MobileMark® 25

An Overview of MobileMark 25

Revision 1.0	Initial release
Revision 1.1	Updated tables in sensitivity study, corrected typos in footer, updated calibration system information.
Revision 1.2	Corrected chart labels for idle in Figure 3 and Figure 6

About BAPCo

Business Applications Performance Corporation (BAPCo®) is a non-profit consortium with a charter to develop and distribute a set of objective performance benchmarks for personal computers based on popular computer applications and industry standard operating systems.

For more information about BAPCo® or a complete list of the current membership, see our website at http://www.bapco.com.

Table of Contents

1 Introduction

MobileMark® 25 is the latest version of the premier performance qualified battery life benchmark for mobile PCs. It features real world applications, updated workloads, and support for Microsoft Windows® 11 64 bit (build 194 or higher), and Windows 10 64 bit (19H2 or higher)

MobileMark 25 gives commercial and government IT decision makers, retailers, media, channel buyers, consultants, component designers, hardware designers, and manufacturers an objective, easy-to-use tool to evaluate the performance-qualified battery life of mobile PCs across the wide range of activities that a user may encounter.

MobileMark 25 is designed for those who want to:

- Evaluate and compare Windows x64-based mobile PC devices on performance-qualified battery life.
- Provide useful information to their audience(s) to assist in the evaluation and purchase of these devices.
- Evaluate mobile PC devices to better tune & optimize.

Unlike benchmarks that only measure battery life, MobileMark 25 measures battery life and performance simultaneously, showing how well a system design addresses the inherent tradeoffs between performance and power management.

Unlike synthetic benchmarks, which artificially drive components to peak capacity or attempt to deduce performance using a static simulation of application behavior, MobileMark 25 uses real applications, real user workloads, and real data sets to accurately measure how overall system performance impacts user experience.

MobileMark 25 builds upon BAPCo's 27-year history of building benchmarks to evaluate platform technologies. Benchmarks designed by BAPCo are the result of cooperative development between companies representing the breadth of the computing industry. They harness a consortium of knowledge to better reflect current and future business needs.

This document describes the methodologies employed in the development of MobileMark 25. For detailed instructions on how to install and run MobileMark products, please refer to the documentation provided on the installation media and the BAPCo web site (www.bapco.com).

2 BAPCo Development Process

BAPCo creates benchmarks in accordance with the BAPCo Development Process, a set of milestones and checkpoints collaboratively developed and agreed upon by the BAPCo membership.

Early in the process, prevailing business mobile PC usage models are identified and grouped into scenarios according to their fit within a workflow. Applications are selected for each usage model based on market research and technical feasibility.

BAPCo members then collaborate with expert application users in development sessions to collaboratively develop a workload specification for each scenario, defining each user/computer interaction which is to be simulated by the benchmark.

The goal of the development sessions is to produce representative business application workloads for the benchmark. Each application workload consists of three elements: the input data set, the tasks performed on the input data set, and the generated output. An example of generated output would be an image generated through an iterative process of steps to create a desired appearance. These three elements of the workload are chosen to represent the workflow of a user skilled in each given application.

After the workload specifications are created at the development sessions, BAPCo developers implement the workloads according to those specifications while satisfying benchmarking constraints to ensure the stability of the benchmark, the consistency of results, and the feasibility of implementation and distribution of the benchmark.

2.1 Milestone Overview

The BAPCo development process is divided into six major phases (Initialization, Design and Planning, Implementation, Validation, Characterization and Launch). Each phase consists of a series of milestones, some of which may be worked on concurrently.

The membership must vote to close each milestone. Once all the milestones within a phase are complete, the membership must vote to exit the current phase and enter the next phase. BAPCo members work in a collaborative process where decisions regarding products are sometimes made by majority vote rather than unanimously.

The following is the list of the development phases and the corresponding milestones. Some of these milestones are explained in greater detail in the following sections, as noted in this list.

1. Initialization Phase
    a. Milestone 1 – Committee kickoff
    b. Milestone 2 – Benchmark market and customer analysis
    c. Milestone 3 – Product positioning and customer value proposition
    d. Milestone 4 – Preliminary marketing requirements document
    e. Milestone 5 – Final marketing requirements document
2. Design and Planning Phase
    a. Milestone 6 – Preliminary engineering requirements document
    b. Milestone 7 – Usage model selection (see section 2.2)
    c. Milestone 8 – Application selection (see section 2.3)
    d. Milestone 9 – Define member resource commitments
    e. Milestone 10 – Define development infrastructure
    f. Milestone 11 – Define scoring methodology (see section 2.5)
    g. Milestone 12 – Define application/API licensing requirements
    h. Milestone 13 – Plan and execute workload development sessions (see section 2.6)
    i. Milestone 14 – Define product release criteria
3. Implementation Phase

   a. Milestone 15 – Create implementation schedule
   b. Milestone 16 – Determine reference system (see section 2.8)
   c. Milestone 17 – Software engineering
4. Validation Phase
   a. Milestone 18 – Validation testing
   b. Milestone 19 – Define risk management plan
5. Characterization Phase
   a. Milestone 20 – Characterization testing
6. Launch Phase
   a. Milestone 21 – Product pricing
   b. Milestone 22 – Pre-launch materials
   c. Milestone 23 – Release to manufacture vote and sign-off
   d. Milestone 24 – Distribute early press evaluation
   e. Milestone 25 – Duplicate and distribute media
   f. Milestone 26 – Post-launch materials

2.2 Usage Model/Scenario Selection

In Milestone 6 of the BAPCo Development Process, usage models are chosen for inclusion in a benchmark. For MobileMark 25, BAPCo chose a wide variety of usage models in which the user experience is influenced by system performance.

BAPCo then groups related usage models into the following three scenario groups (for detailed descriptions of each scenario, please see section 2.7):

Productivity

The Productivity scenario models productivity usage including word processing (mail merge, document comparison, and PDF conversion), OCR, spreadsheet data manipulation (data modeling, financial forecasting), email creation/management, presentation editing, application installation, web browsing, archiving files, and video playback.

Creativity

The Creativity scenario models editing digital photos (creating HDR), cataloging digital photos (organizing catalog, use of facial detection to group people), and editing digital video (create a timeline from various source clips and transcode the output).

Responsiveness

The Responsiveness scenario is a combination of operations taken from the Productivity and Creativity scenarios. Such operations include application opens, file opens, file saves, and more.

2.3 Application Selection

In milestone 7, after the usage models have been collected into scenarios, applications are chosen for the scenarios based on market research and technical feasibility.

Sufficient lead time is needed after the applications are selected for BAPCo to develop workloads, integrate the applications into the benchmark, and perform validation of the benchmark. Therefore, some of the application versions are not the newest available at the time of the launch of MobileMark 25.

The criteria that BAPCo uses for application selection includes, but is not limited to:

- Ability of the application to perform the needed task
- Applications with broad install base
- Minimum system requirements of the application
- Hardware support of the application
- Diversity of application vendors

For MobileMark 25, BAPCo has identified the following representative applications for the three usage scenarios.

Productivity

- Adobe® Acrobat® Pro DC (15.010.20060)
- Audacity (2.3.2)*
- Corel WinZip 24.0 Enterprise
- Google Chrome™ (90.0.4430.212)
- Microsoft Excel® 2019 Professional Plus VL
- Microsoft Outlook® 2019 Professional Plus VL
- Microsoft PowerPoint® 2019 Professional Plus VL
- Microsoft Word® 2019 Professional Plus VL
- Shotcut (19.09.14)*

Creativity

- Adobe Lightroom® Classic CC (10.0)
- Adobe Photoshop® CC (22.0)
- Adobe Premiere® Pro CC (14.5.0)

Responsiveness

- Adobe Acrobat Pro DC (15.010.20060)
- Adobe Lightroom Classic CC (10.0)
- Adobe Photoshop CC (22.0)
- Adobe Premiere Pro CC (14.5.0)
- Audacity (2.3.2)
- Corel WinZip 24.0 Enterprise
- Google Chrome™ (90.0.4430.212)
- Microsoft Excel 2019 Professional Plus VL
- Microsoft Outlook 2019 Professional Plus VL
- Microsoft PowerPoint® 2019 Professional Plus VL
- Microsoft Word 2019 Professional Plus VL
- Shotcut (19.09.14)

*This application is used for installation measurement only. Features of this application are not utilized in measured workloads.

2.4 Scenario Grouping

The sub scenarios are grouped according to the descriptions below and depicted in the illustration.

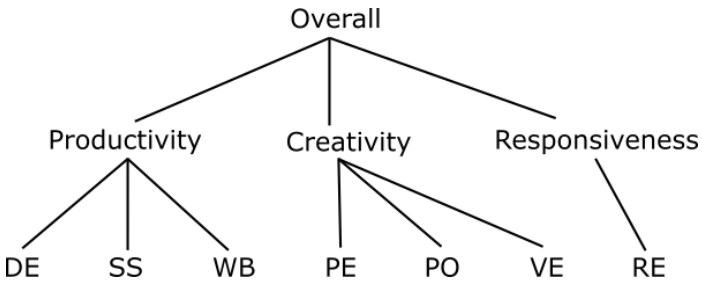


Figure 1: MobileMark 25 scenario grouping

Productivity

The Productivity scenario contains Document Editing, Spreadsheets, and Web Browsing sub scenarios.

Creativity

The Creativity scenario contains Photo Editing, Photo Organization, and Video Editing sub scenarios.

Responsiveness

The Responsiveness scenario contains usage models such as application launches, and file opens taken from other sub scenarios.

2.5 Scoring Methodology

In milestone 11, BAPCo decides the types of results that will be produced by a benchmark and the scoring methodology that determines how those results are calculated.

Importantly, BAPCo determines the scoring methodology before determining the content of the workloads, which helps ensure that a methodology is chosen for its ability to generate results that correspond to user experience, not for the results it produces on a pre-determined set of workloads.

For MobileMark 25, BAPCo evaluated the merits of a variety of scoring methodologies and chose a methodology based on how it met the following criteria:

- The scoring methodology should give expected results:
  - The resulting score should differentiate between systems with different performance.
  - The resulting score should be repeatable and not have high variation.
  - The resulting score should not be affected by benchmark artifacts, such as the number of tasks within a scenario.
- The relative performance between any two systems should not be affected by the selection of the calibration system.
- The resulting score should reflect the performance of user initiated multitasking operations.
- The scoring methodology should be easy to understand.

MobileMark 25 measures system performance by measuring the response time of tasks on a PC using real applications and simulated user input while executing on DC (battery) power. In the MobileMark 25 scoring methodology, task response times are used to generate a DC performance rating that reflects the user experience. The faster a PC responds to the application workloads in MobileMark 25, the higher its MobileMark 25 DC performance rating will be.

MobileMark 25 produces three main scores at the conclusion of a successful run: MobileMark Index score, Battery Life score, and the DC Performance score. The

SUT must complete at least one iteration of the MobileMark 25 workload to report scores

Battery Life Rating

The battery life rating for MobileMark 25 is calculated by measuring the actual battery duration observed (from a fully charged state to a fully depleted state), in whole minutes, while running all scenarios (PR->CR->RE) in repetition. For readability, the battery life rating is displayed in hours and minutes in the PDF report and in the benchmark UI.

