Advances in Web Development Journal
vol. 1 no. 8, pp. 107–119

Submitted: 2023-10-29 | Revised: 2023-11-15 | Accepted: 2023-12-29

Keywords: operating systems, Linux, Windows, performance, architecture

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PERFORMANCE COMPARISON OF DIFFERENT VERSIONS OF WINDOWS AND LINUX OPERATING SYSTEMS

Abstract

The objective of this project is to conduct a comparative analysis of the performance of selected versions of the Linux and Windows operating systems using specific performance tests. Subsequently, the superior performance outcomes in the given scenario will be evaluated. To ensure the dependability of the results, software that is compatible with both platforms and offers identical tests for the chosen systems will be employed. Additionally, a virtual environment in which both operating systems will be executed using the VirtualBox software. This approach will allow the performance of both systems to be evaluated and contrasted under the same conditions. All examinations and their corresponding results will be included in this study as visual documentation.

1. INTRODUCTION

The Windows operating system has a rich history, starting in 1985 when Microsoft introduced the first version of the Windows system. Since then, the Windows operating system has undergone numerous changes and updates, becoming one of the most recognizable operating systems in the world [1].

In November 1984, Microsoft unveiled their initial graphical user interface within the Windows series. This graphical interface was designed as an overlay for the MS-DOS operating system in response to the increasing demand for user-friendly graphical interfaces, similar to those seen in computers like the Macintosh. This graphical shell, followed by the

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full-fledged Windows operating system, eventually asserted its dominance in the worldwide personal computer market. The first official, stable version was Windows 1.01, as Windows 1.00 remained in beta and was never formally launched. In November 1984, Microsoft unveiled their initial graphical user interface within the Windows series. This graphical interface was designed as an overlay for the MS-DOS operating system in response to the increasing demand for user-friendly graphical interfaces, similar to those seen in computers like the Macintosh. This graphical shell, followed by the full-fledged Windows operating system, eventually asserted its dominance in the worldwide personal computer market. The first official, stable version was Windows 1.01, as Windows 1.00 remained in beta and was never formally released [2].

2. THE ARCHITECTURE OF THE WINDOWS OPERATING SYSTEM

The architecture of the Windows operating system comprises the system kernel, system modules, drivers, user interface, and application layer.

- The system kernel manages hardware and software resources, handles processes, manages memory, and schedules tasks,
- System modules extend the functionality of the kernel and include system services such as file management, networking, and security,
- Drivers enable communication between the operating system and hardware devices.
- The user interface allows user interaction with the system through elements like the Taskbar and the Start Menu,
- The application layer consists of a collection of programs and applications running on the Windows system.

This entire architecture is a complex framework that ensures the stability, security, and efficiency of the Windows operating system [3].

3. WINDOWS USER INTERFACE

The user interface (Fig. 3.1) of the Windows system is a graphical environment that allows us to interact with the system. It includes the Taskbar, Start Menu, File Explorer, windows, buttons, and toolbars. The Taskbar consists of the Start button, notification icons, and a search field. The Start Menu contains applications and system functions. File Explorer allows us to manage files and folders. Windows and buttons enable us to manipulate open applications. Toolbars contain shortcuts to frequently used functions. The Windows user interface provides a convenient and intuitive way to operate the system and applications.

