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Research Article

Deployment and Evaluation of ChromeOS

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ABSTRACT

This paper aims to deploy the Google ChromeFlex Operating System and evaluate its efficiency. It uses a deep learning algorithm that analyzes all results from other users with the same browser type and on the same OS. This provides a meaningful evaluation of the computer unit's stressed components, including CPU, GPU, Memory, and Storage. Findings reveal that ChromeFlex OS works efficiently when the computer is connected online. Furthermore, GPU performance in ChromeFlex OS is lower in applications requiring graphics-related work like effects and videos. Using ChromeFlex OS on computer units used for daily tasks using Internet-based applications is recommended. ChromeFlex OS is a new operating system with limited compatibility, and most productivity tools compatible with old operating systems, such as Windows OS, MAC OS, and LINUX, among others, will not run in ChromeFlex OS.

Keywords: *ChromeFlex OS, GPU performance, Operating Systems, BenchMark, Memory Rating*

Introduction

An operating system (OS) serves as a crucial interface between computer hardware and software, managing resources and facilitating program execution (Brauns et al., 2021; Cohen et al., 2020; Dong et al., 2022; Hahm et al., 2016; Joseph et al., 2019). There is no dispute that the operating system is one of the most important components of a computer system, whether it is for personal use or heavy-duty business (or industrial) use. Different operating systems will work in other ways, and they may appear visually different, have different terms for standard functions, and organize programs in various ways. Many operating systems are available on the market today, including Microsoft OS, Mac OS, UNIX, and Linux. Although one OS has its own advantages and disadvantages, the study of (Ghate, 2017) found that Windows OS is dominant over Linux and Mac OS because Windows OS has the largest number of people using it. Over the years, Windows OS is the dominant desktop operating system (OS) worldwide as of June 2022, with a share of just over 76 percent (Statista Research Department, 2022). Based on the study of Odun-Ayo

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et al. (2021), Windows has more graphical user interface, hardware capability, portability, and process management capabilities. Because of the familiar interface of Windows OS, many schools and universities use it in their offices and classrooms. Windows OS leads the way in the realm of user-friendliness and would be most appropriate for a server that is easy to manage and will not perform critical functions (Bahadur, 2016). Microsoft developed and distributed Windows OS, which is available for a certain amount of money. Because of the cost of Windows OS, many organizations are looking for an alternative with no cost or free and open-source software, like the Linux operating system. This operating system is also available in PRO versions, which are usually cheap. It is also virus-free, possibly malware-free, costs no money, and makes more efficient use of resources like CPU and Memory Golam & Ar, 2019). At present, there are many free and open-source operating systems with different promises of saving organizational resources. In the mid-year of 2022, Google recently released Chrome OS Flex, a lightweight OS designed for businesses and schools to install and run on old PCs and Macs. ChromeOS Flex is designed primarily for businesses running old Windows PCs. A lightweight operating system (OS) is characterized by its minimalistic design, optimized resource usage, and efficient performance tailored for specific applications or devices with limited hardware capabilities (Ferreira and Bridges, 2008). These OSs often employ event-driven and cooperative scheduling approaches, supporting lightweight pseudo-threading to manage system resources (Joseph et al., 2019) efficiently. Compared to traditional operating systems, lightweight OSs offer several advantages. They are designed to be compact, consuming less memory and processing power, which is particularly beneficial for resource-constrained devices like IoT sensors or embedded systems (Balsamo et al., 2019). They are also known for their high reliability and real-time capabilities, making them suitable for applications requiring precise timing and control, such as machinery control systems (Komori et al., 2024). Moreover, the minimalistic design of lightweight OSs may lead to limited security features and vulnerability to cyber threats, posing risks, especially in environments where data protection is critical (Jun et al., 2020). The researchers considered these features to update the existing computers in the university library section by deploying and evaluating ChromeOS Flex.

Objectives of the Study

This paper aims to deploy ChromeOS Flex in the computer units of the Internet Room in the University Library Section and evaluate the performance of the computer units after the deployment.