The MobileMark 25 battery life rating for a given machine may differ from the actual battery life of real end users. Some reasons for this include but are not limited to:

- Different usage characteristics when using the system
- An old or degraded battery
- Additional OEM/IT software installed on the system
- Heavier network traffic
- Different power settings/optimizations
- Different screen brightness
- Ambient operational temperature

DC Performance

The DC performance score is the relative performance rating of the SUT vs the MobileMark 25 reference system on DC (battery) power. The MobileMark 25 reference system scores 1000 for the DC performance rating, therefore a SUT with a 1500 DC performance rating is performing 50% faster than the reference system. The DC Performance score is calculated by taking the geometric mean of all 7 of the sub scenario ratings (see section 2.4) prior to rounding. The result is rounded to the nearest integer.

MobileMark 25 Index

The MobileMark 25 Index score combines the Battery life score (in minutes) and the overall DC performance score into a single metric, showing the balance between battery life and performance. A higher MobileMark Index value is better. The formula for calculating the MobileMark Index score is as follows:

$$MobileMark\ Index\ = \left(\frac{Battery\ Life\ in\ minutes * DC\ Performance}{1000}\right)$$

The chart below uses example scores to illustrate the how the battery life and DC Performance scores influence the MobileMark Index score:

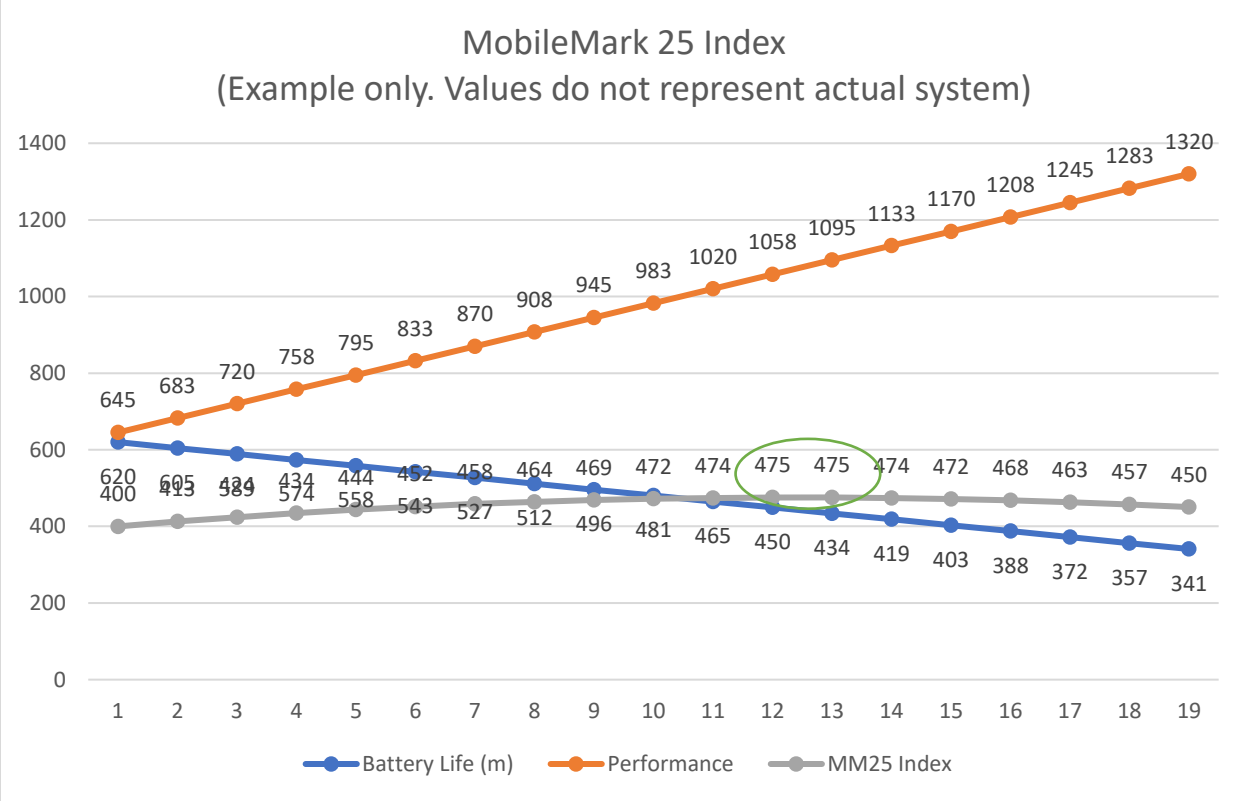


Figure 2: MobileMark Index score, example data. Chart illustrates the optimal point for battery life and performance.

In general, battery life (represented by the blue line) and DC Performance scores (represented by the orange line) are inversely proportional. As the battery life score increases, the DC Performance score decreases, and conversely, as DC performance increases, battery life drops. Customers may value long battery life, but not at the cost of a poor user experience.

This is where the MobileMark Index (represented by the grey line) offers guidance to PC OEMs in the design phase, and to customers in the purchasing phase. The MobileMark Index shows the convergence point where a balance of battery life and

DC Performance create the best overall user experience. For this illustration, we have circled the point (in green) on the chart where DC Performance is maximized while still providing a balanced battery life. Notebook manufacturers can use the MobileMark Index score to target this balance when designing systems, and PC consumers can use the same information when making purchasing decisions.

Sub Scenario Rating

Each sub scenario has a rating calculated by taking the sum of the response times of tasks in that sub scenario as performed on the test system and then comparing it with the sum of those same task response times as performed on the calibration system (see section 2.8). The calibration sum is divided by the measured sum on the test system and multiplied by 1000.

Productivity Rating

The Productivity Rating is calculated by taking the geometric mean of all the Document Editing (DE), Spreadsheets (SS), and Web Browsing (WB) sub scenario ratings (prior to rounding). The result is rounded to the nearest integer.

Creativity Rating

The Creativity Rating is calculated by taking the geometric mean of all the Photo Editing (PE), Photo Organization (PO), and Video Editing (VE) sub scenario ratings (prior to rounding). The result is rounded to the nearest integer.

Responsiveness Rating

The Responsiveness rating is simply the Responsiveness sub scenario rating taken as is.

Scenario Rating

Each scenario has a rating calculated by taking the sum of the response times of tasks in that scenario as performed on the test system and then comparing it with the sum of those same task response times as performed on the calibration system (see section 2.7). The calibration sum is divided by the measured sum on the test system and multiplied by 1000. The result is rounded to the nearest integer.

The calibration scenario rating number is obtained by performing a complete MobileMark 25 rundown test on the calibration machine and for each scenario

taking the median value of the sum of response times in the set of completed iterations for that scenario.

Battery Life Estimation

During testing, once a scenario has completed, projected battery life ratings are calculated and displayed in the heads-up display. These values are rough estimates, reflecting the system behavior in the benchmark up to that point, and subject to the accuracy of the test system's battery level reporting mechanism.

The battery life rating estimate b_e is calculated using the following formula:

$$b_e = \frac{t(c_t)}{c_t - c_n}$$

Where:

t is the elapsed time since the test was started, in minutes.

c_t is the level of charge the battery reports having the capability to hold when fully charged, in any units as reported by the battery (typically amp-hours or watt-hours).

c_n is the level of charge reported by the battery presently, in the same units as c_t.

2.6 Workload Development Sessions

Once the usage models, scenarios, application models, and scoring methodology for the benchmark are decided, BAPCo members and application experts meet to create the application workloads that will be used in the benchmark.

For MobileMark 25, the workload development sessions consisted of one week of face-to-face meetings that included representatives from BAPCo member companies and expert application users who had professional experience with the applications chosen for the benchmark. The application experts included professionals in the fields of small business marketing, financial forecasting, graphic design, video editing, web development, and enterprise IT deployment.

In the workload development sessions, the experts take the lead, weaving the usage models supplied by BAPCo into a storyboard of user interactions with a series of application models. Each user interaction is written down in a workload specification, which is later used to automate the workloads.

At the end of the workload development sessions, BAPCo comes away with a detailed workload specification for each of the benchmark scenarios and all the input data sets needed to reproduce the workloads created at the sessions.

Additional Workload Considerations

The following additional factors were considered at the workload development sessions:

Input Data Set
Frequently in the sessions, the experts need raw digital content to serve as input data set for a workload. Examples of such content might include a video to transcode, an email to modify, or photos to manipulate. When experts need such content, care is taken to ensure that they use something that is functionally representative of content they might use or encounter professionally.

For instance, if pictures are needed in order to create a photo slideshow, an expert might walk outside and take pictures using the same equipment he/she uses professionally. If a song track is needed as the background music for creating a movie, an expert might purchase a stock track from his/her usual online resource. Like the user interactions, all of these source materials are captured at the development session and used later in the development of automated workloads.

2.7 Scenario Workload Descriptions

The scenario workloads created at the workload development sessions for MobileMark 25 are described below:

Productivity

Read and manipulate notes from a notebook. Archive a diverse set of files into a single compressed file. Convert a PDF document into an editable word processing document. Perform a mail merge. View a complex presentation that includes multimedia and export it to PDF/video. Combine multiple scanned pages from a complex document into an encrypted PDF document using optical character recognition (OCR). Execute a rule on email inbox. Unpack a single compressed archive with a diverse set of files. Use a spreadsheet program to do data analysis. Perform financial analysis using a spreadsheet program. Browse multiple web sites (26 in total), of various content such as travel blogs, shopping sites, search pages, etc. Playback video clip in the browsers. Perform application install/uninstall.

Creativity

Combine a set of photos into one high dynamic range (HDR) image, and adjust and prepare both images for print. Import photos into a catalog. Export a large set of photos from a catalog. Detect faces using machine learning and artificial intelligence on a catalog of photos for labeling and grouping. Apply various filters to a group of photos. Transcode a video into a different format. Encode the video to a format suitable for web publishing using a video editing application.

Responsiveness

The Responsiveness scenario measures activities such as application opens, file opens and file saves during the Productivity and Creativity scenarios. These measurements are recorded as part of the flow of the other scenarios, as a user would experience them, rather than as a standalone scenario. Peform application install/uninstall.

2.8 Calibration System

The calibration system is a system chosen in Milestone 16 as a reference point for all other MobileMark 25 results. BAPCo chose the configuration below for its wide availability and its representation of a typical mainstream notebook/2-in-1 computer at the time of release of MobileMark 25.

MobileMark 25 has been calibrated in such a way that a notebook/2-in-1 computer with performance equivalent to this calibration system for a given workload will have a scenario performance rating of 1000. A system twice as fast as the calibration system on a given workload (or, equivalently, that responds in half the time on average) will have a scenario performance rating of 2000. This is true for each of the scenario performance ratings.

MobileMark 25 DC performance scores are normalized using a reference system. The reference system scores '1000' for DC performance on each scenario and '1000' on the overall MobileMark 25 DC performance score. The MobileMark 25 Index score for the reference system is 580. The battery life of the system under test is reported in hours and minutes.