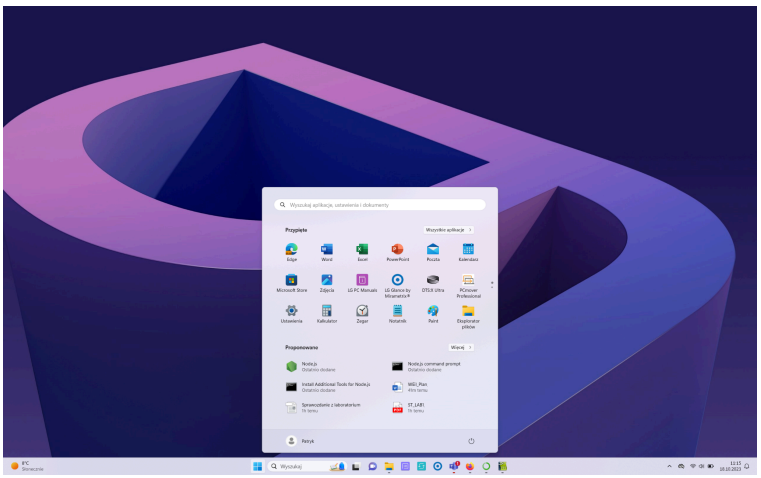

Fig. 3.1:. Windows 11 22H2 Desktop.

4. POPULAR VERSIONS OF WINDOWS

The Windows operating system is available in various versions. The most popular ones are Windows 10, Windows 11, Windows 7, Windows 8/8.1, and Windows XP. Windows 11 is currently the latest version, introduces many new features and updates. Windows 7 is praised for its stability, and Windows XP, although older, gained popularity due to its application support and wide usage.

1. Windows 10 is one of the latest and most widely used versions of the Windows operating system. Released in July 2015, it brings many new features and improvements. Windows 10 is based on a Software-as-a-service model, which means regular updates and security fixes [4].

2. Windows 11 is the newest version of the Windows operating system, officially announced by Microsoft in June 2021 [5]. Windows 11 introduces many new features, visual enhancements, and improvements compared to previous versions. It includes a new user interface look, a refreshed Start menu, a notification center, better support for mobile apps, improved gaming support, and many others. Windows 11 is designed to enhance productivity, flexibility, and security for users. Currently, Windows 11 is available as a free update for qualifying Windows 10 systems.

3. Windows 7 is one of the most successful versions of the Windows operating system. Released in 2009, it enjoyed widespread popularity due to its stability and intuitive interface [6]. Windows 7 was widely used for many years.

4. Windows 8/8.1, released in 2012, introduced a new user interface known as the Modern UI or Start Screen [7]. Windows 8 received mixed reviews, but Windows 8.1 provided improvements and adjustments for a better user experience.

5. Windows XP is one of the longest-lasting versions of the Windows operating system. Released in 2001 [8], it gained popularity for its stability and application support.

However, the lack of further support and security updates has been in effect since April 2014.

5. HISTORY OF THE LINUX OPERATING SYSTEM

The history of the Linux operating system began in 1991 when Linus Torvalds, a student at the University of Helsinki, created the prototype of the Linux kernel. This system is based on the open-source software model, which means that the source code is publicly available, and anyone can modify it.

The development of the Linux system is continued by a global community of programmers who progressively introduce new features and improvements. On September 17, 1991, the inaugural edition of the Linux kernel was made available to the public. It was designed for the PC computer architecture, specifically using the IA-32 microprocessor. This kernel was complemented by a set of system tools, often referred to as the 'Development Kit,' and libraries sourced from the GNU project. These elements combine to form a functional operating system. Consequently, the entire system is commonly known as GNU/Linux [9].

6. ARCHITECTURE OF THE LINUX OPERATING SYSTEM

The Linux operating system is built in a modular fashion, which allows for flexibility and customization to meet various user needs. The Linux kernel, modules, drivers, and user interfaces collaborate to provide system functionality and performance.

- The Linux kernel serves as the core of the operating system, managing hardware resources and providing a programmatic interface for applications. It is responsible for fundamental functions such as memory management, process scheduling, handling input/output, and devices [3].
- Modules are flexible pieces of software that can be added or removed while the system is running. They allow for customizing the kernel to specific needs or to support particular devices [11].
- Drivers are modules that facilitate communication between the kernel and hardware devices. They provide support for various types of devices such as graphics cards, sound cards, network cards, and more. Drivers are essential for the proper operation of hardware in the Linux system.
- Linux offers various user interfaces, such as the command-line interface (CLI) and graphical environments (e.g., GNOME, KDE).

