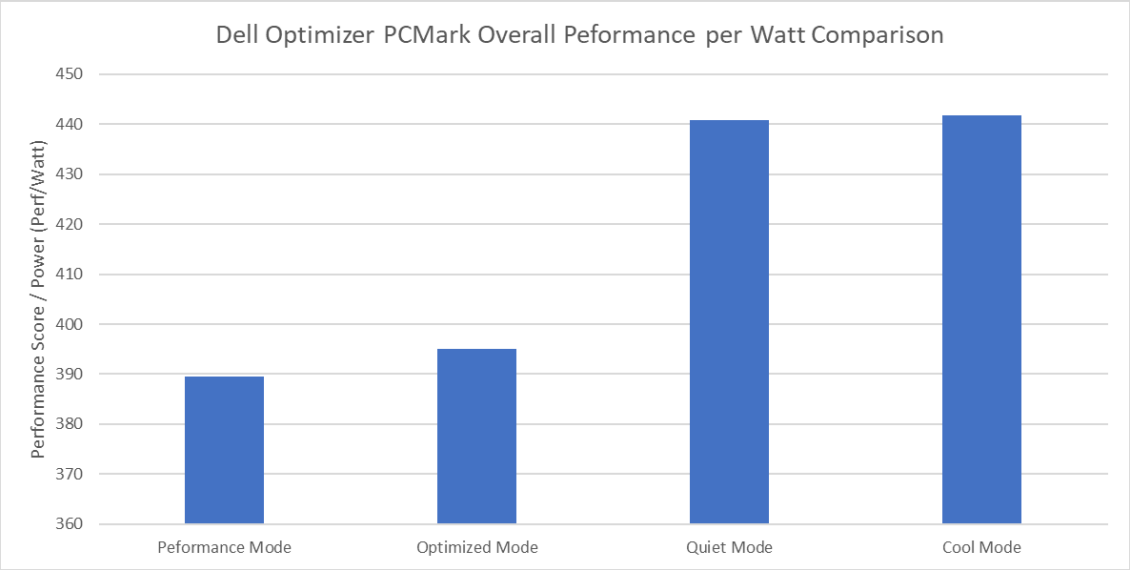
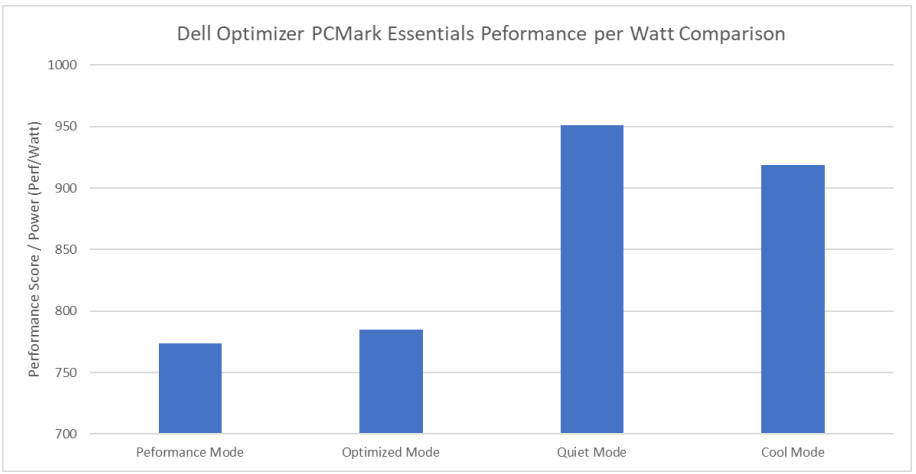


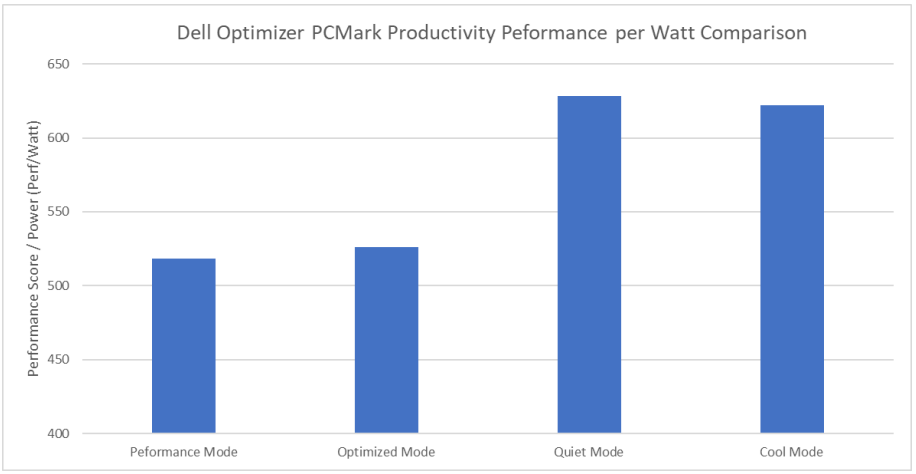
Figure 3: Overall Performance per Watt impact of Thermal Management Modes in DO

As observed by moving the thermal management mode to Quiet or Cool mode both provide close to a 12% in an overall improvement in Performance per Watt over the default Optimized mode. While this is significant, we need to dig a bit deeper to understand the subtest and the impact based upon the various workloads, and how our customers use the system (Essentials, Productivity, and DCC). As illustrated in Figure 4 we have provided the subset score comparison in Performance per Watt for the 3 subtests (Essentials, Productivity, and DCC). For those customers that are primarily focused on general compute activities such as video conference call, web browsing, and general response time of opening and closing applications you can observe that Quiet Mode provides an improvement in Performance per Watt of 21.19% over the default mode. Similarly for those customers that are focused on productivity office applications we can observe the Quiet mode provided a further efficiency improvement over the defaults optimized mode of 19.4%.