Dell® Latitude™ 5420 calibration system configuration details

- CPU: Inte Core™ i5-1145G7 processor @ 2.60 GHz
- Graphics: Intel Iris XE
- Resolution: 1920x1080 non touch
- Display Brightness: 250 nits
- OS build version: Windows 10 (20H2) build 10.0.19042.508 (64 bit), retail copy
- RAM: 2 x 16 GB (Dual Channel) DDR 3200 non ECC
- Storage: 256 GB Solid State Drive, PCIe-NVMe OPAL2.0 M.2
- Power slider position: Better Performance (default)
- Power profile: Balanced (default)

For more details about the configuration of the calibration system, please contact support@bapco.com.

2.9 Benchmark Implementation

Once the workload specifications have been created, BAPCo begins the work of translating the workload specifications into an automated benchmark in milestone 17.

MobileMark 25 is built upon scripts that do things in much the same way as a user would, using controls like buttons, text input boxes, and menus to navigate applications. See Appendix C for screenshots of the benchmark in action.

To ensure that MobileMark 25 has deterministic behavior, BAPCo uses a framework to install applications, collect system information, run the scenario scripts, record performance measurements, calculate performance ratings, and display test results. The framework is kept lightweight, consuming a minimal amount of memory and compute resources, to ensure that battery life and performance measurements reflect the workload behavior and do not include overhead from the framework.

The fundamental performance unit upon which the MobileMark 25 DC Performance Rating is based is *response time*. Response time is defined as the time it takes the computer to complete a task that has been initiated by the automated script. A task can be initiated by a mouse click or a keystroke. The duration of each task is measured by the framework. Examples of tasks include launching an application, finding text in a document, copying a file, encoding a video, and performing an image manipulation.

The framework has several methods of detecting task completion, depending upon the method the application uses to signal task completion to the user. For example, the framework may wait for the application to show a completion message in the form of a pop-up window, or it may wait for a progress dialog to disappear and for control of the application to be returned to the user.

3 Workload Characteristics

This section provides data illustrating the battery life and performance characteristics of MobileMark 25.

3.0.1 User Activity Sates

MobileMark 25 aims to model users' activity over a range of tasks which are grouped into scenarios. An iteration is defined as one complete run of each of the scenarios. MobileMark 25 runs iterations continuously until the system battery charge is exhausted. Each iteration contains a portion of active time and idle time as detailed in the chart below.

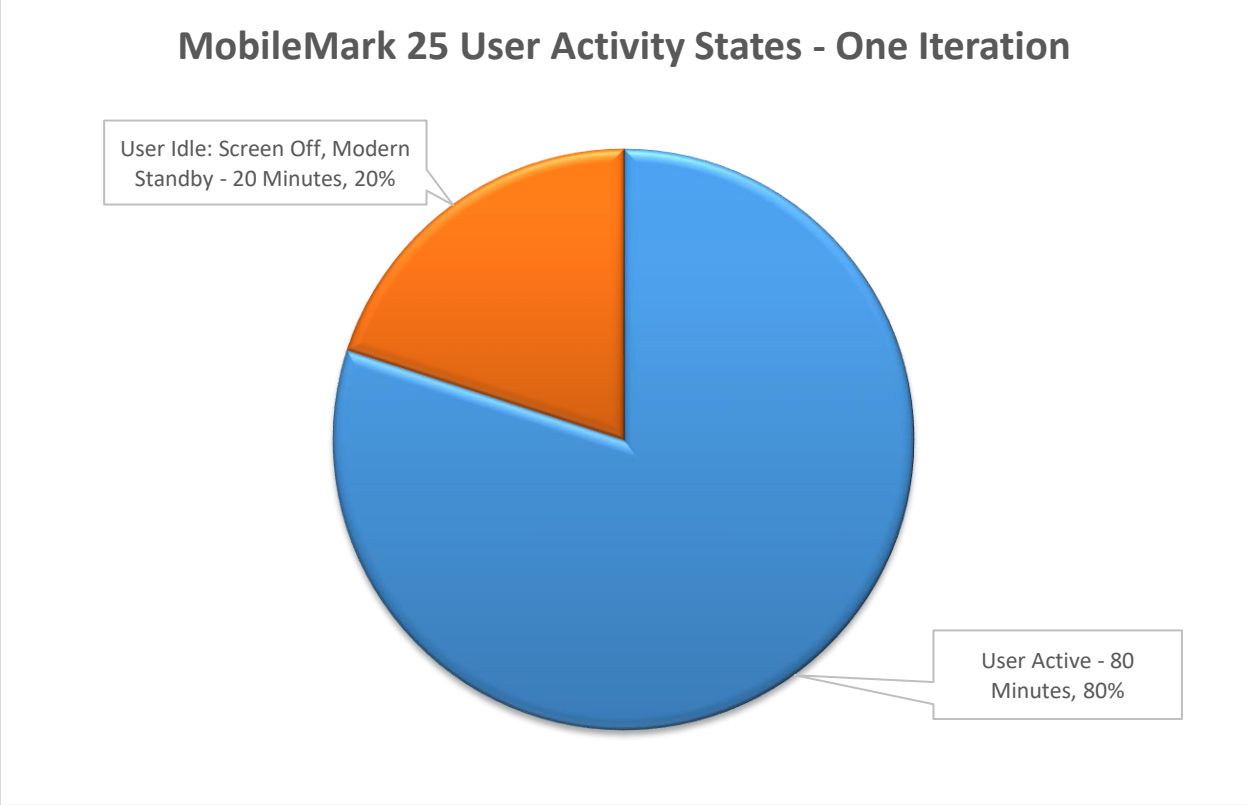


Figure 3: MobileMark 25 User activity states for one iteration

3.1 Sensitivity Analysis

The series of tables below shows the sensitivity of MobileMark 25 performance scores to different system characteristics, including the amount of system memory (RAM), number of CPU cores, type of storage device, and display resolution. The study was conducted using a desktop system to allow better control of the system components being evaluated. The effect of component sensitivity on battery life is not included in this study.

Within each configuration only one system component (e.g. memory) is varied. All the other system components are held constant. To best illustrate the sensitivity, one configuration is chosen as a baseline and the ratings for the other configurations are shown as the percentage difference relative to the baseline.

Sensitivity study system configuration information

- CPU: Intel Core i9-11900k, Turbo and HT disabled, except as noted
- RAM: 2x8gb (16gb dual channel)
- Storage: Samsung 980 Pro 500gb
- GPU: Intel UHD 750
- Resolution: 1920x1080
- OS: Windows 11 Pro version 10.0.22000.282

For the tables below, the following components are varied as noted:

- System Memory:
    - 1x8gb
    - 2x8gb
    - 1x16gb
    - 2x16gb

- CPU - Cores adjusted in OS settings
    - 2c2t
    - 4c4t
    - 6c6t
    - 8c8t

- Storage
  - Seagate 500GB ST500LT012 @ 5400rpm
  - Western Digital 1TB WD1003FZEX @ 7200rpm
  - Kingston 120GB SATA SSD
  - Intel 545s SSD SATA 3.0 256 GB
  - Intel Optane 660p NVME 512GB
  - Samsung 980 Pro NVME 500GB
  - Intel Optane 900p PCIE 260GB
- Graphics
  - Intel UHD 750
  - NVIDIA GT 1030
  - NVIDIA GTX 1650
  - NVIDIA RTX 2080Ti
  - NVIDIA RTX 3080
- Resolution
  - 1280x800 @ 60Hz
  - 1366 x 768 @ 60Hz
  - 1920 x 1080 @ 60Hz
  - 2560 x 1600 @ 60Hz
  - 3840 x 2160 @ 60Hz
- Display Brightness (MobileMark 25 calibration system was used for this study, with Turbo and Hyper-Threading ON)
  - 100 Nits
  - 150 Nits
  - 200 Nits
  - 250 nits

3.1.1 Sensitivity to System Memory

The total system memory is changed from 4 GB single channel to 8 GB single channel to 8 GB dual channel to 16 GB dual channel. Turbo and HyperThreading were disabled for this study.

DC Performance (desktop on AC power)				
System Memory Sensitivity	8 GB (1 x 8 GB)	16 GB (2 x 8 GB)	16 GB (1 x 16 GB)	32 GB (2 x 16 GB)
MobileMark 25	Baseline	+7.8%	+3.8%	+8.9%

Table 1: System Memory Sensitivity

3.1.2 Sensitivity to CPU Cores

Cores and threads available to the system were limited using Windows OS settings. Turbo and Hyper-Threading were turned off for all configs with the exception of the 8 Core/16 Thread data point.

CPU Core Sensitivity	2 Core, 2 Threads	4 Cores , 4 Threads	6 Cores, 6 Threads	8 Cores, 8 Threads
MobileMark 25	Baseline	+28.6%	+36.2%	+37.3%

Table 2: CPU Core Sensitivity

3.1.3 Sensitivity to I/O Subsystem

The primary storage device is changed from a 5400 RPM hard disk drive to a 7200 RPM hard disk drive to a 240 GB Sata SSD.

DC Performance (desktop on AC power)							
I/O Subsystem Sensitivity	500GB 5400 RPM HDD	1TB 7200 RPM HDD	Kingston SSD 120 GB	545s 256GB SSD	660p 512GB SSD	980 Pro 500GB SSD	900p 260 GB SSD
MobileMark 25	Baseline	+0.60%	+23.7	+24.8%	+25.5%	+25.7%	+25.5%

Table 3: I/O Subsystem Sensitivity

3.1.4 Sensitivity to Graphics Card

The system graphics controller is changed from the Integrated GFX to various models of discrete graphics cards.

DC Performance(desktop on AC power)					
	Intel UHD 750	NVIDIA GT1030	NVIDIA GTX1650	NVIDIA RTX2080Ti	NVIDIA RTX3080
MobileMark 25	Baseline	-0.99%	+0.02%	+0.03%	+0.05%

Table 4: Display Resolution Sensitivity

3.1.5 Sensitivity to Display Resolution

The system display resolution is changed, from 1366 x 768 to 1920 x 1080 to 2560 x 1440 to 3840 x 2160.

DC Performance(desktop on AC power)					
	1280 x 800	1366 x 768	1920 x 1080	2560 x 1600	3840 x 2160
MobileMark 25	Baseline	-0.98%	-0.98%	-0.99%	-0.99%

Table 5: Display Resolution Sensitivity

3.1.6 Sensitivity to Display Brightness

The chart below details the sensitivity to display brightness. The data for the chart below was collected using the MobileMark 25 Calibration system.