7. LINUX USER INTERFACE

The user interface of the Linux system (Fig 7.1) can take various forms, such as the command-line interface (CLI) and graphical environments. The command-line interface allows users to input text-based commands into the system. At the same time, graphical environments provide a visual interface that enables more intuitive interaction with the system using a mouse and keyboard. Linux users have the freedom to choose their preferred method of interaction, customizing it to suit their needs and skills.

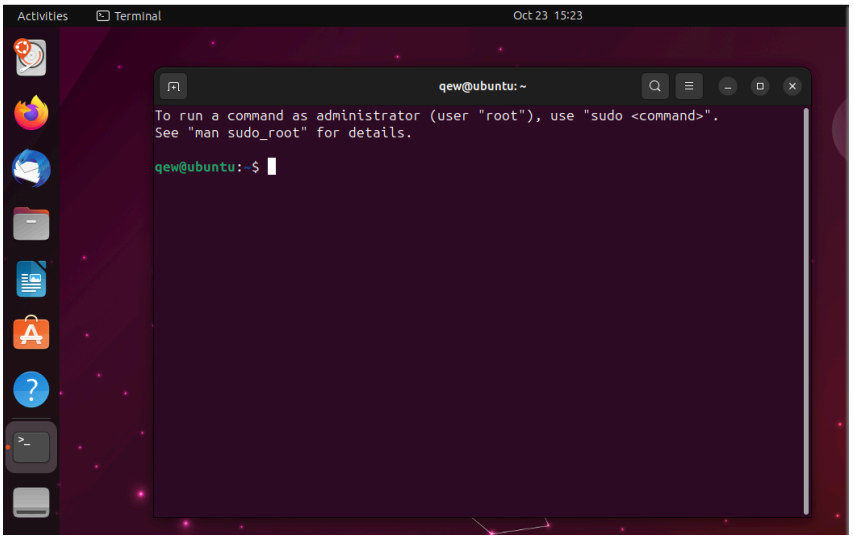

Fig. 7.1:. Ubuntu Lunar Lobster Desktop.

8. POPULAR VERSIONS OF LINUX OPERATING SYSTEM

The Linux system offers extraordinary possibilities of different distributions that can be customized to meet diverse user needs. Distributions such as Ubuntu, Debian, Fedora, Linux Mint, CentOS, and Arch Linux offer various features, from simplicity and stability to advanced tools and control. With each distribution, users can select the system that best suits their requirements, preferences, and skills. This diversity makes the Linux system a flexible solution for a wide range of users, from beginners to advanced professionals.

1. Ubuntu is one of the most popular Linux distributions known for its simplicity and user-friendly interface. It offers stability, long-term support (LTS), and a rich software ecosystem, making it an ideal choice for both beginners and professionals [12].

2. Debian is an independent and stable distribution that focuses on free software and security. Its package system is extensive, allowing users access to a wide range of applications and tools. It is particularly popular in server environments [13].

3. Fedora is a community-driven distribution aimed at providing the latest versions of software and technologies [14]. It is often chosen by advanced users and developers who want to stay up-to-date with the latest features and tools.

4. CentOS is based on the Red Hat Enterprise Linux (RHEL) source code and focuses on stability and reliability [15]. It is often used as a server platform, providing long-term support and security.

5. Linux Mint is based on Ubuntu and aims to provide an easy-to-use and user-friendly operating system. It offers various graphical environment variants, such as Cinnamon, MATE, and Xfce, to cater to different user preferences [16].

9. RESEARCH TOOLS AND METHODOLOGY

To compare performance between the systems, open-source benchmarking software Phoronix Test Suite (Fig. 9.1) will be used. This software is designed for performance comparisons of systems. It can be utilized on various platforms, including Windows and Linux, enabling performance testing on both selected systems. The software can be operated in both console mode and graphical user interface (GUI), although a console-based approach will be employed in this work. To test the system, you can run individual tests or select a sequence of tests to be executed one after the other. After each test, an interactive report is generated, which can be opened in any web browser window and saved in a variety of formats.