For most Latitude customers that want to prioritize performance efficiency, Quiet mode will provide a significant benefit in power saved for the amount of work computed. For those Latitude based customers that want to push the boundaries of the system for Digital Content Creation, we can also observe the impact in overall efficiency. For Latitude customer who focused on rendering or video processing, Quiet mode Performance per Watt inverts with a 4% reduction over the previous modes and is not a strong mode to run for rendering or video processing.

This is primarily due to the type of work loads associated with rendering and photo editing and the limitation in available power in Quiet mode. For this usage case for those customers that want to focus on power efficiency in DCC Cool mode provides a 1% improvement in efficiency over the default Optimized mode.





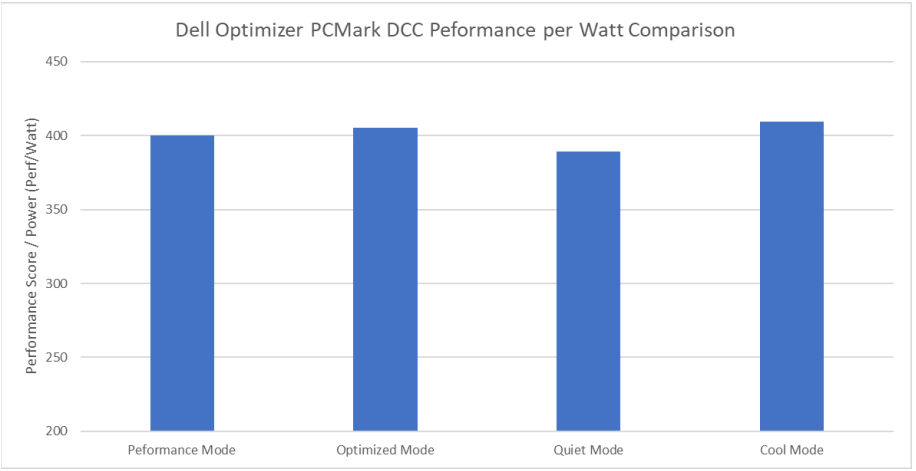


Figure 4 PCMark 10 Subscore power efficiency

Figure 1: Express Connect Software Architecture

CONCLUSION: DELL OPTIMIZER MAXIMIZES TUNABILITY

In this case study we illustrated the benefit of Dell Optimizer's Thermal Management features, and how those features can impact runtime efficiency in Performance per Watt. For raw performance without a focus on power efficiency, Performance Mode provided the greatest overall benefit in computational performance. For most productivity and essential work tasks such as office applications, video conference, and web-based applications it was shown that Quiet mode provides up to a 21.19% (~2.4W savings) benefit in performance efficiency providing significant power savings over the default optimized mode. Further, while digital content creation is a rare workload for Latitude based customers, we illustrated utilizing Cool mode could provide a 1% improvement in overall efficiency for DCC. Finally, beyond power efficiency Quiet mode provides up to a 30% improvement in over sound pressure and reduced surface temperatures are obtained in Cool mode. At Dell we strive to optimize our system designs while providing our customers ultimately tunability, and with DO and our Thermal Management Modes the power is in our customers hands.

References

Intel® Core™ i7-1265U Processor

About the Authors

Travis is a Texas Registered Professional Engineer, and a Sr. Distinguished Engineer within Dell's Technical Leadership Community. His responsibilities include strategy, research, product development, and performance optimization with a focus in high-impact technologies for mobile and fixed compute products. Travis is chair of Dell's Client Patent Committee with 131 granted and pending patents. Travis is an active member of multiple standards bodies and organizations inclusive of AHSRAE, Green Grid, and represents Dell Client Organization on the ECMA TC 26 subcommittee. Travis leads a talented technical team of engineers, technologists, and key partners focused on pushing the boundaries of cooling, power, acoustics, and performance technology. Travis graduated from the University of Missouri Columbia with a Master of Science in Mechanical and Aerospace Engineering with a focus in heat transfer.

Mitch has been at Dell Technologies for over 21 years and is a Senior Distinguished Engineer driving the client long range silicon architecture, leads the Performance Center of Excellence and actively building the foundational architecture for modern compute. Mitch is focused on technology solutions that drive groundbreaking use cases and compute architectures.

Mitch has brought his leadership and technology depth across several roles at Dell including Senior Director of Client Technologies, Corporate CPU Technologist, Senior Director of Audio Systems, Senior Director of Displays, and Senior Director of Commercial Platforms.

Before Dell, Mitch held director and research roles at Compaq, BOSE, Altec Lansing, and several acoustical consulting firms.

Mitch holds over 50 patents with much more pending.

Mitch has an MS from the Massachusetts Institute of Technology and a BSME from the University of Texas at Austin.

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