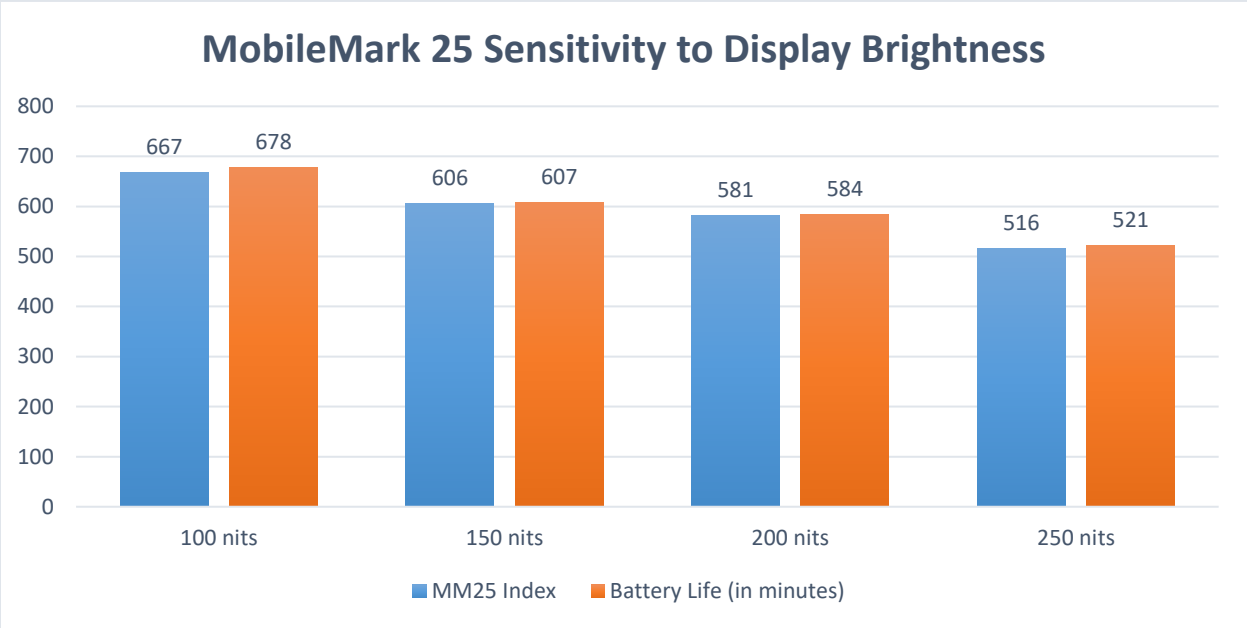


Figure 4: MobileMark 25 sensitivity to display brightness

3.2 Battery Life Rating Analysis

The following chart shows the approximate contribution of each scenario to the MobileMark 25 Battery Life rating on the calibration system.

Due to system implementation differences, this chart is accurate for the calibration system only. These contributions will vary from one system to the next.

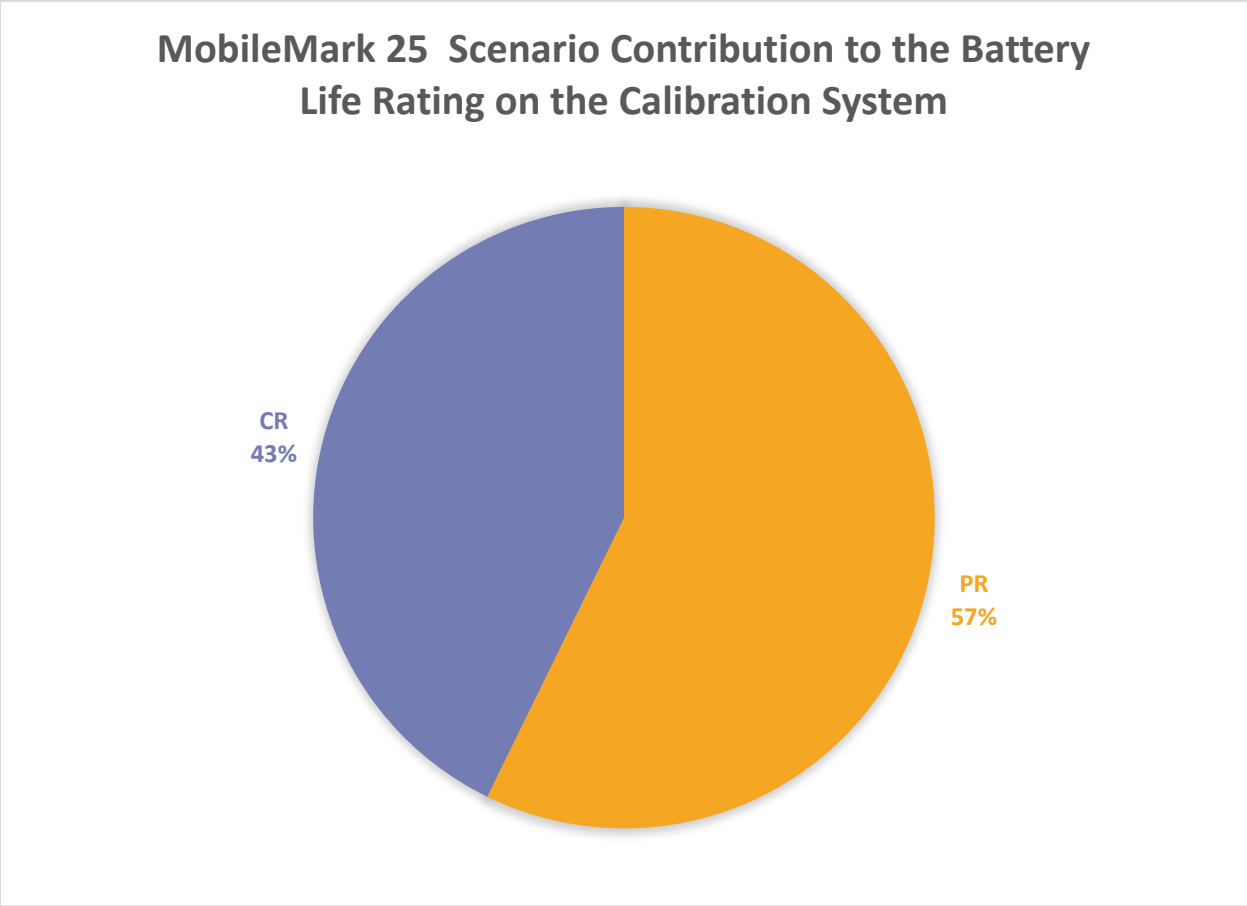


Figure 5: Scenario contribution to the MobileMark 25 Battery Life rating on the Calibration System (See Section 2.8 for system details)

3.3 Iteration User Activity Analysis

The following chart shows the order each activity is run in and its relative time in an iteration for all three scenarios.

Due to system implementation differences, this chart is accurate for the calibration system only. These contributions will vary from one system to the next.

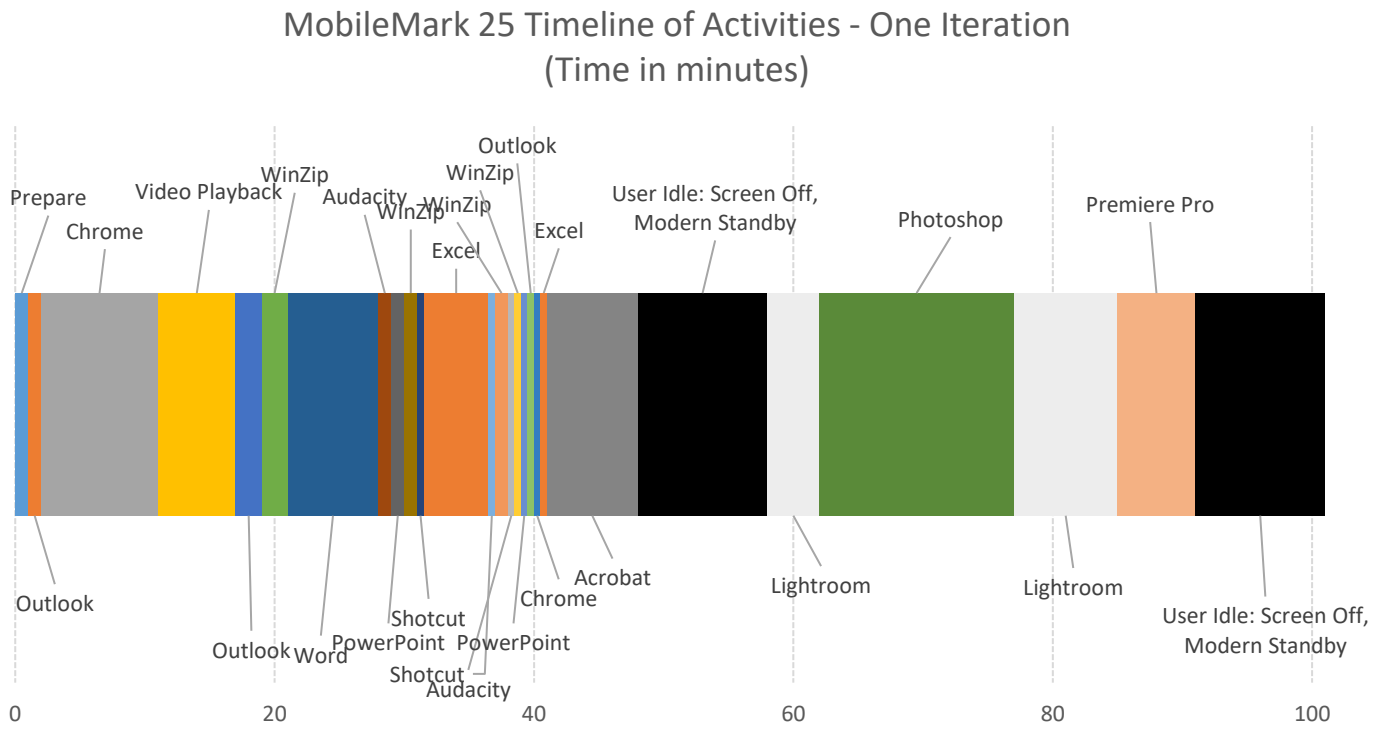


Figure 6: MobileMark 25 timeline of activities (in minutes) for one iteration on the Calibration System (See Section 2.8 for system details).

3.4 DC Performance Rating Analysis

The following charts shows the approximate contribution of each application to the MobileMark 25 DC Performance Rating on the calibration system.

Due to system implementation differences, this chart is accurate for the calibration system only. These contributions will vary from one system to the next.