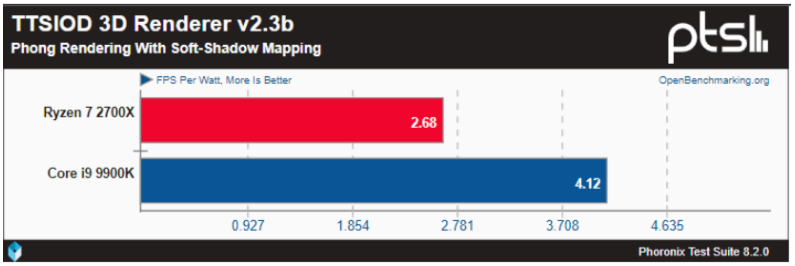

Fig. 9.1:. Phoronix Test Suite CPU Benchmark. Source: https://openbenchmarking.org/embed.php?i=1810177-SK-COREI999024&sha=c740944&p=2

The research methodology encompasses the following steps:

1. **Virtual Machine Configuration**: Initially, a virtual machine will be created to simulate the operating environment of the systems. The selection of appropriate virtualization software, such as VirtualBox, will allow the simultaneous execution of both the Windows and Linux operating systems on the same virtual machine.

2. **Operating System Installation**: Subsequently, the chosen versions of the Windows and Linux operating systems will be installed on the virtual machine. For the Windows system, Windows 11 (Version 22H2) will be installed, and for Linux, Ubuntu 23.04 Lunar Lobster will be installed.

3. **Test Environment Configuration**: After the installation of the operating systems, basic system configuration will be performed, and the previously mentioned testing software will be installed. The tests will be conducted on "clean" systems without further configurations or the installation of specific drivers.

10. TEST SELECTION

To measure the performance of the selected systems, the most popular test from the set of OSBench comparative micro tests, called "Create files," was chosen (Fig. 10.1).

The Create Files test aims to assess the operating system's performance when creating files. During this test, random files of a specified size and quantity are generated, and the time required to complete these tasks is measured and reported as the test result. Specifically, 65 534 files are created, each containing 32 bytes of data, and then deleted. To measure the file system's performance rather than the storage media performance, the test utilizes a virtual file system in RAM.

Conducting tests on both systems, performing measurements, and gathering results will allow for a comparison of the performance of the Windows and Linux operating systems. This will be crucial for understanding which of these systems will perform better in different scenarios and applications.

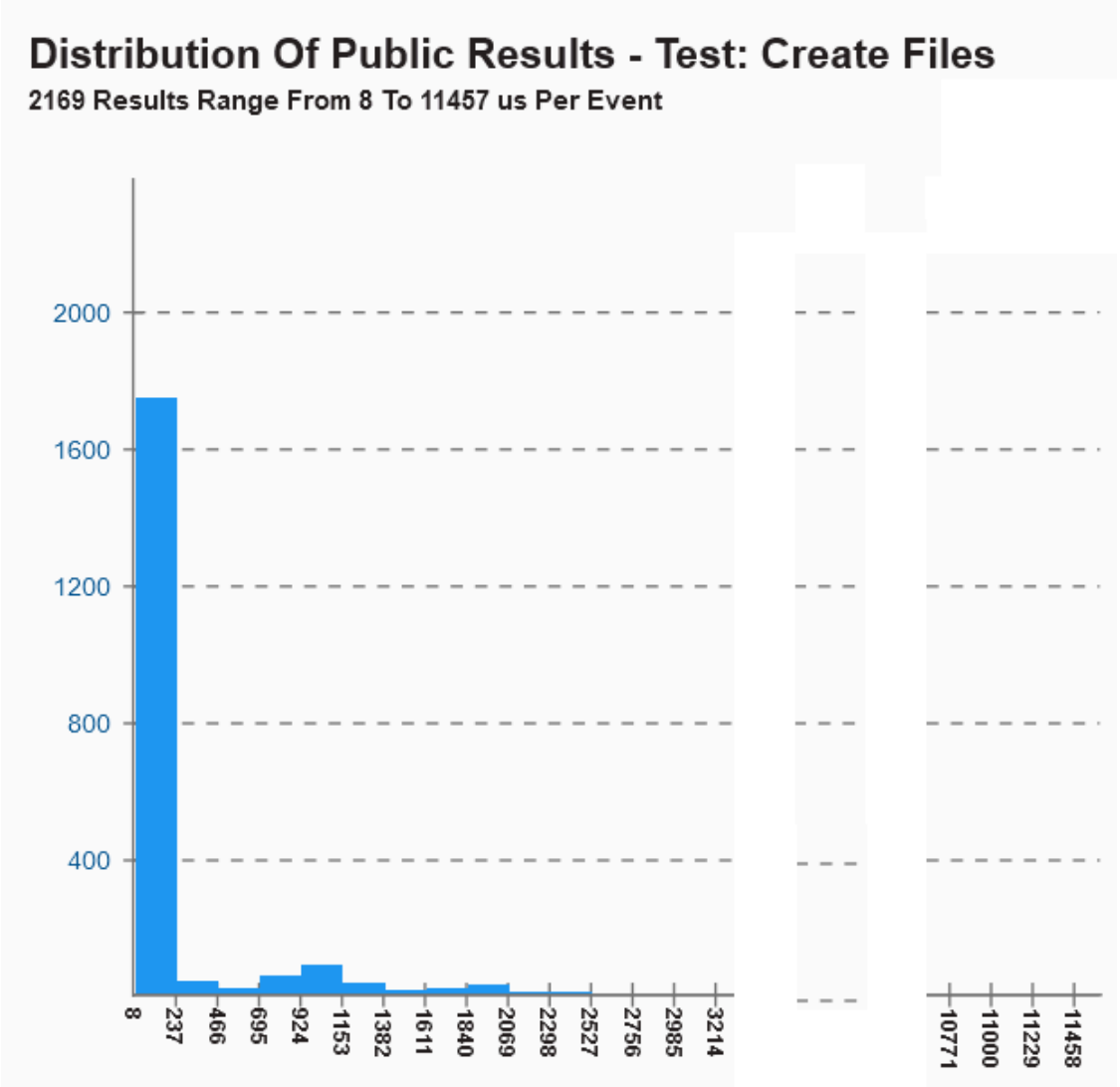

Fig. 10.1:. Distribution of various Create Files test results (example). Source: https://openbenchmarking.org/test/pts/osbench

11. TEST RESULTS FOR WINDOWS OPERATING SYSTEM

The result for the Windows 11 22H2 system (Fig. 11.1, Fig. 11.2) indicates that, on average, the system required 1204.28 microseconds for one event. This result is relatively good, considering the histogram above, which shows a range of values from 8 to 11457 (Fig. 11.3).

Microsoft Windows 11 Home Build 22621

Processor: Intel Core i5-6500 @ 3.19GHz (4 Cores), Motherboard: Oracle VirtualBox, Memory: 4178MB, Disk: 60GB VBOX HDD, Graphics: Podstawowa karta graficzna Microsoft, Audio: Urzdzenie zgodne ze standardem HD Audio

OS: Microsoft Windows 11 Home Build 22621, Kernel: 10.0.22621.1702 (x86_64), Display Driver: 10.0.22621.1, File-System: NTFS, Screen Resolution: 1024x768, System Layer: VirtualBox