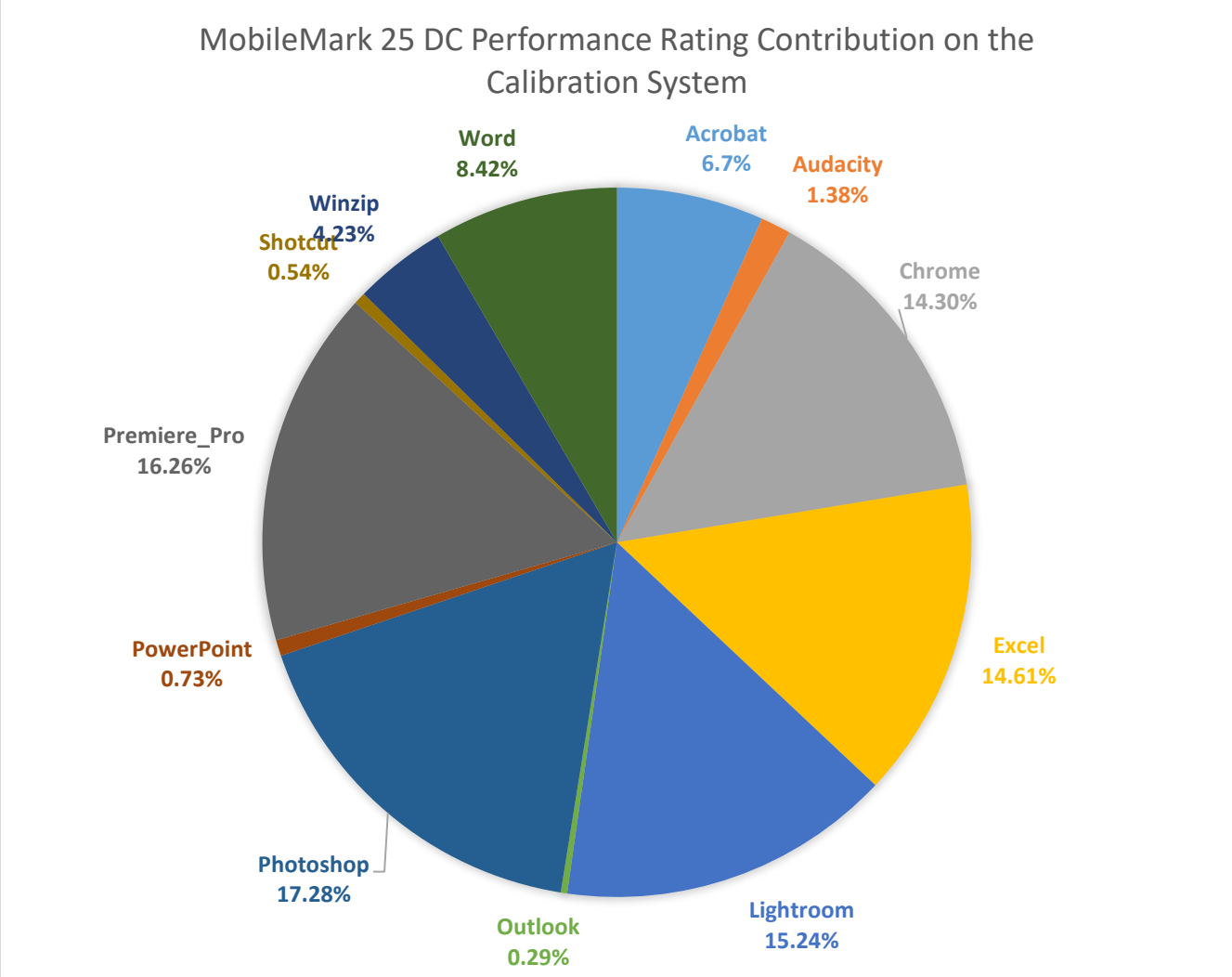


Figure 7: MobileMark 25 timeline of activities for one iteration on the Calibration System (See Section 2.8 for system details).

3.5 Windows Performance Power Slider Analysis

Microsoft first introduced the performance/power slider in Windows 10 build 1709. The slider continues to be available in Windows 11 provided the SUT is configured with the Balanced power plan, or a power plan derived from the Balanced power plan.

Figure 5: Windows performance power slider control panel on Windows 10

The following chart shows the battery life and DC Performance Ratings on the calibration system for each power slider position.

Due to system implementation differences, this chart is accurate for the calibration system only. These contributions will vary from one system to the next.

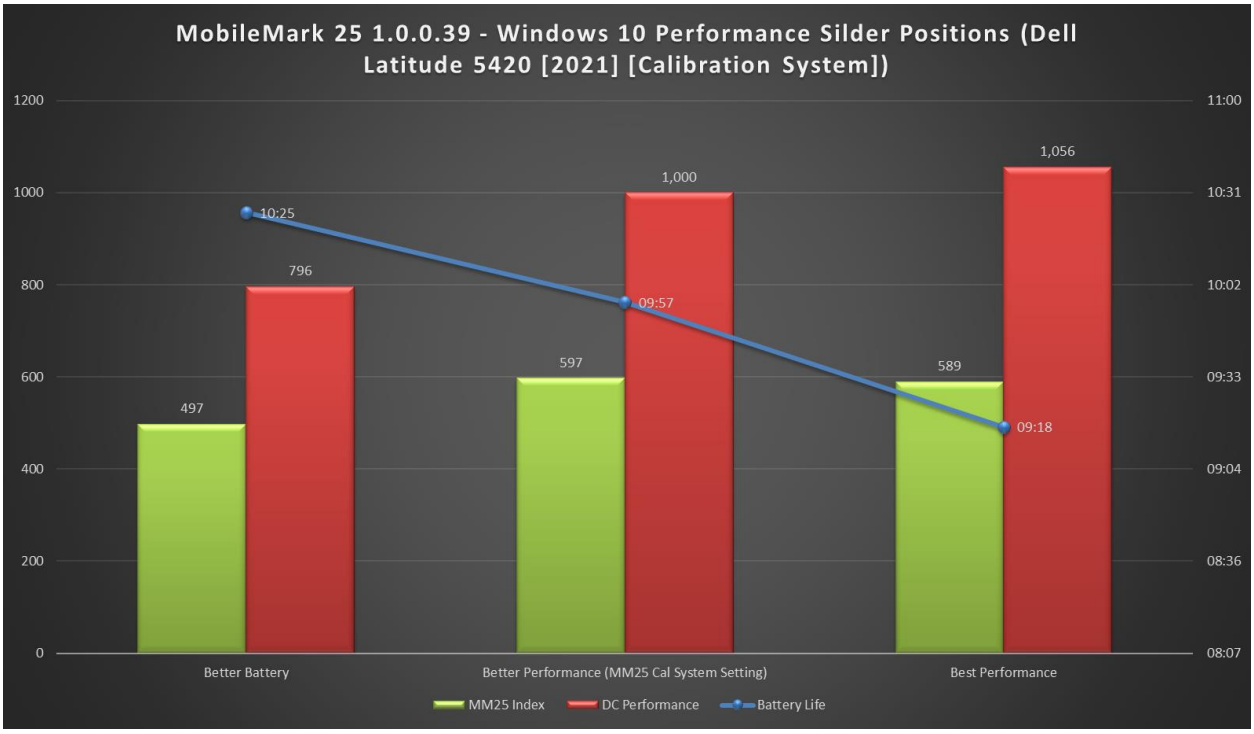


Figure 8: Effect of the various Windows 10 Performance Power slider positions on MobileMark 25 Battery Life and DC Performance Rating on the Calibration System (See 2.8 for system details).

APPENDIX A: System Requirements

MobileMark 25 has the following requirements:

- System running on DC battery power
- **CPU**:– CPU: 2015 or newer x86 processor (Intel 6th Generation Core or AMD 7000 series APU)
- **RAM:** 8 GB
- **HDD/SSD:** 25 GB of free space on the primary drive
- **Operating System:** Microsoft® Windows® 10 64-bit version 19H2 or higher. Microsoft Windows 11 64-bit version 22000.194 or higher
- **Resolution:** 1280x800 or 1366x768, 2gb of VRAM
- **Graphics:** DirectX 12 compatible
- **Network:** Associate to Wi-Fi network

APPENDIX B: Screenshots

The screenshots below illustrate the user interface and workloads included in the current version of MobileMark 25. These screenshots may not depict future releases of MobileMark 25.