Fig. 11.1:. Parameters of the tested Windows system.

```
        3 Seconds Estimated Install Time

    pts/osbench-1.0.2:
        Test Installation 1 of 1
        1 File Needed [0.03 MB]
        Downloading: osbench-win64-20170529.zip                                    [0.03MB]
        Downloading .....................................................................................
        Approximate Install Size: 1 MB
        Estimated Install Time: 3 Seconds
        Installing Test @ 14:36:52

    Would you like to save these test results (Y/n): Y
    Enter a name for the result file: osbenchmarktest

OSBench:
    pts/osbench-1.0.2 [Test: Create Files]
    Test 1 of 1
    Estimated Trial Run Count:    3
    Estimated Time To Completion: 1 Minute [14:37 CEST]
        Started Run 1 @ 14:37:16
        Started Run 2 @ 14:38:40
        Started Run 3 @ 14:40:03

    Test: Create Files:
        1216.912117
        1203.611719
        1192.30582

    Average: 1204.276552 us Per Event
    Deviation: 1.02%

    Do you want to view the results in your web browser (Y/n): Y
```

Fig. 11.2:. Test output. Source: own.

Fig. 11.3:. Results of Create Files test. Source: Author's own work.

12. TEST RESULTS FOR LINUX OPERATING SYSTEM

The result Fig. (12.3) for the Linux Ubuntu 23.04 Lunar Lobster system (Fig. 12.1, Fig. 12.2) indicates that, on average, the system required 16.03 microseconds for a single event. This result is over 75 times better than the result of the previously tested system. Considering publicly available results, this outcome is one of the best.

Ubuntu 23.04

Processor: Intel Core i7-10870H (4 Cores), Motherboard: Oracle VirtualBox v1.2, Chipset: Intel 440FX 82441FX PMC, Memory: 4096MB, Disk: 64GB VBOX HDD, Graphics: VMware SVGA II, Audio: Intel 82801AA AC 97 Audio, Network: Intel 82540EM

OS: Ubuntu 23.04, Kernel: 6.2.0-20-generic (x86_64), Desktop: GNOME Shell 44.0, Display Server: X Server 1.21.1.7, Compiler: GCC 12.2.0, File-System: overlayfs, Screen Resolution: 1280x800, System Layer: Oracle VMware

Fig. 12.1:. Parameters of the tested Linux system. Source: Author's own work.

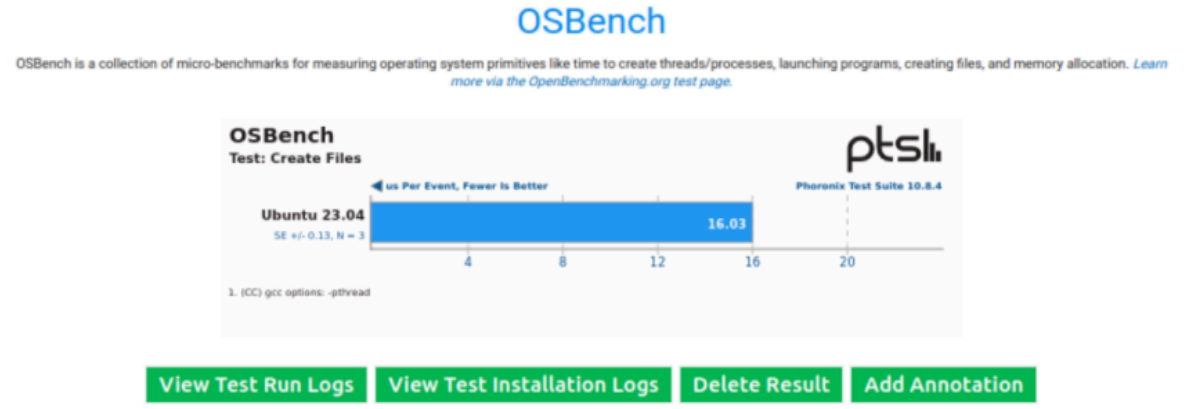

Fig. 12.1:. Creating files test results.