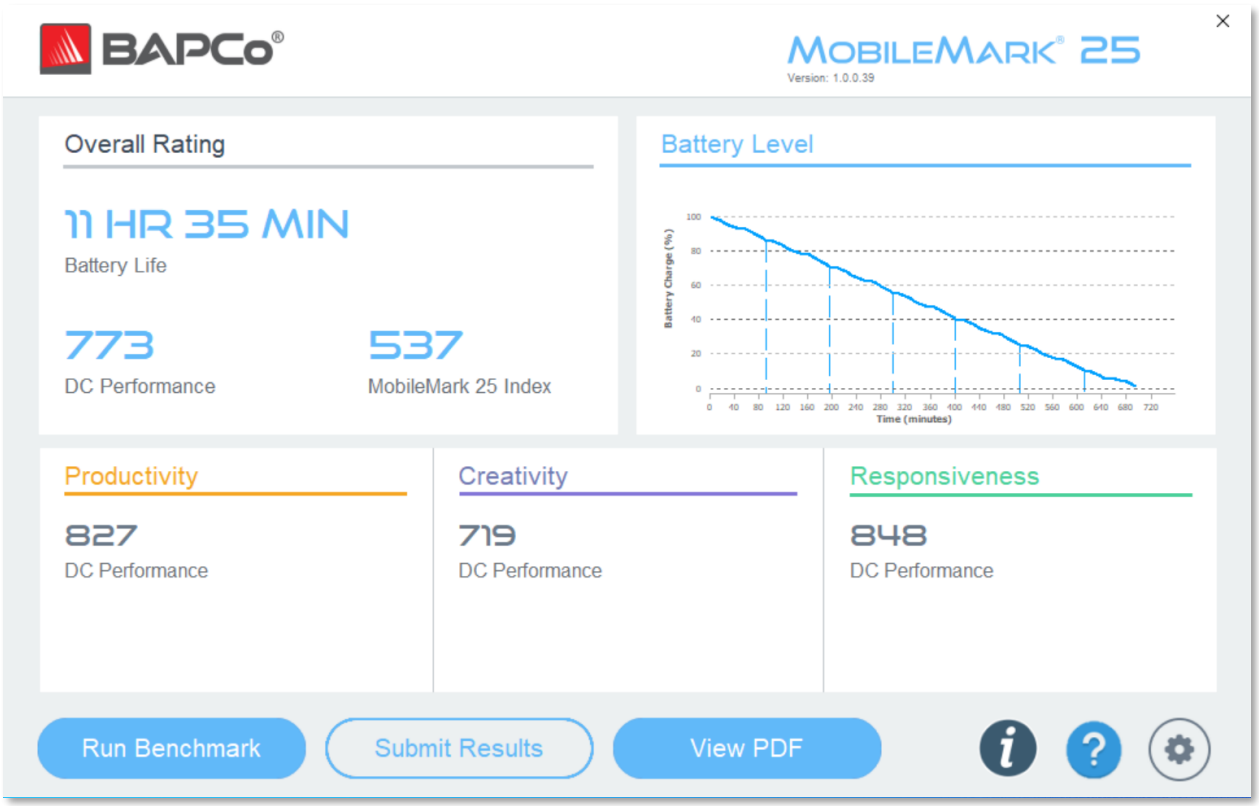


Figure 9: MobileMark 25 launch screen

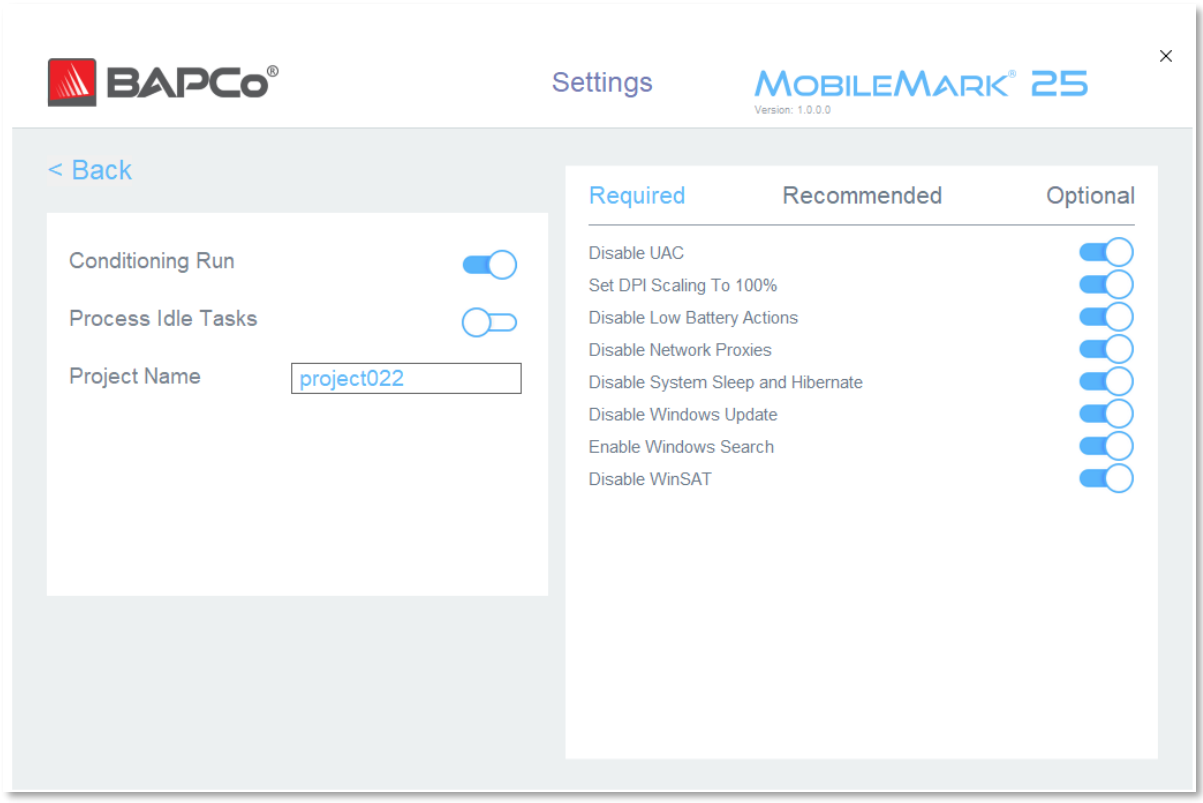


Figure 10: MobileMark 25 Config Tool settings

Figure 11: MobileMark 25 Heads Up Display

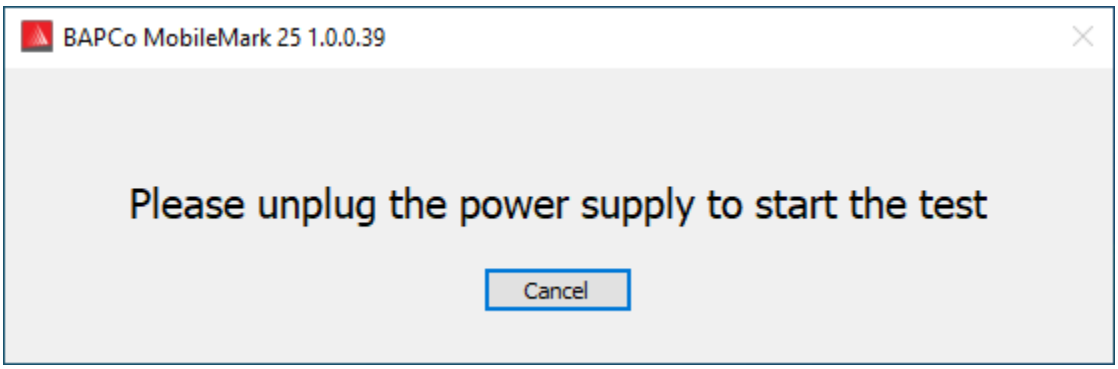


Figure 12: MobileMark 25 prompt to unplug

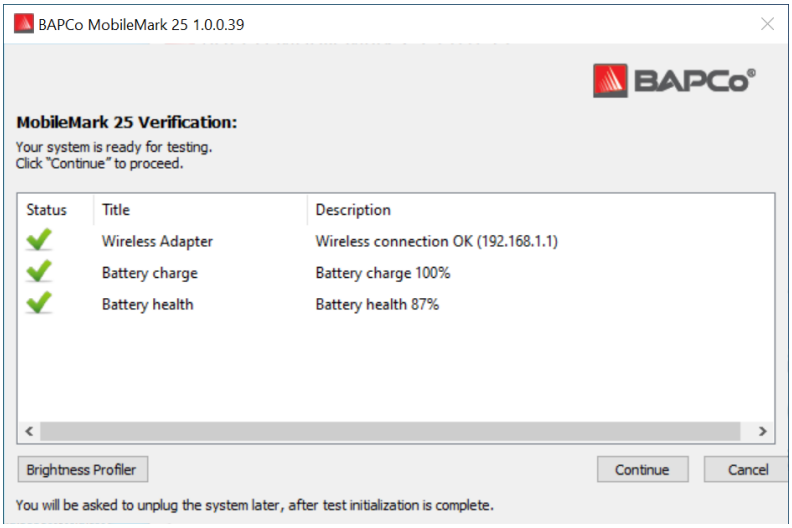


Figure 13: MobileMark 25 verification screen

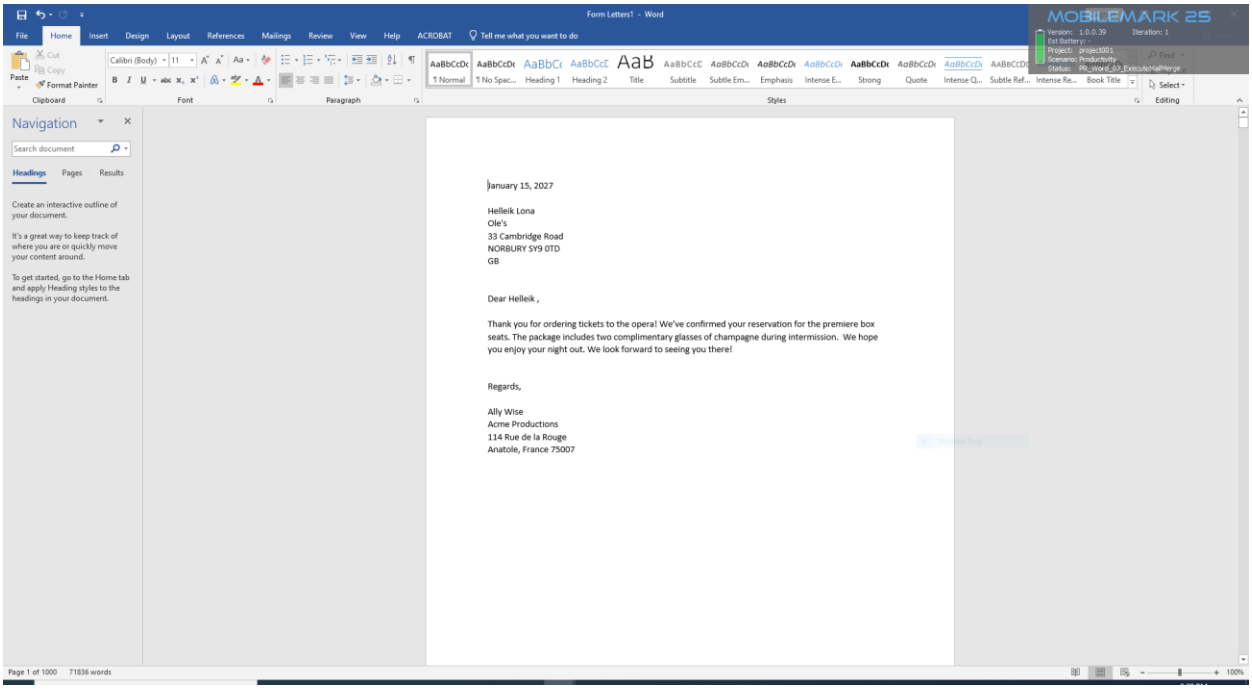


Figure 14: MS Word, part of the MobileMark 25 Productivity scenario