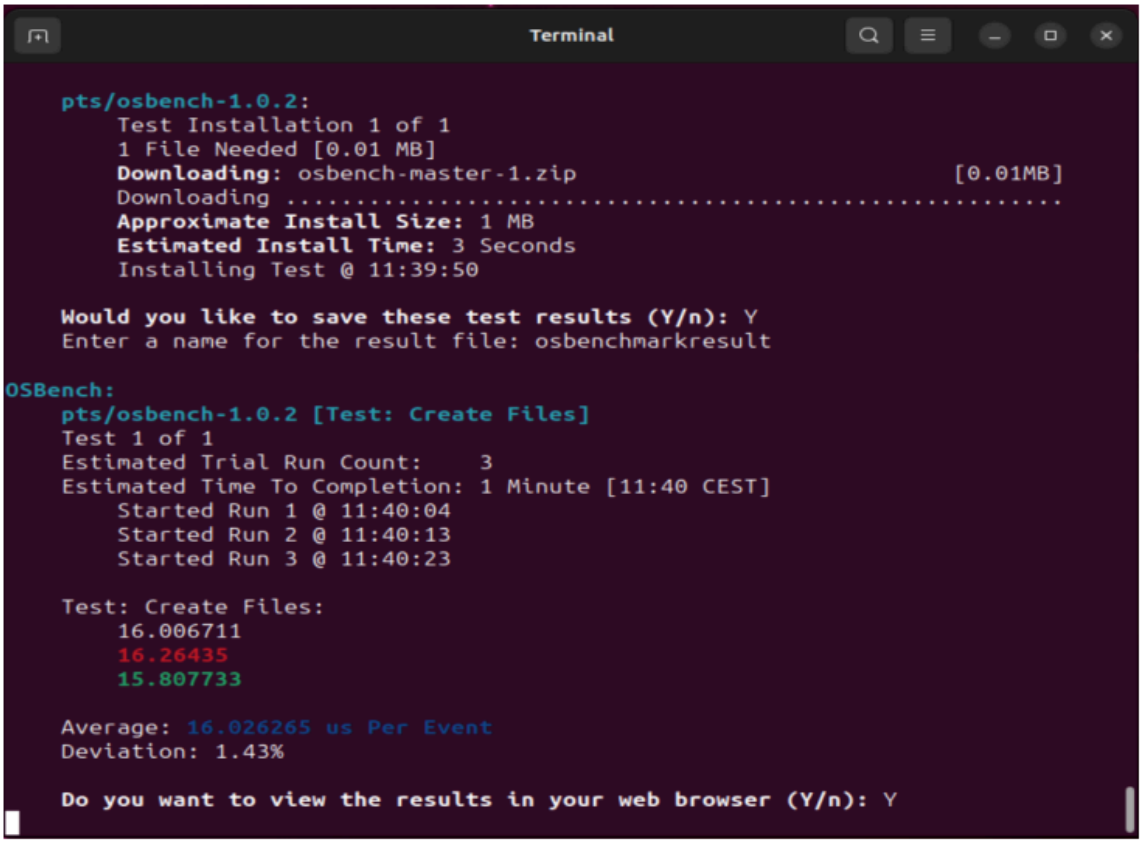

Fig. 12.2:. Test output.

13. CONCLUSION

For the conducted test, the systems achieved the following average results:

- Windows 11 22H2: 1204.28 microseconds (µs)
- Linux Ubuntu 23.4 Lunar Lobster: 16.03 microseconds (µs)

Based on the above results, it can be observed that Linux achieved significantly better performance than Windows. This is evident as the result value for Linux is over 75 times smaller than that of Windows.

The differences between these test systems may stem from the distinct architectures of both operating systems. Open-source Linux offers greater flexibility and integrity, which can impact its performance in various testing areas. Windows, being a closed-source operating system, has its own mechanisms and limitations. Both systems also use different file systems, which can significantly influence input/output performance and file management.

In conclusion, Linux may be more advantageous in scenarios where the creation of many files in a short period is required. Performance test results based on the "Create Files" test may not reflect the overall performance of the operating systems in other applications. To gain a more comprehensive understanding of the performance of both operating systems, further research and testing in various scenarios are necessary.

Author Contributions

All authors declare equal contribution to this research paper.

Conflicts of Interest

☑ *The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.*

☐ *The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:*

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