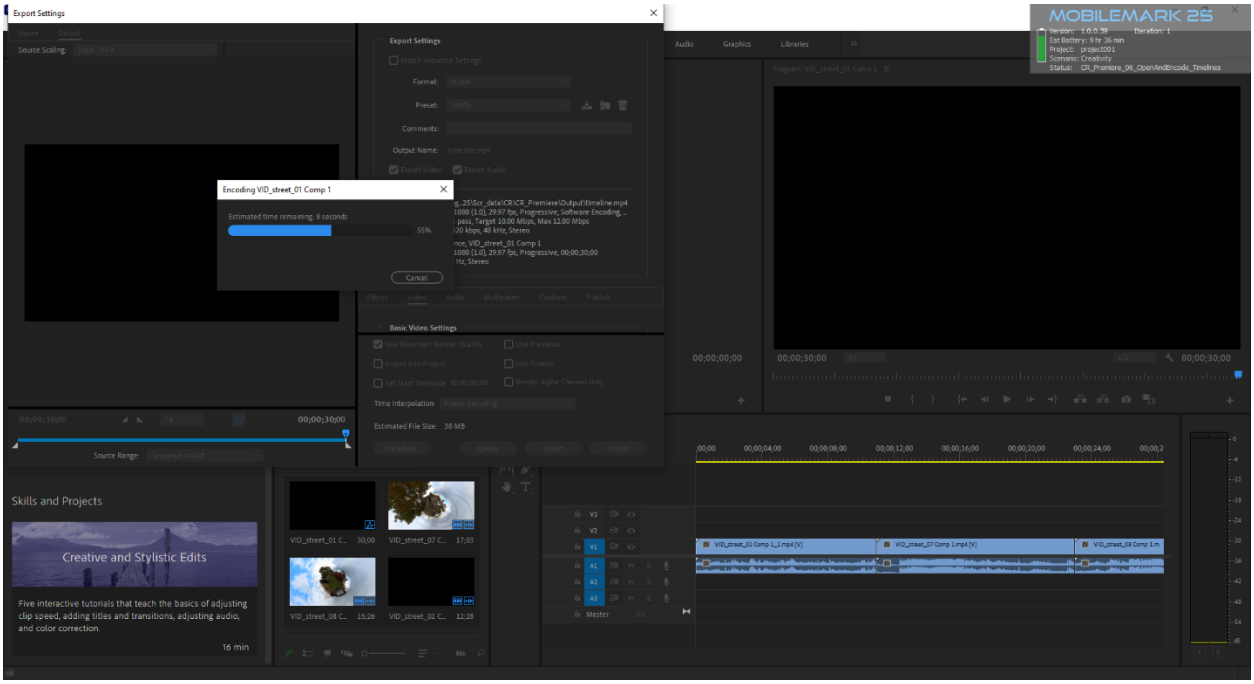


Figure 15: Adobe Premiere, part of the MobileMark 25 Creativity scenario

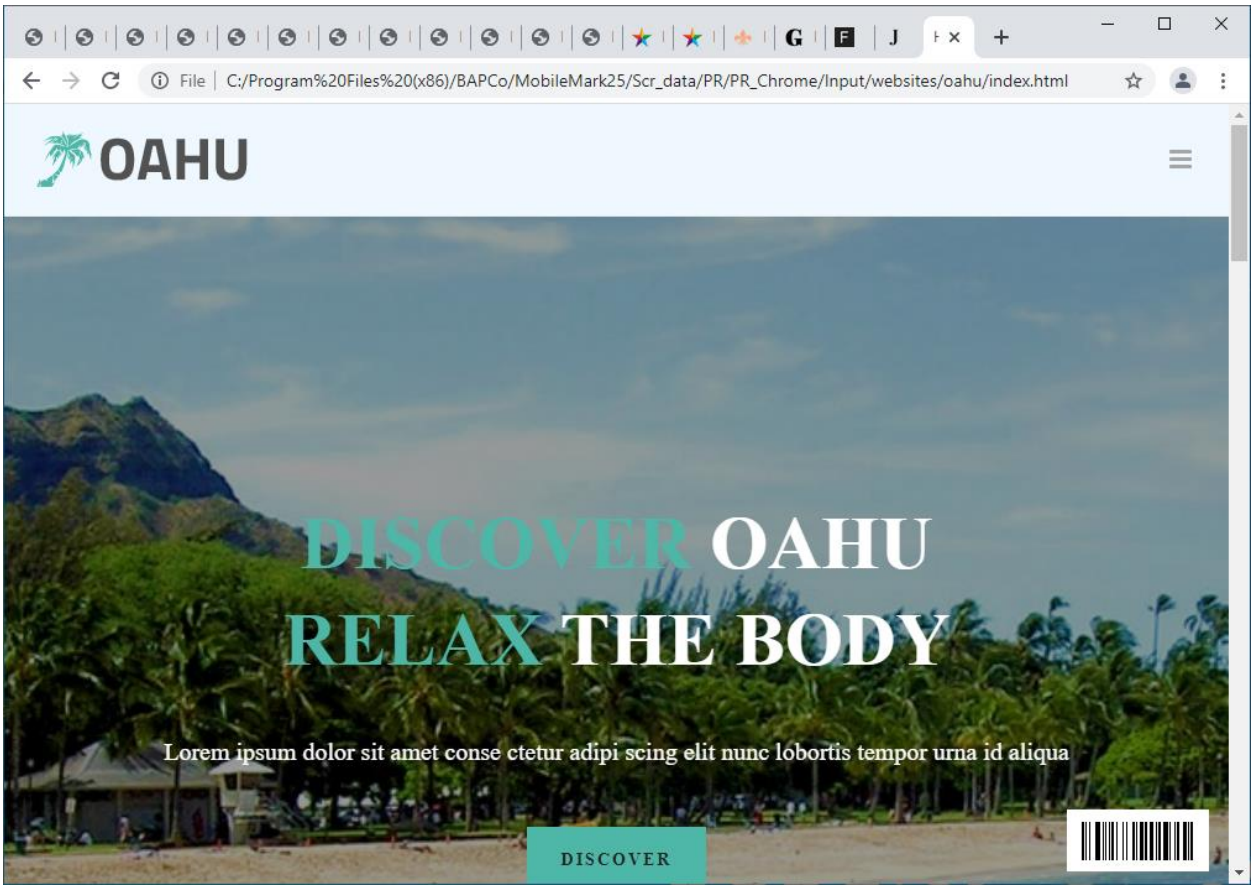
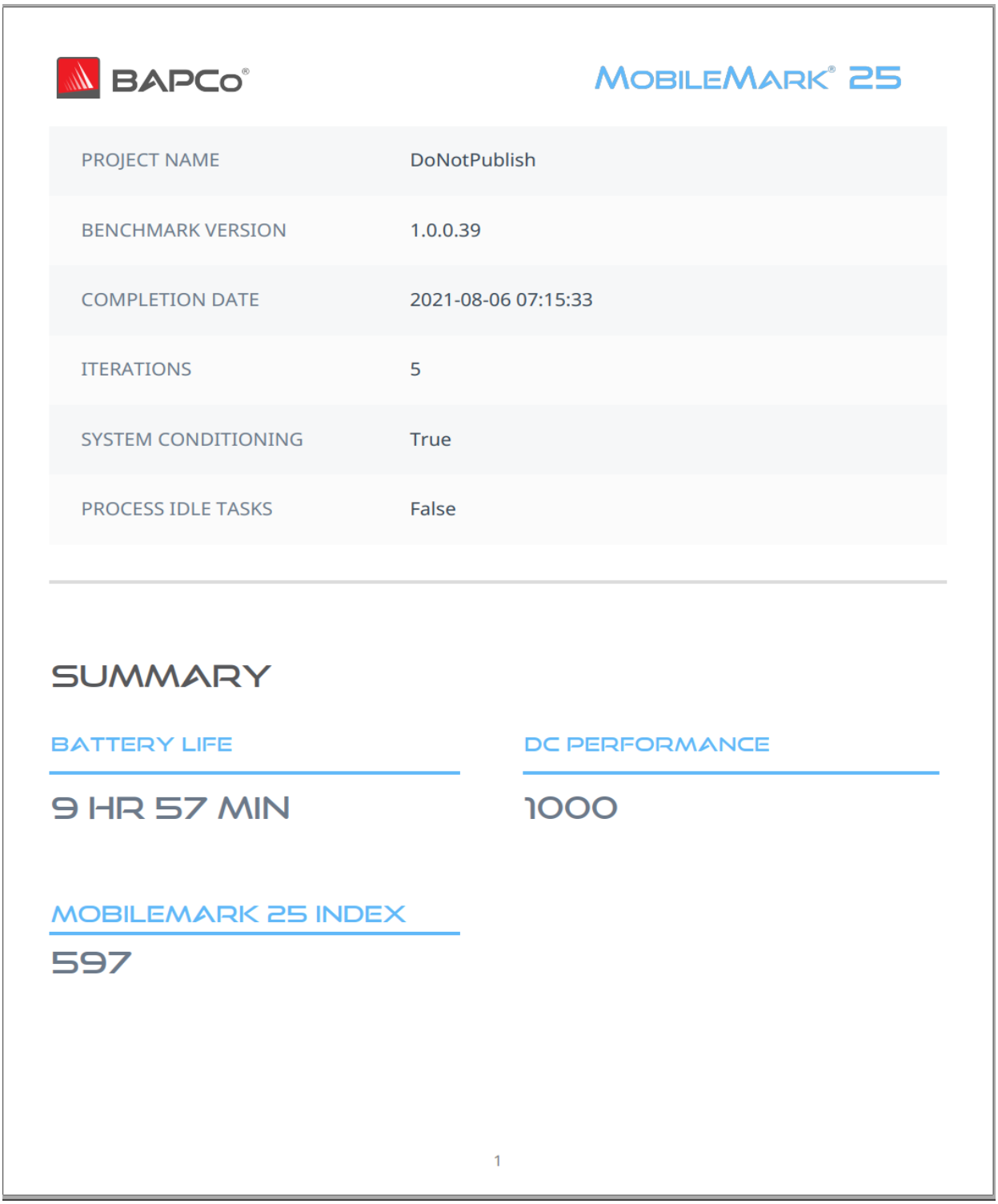


Figure 16: Google Chrome browser, part of the MobileMark 25 web browsing workload



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MOBILEMARK® 25

PROJECT NAME	DoNotPublish
BENCHMARK VERSION	1.0.0.39
COMPLETION DATE	2021-08-06 07:15:33
ITERATIONS	5
SYSTEM CONDITIONING	True
PROCESS IDLE TASKS	False

SUMMARY

BATTERY LIFE

9 HR 57 MIN

DC PERFORMANCE

1000

MOBILEMARK 25 INDEX

597

1

Figure 17: MobileMark 25 results PDF page 1

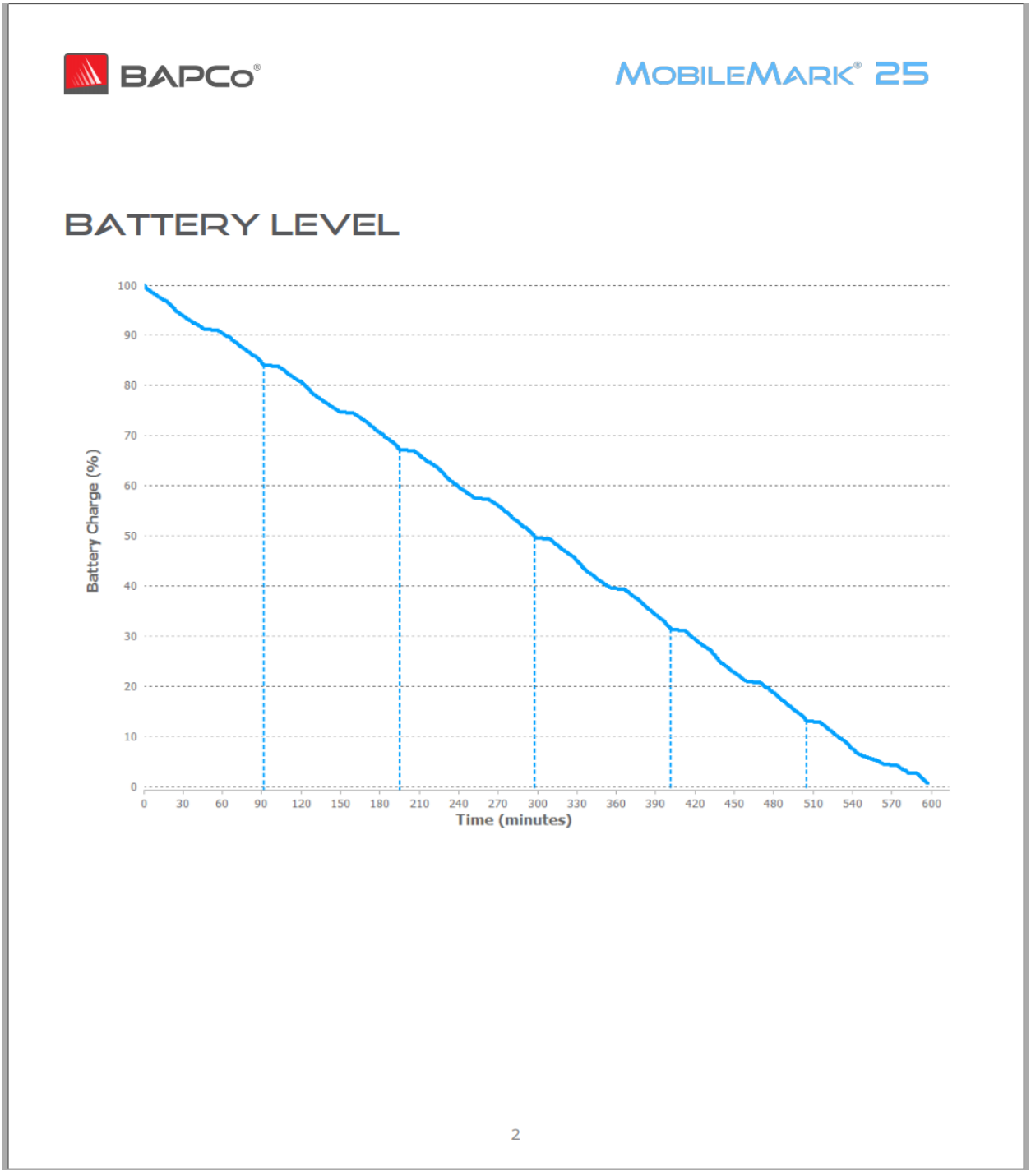
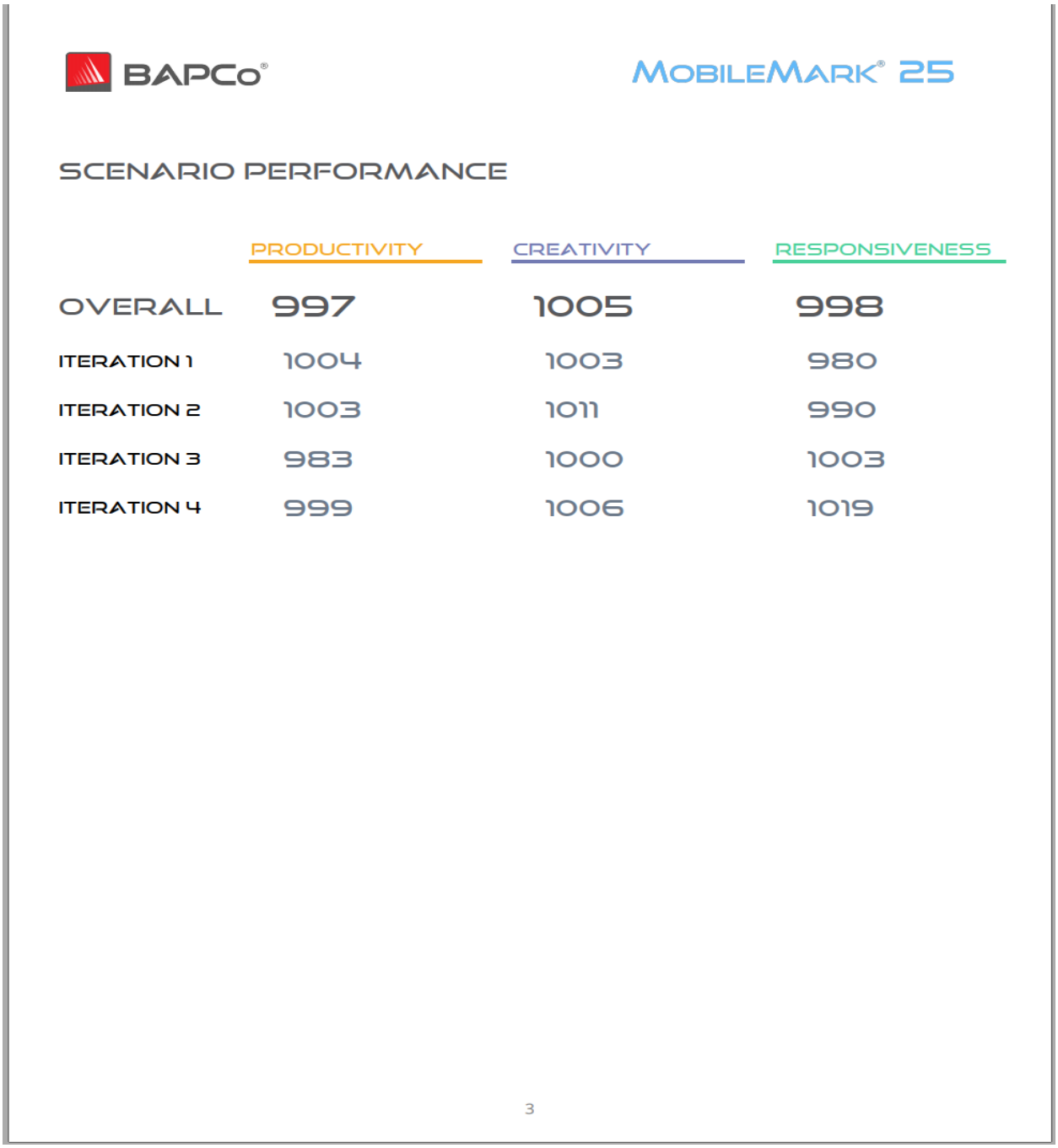


Figure 18: MobileMark 25 results PDF page 2



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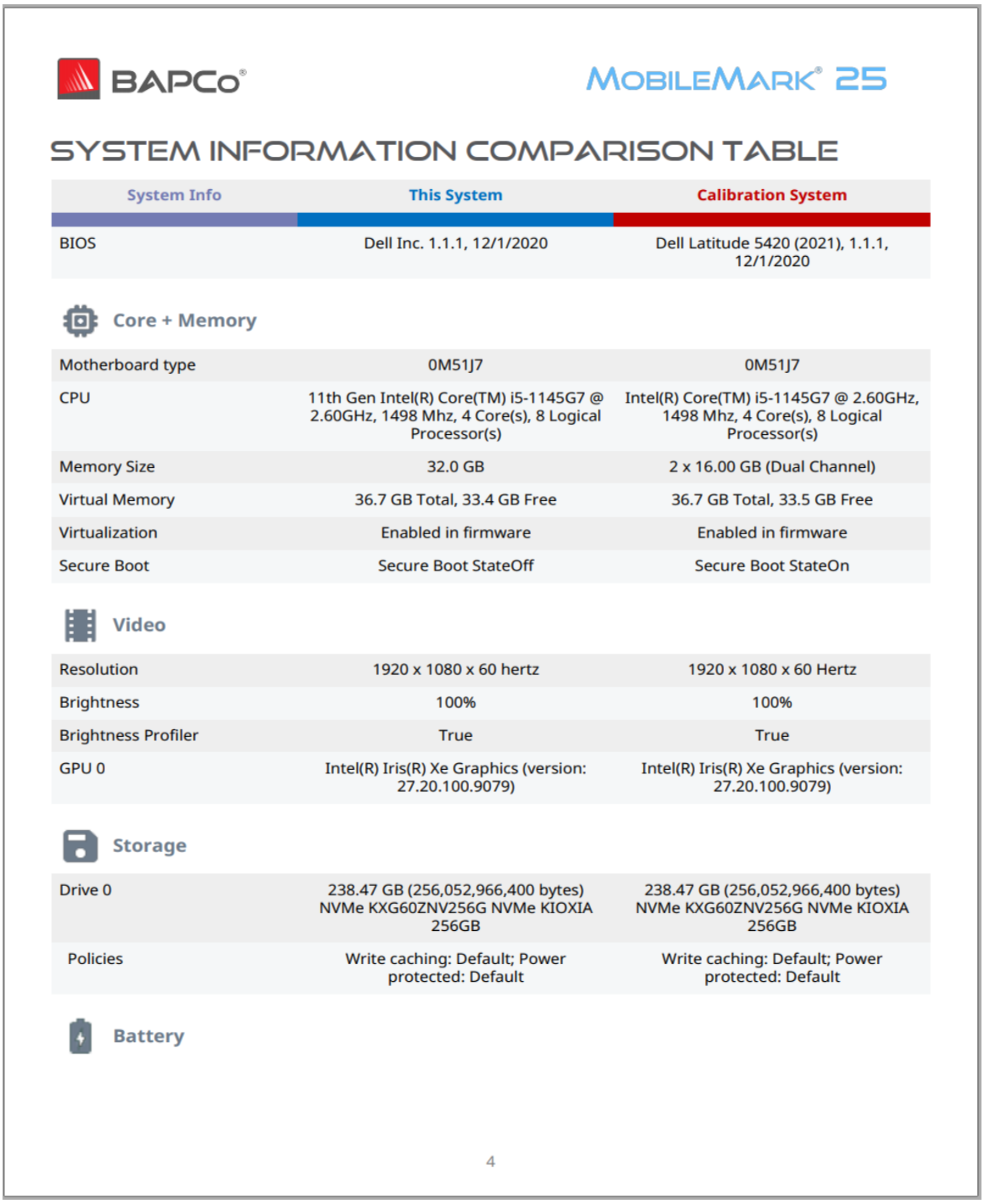
MOBILEMARK® 25

SCENARIO PERFORMANCE

	PRODUCTIVITY	CREATIVITY	RESPONSIVENESS
OVERALL	997	1005	998
ITERATION 1	1004	1003	980
ITERATION 2	1003	1011	990
ITERATION 3	983	1000	1003
ITERATION 4	999	1006	1019

3

Figure 19: MobileMark 25 results PDF page 3



BAPCo® MOBILEMARK® 25

SYSTEM INFORMATION COMPARISON TABLE

System Info	This System	Calibration System
BIOS	Dell Inc. 1.1.1, 12/1/2020	Dell Latitude 5420 (2021), 1.1.1, 12/1/2020
Core + Memory		
Motherboard type	0M51J7	0M51J7
CPU	11th Gen Intel(R) Core(TM) i5-1145G7 @ 2.60GHz, 1498 Mhz, 4 Core(s), 8 Logical Processor(s)	Intel(R) Core(TM) i5-1145G7 @ 2.60GHz, 1498 Mhz, 4 Core(s), 8 Logical Processor(s)
Memory Size	32.0 GB	2 x 16.00 GB (Dual Channel)
Virtual Memory	36.7 GB Total, 33.4 GB Free	36.7 GB Total, 33.5 GB Free
Virtualization	Enabled in firmware	Enabled in firmware
Secure Boot	Secure Boot StateOff	Secure Boot StateOn
Video		
Resolution	1920 x 1080 x 60 hertz	1920 x 1080 x 60 Hertz
Brightness	100%	100%
Brightness Profiler	True	True
GPU 0	Intel(R) Iris(R) Xe Graphics (version: 27.20.100.9079)	Intel(R) Iris(R) Xe Graphics (version: 27.20.100.9079)
Storage		
Drive 0	238.47 GB (256,052,966,400 bytes) NVMe KXG60ZNV256G NVMe KIOXIA 256GB	238.47 GB (256,052,966,400 bytes) NVMe KXG60ZNV256G NVMe KIOXIA 256GB
Policies	Write caching: Default; Power protected: Default	Write caching: Default; Power protected: Default
Battery		

4

Figure 20: MobileMark 25 results PDF page 4

Battery 0	BYD DELL M033W0C 1070BYDDELL M033W0C	BYD DELL M033W0C 892BYDDELL
Design Capacity	62366 mWh	62366 mWh
Full Capacity	57806 mWh	62366 mWh
Battery Health	93%	100%
Cycle Count	--	--

Operating System

OS TYPE	Microsoft Windows 10 Pro	Microsoft Windows 10 Pro
OS VERSION	10.0.19042.508	10.0.19042.508
Bitlocker	Volume C: Protection Off	Volume C: Protection Off
Tamper Protection	Disabled	Disabled
Windows Defender Antivirus	Disabled	Disabled
Windows Security Center	Disabled	Disabled
Power Policy	BAPCo MobileMark 25	BAPCo MobileMark 25
Power Slider Overlay	Better Performance	Better Performance
Dark Mode (MobileMark/OS)	Disabled/Custom; Windows Mode: Dark; App Mode: Light	Disabled/Custom; Windows Mode: Dark; App Mode : Light
Virtualization-based security	Disabled	Disabled

5

Figure 21: MobileMark 25 results PDF page 5