Methodology

The research is conducted in two phases, namely (1) deployment of the ChromeOS Flex and (2) evaluation of the OS. ICT and the Library Section were involved in both phases. There are 6 stages in Phase 1, including requirements gathering, inventory of the resources, preparation of the materials, installation, test, and turnover. After completing the first phase, the researchers conducted the performance evaluation using the Online Benchmark.

A. Deployment. To successfully roll out the update on the library section's computers, the deployment involves interrelated processes. The figure below illustrates the processes involved in the deployment.

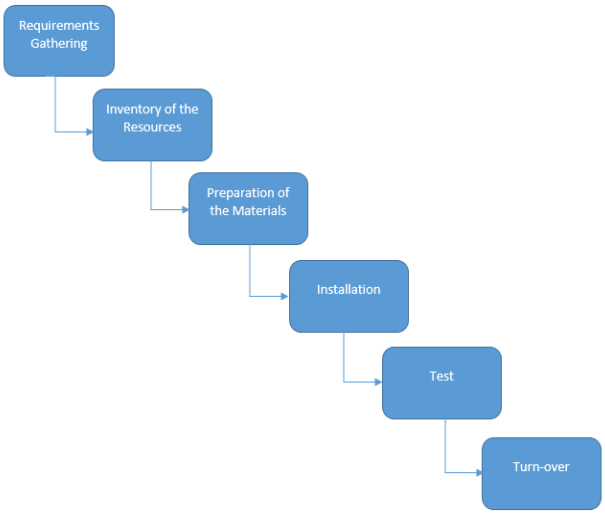

Figure 1. Deployment Stages

Requirements Gathering. The first stage of the research process involves requirement

gathering. Researchers initially reviewed ChromeOS Flex and its capabilities, features, and requirements. Since the ChromeOS Flex was released in 2022, studies or research have yet to be conducted about this OS. Therefore, user and expert reviews from technology websites were considered in this stage. The review of Raphael and Raphael, 2022) highlighted ChromeOs Flex as a way to convert any old Windows or Mac system into a fully functioning Chrome OS device that is always as secure as possible. While Cunningham (2022) reviewed the limitations of ChromeOS Flex in terms of hardware, Google has a list of PC features that Flex does not support and hardware functionality that it does not guarantee. This includes biometric login devices like fingerprint scanners and IR cameras, SD card readers, display outputs, optical drives, FireWire and Thunderbolt ports (though Thunderbolt 3 and 4 ports should work fine in USB-C mode), and stylus and pen input. External Wi-Fi dongles "often work," but Google isn't testing them specifically.

Considering the pros and cons of ChromeOS Flex, the researchers identified the need to update the computer units in the Library Section at this stage. The identified units are primarily used by students to conduct Internet research or for Internet applications only.

Inventory of the Resources. During this phase, the researchers conducted an inventory of computers in the library section. Based on the requirements gathering criteria, these are computer units located in the library Internet Room with 20 units, which were acquired in December 2014. Specifications of the units were also identified as:

Model:	HP PRO Desk 400 G2
CPU options:	Intel Gen4 i3/i5/i7; Celeron; Pentium;
RAM:	DIMM DDR3-1600
USB ports:	(2x)USB-A 3.0; (4x)USB-A 2.0

The researchers then compared the resources to the specified requirements of installing Chrome Flex OS. The specifications are one of the Certified models in the Chrome Flex Help Center. Minimum device requirements were also considered, as suggested in the help center:

Architecture: Intel or AMD x86-64-bit compatible device

RAM: 4 GB

Internal storage: 16 GB

Bootable from USB drive

BIOS: Full administrator access

Processor and graphics: Components made before 2010 might result in a poor experience.

Once the requirements were verified, the following research stage was conducted.

Preparation of the Materials. In this stage, the researchers followed the instructions from the Chrome Flex Help Center for preparing the installation materials. The following materials were prepared:

Device to create the USB installer

ChromeOS, Windows, or Mac device with the current version of Chrome browser.

The device you use to create your USB installer can differ from the device you plan to install ChromeOS Flex on.

USB drive

8 GB or more.

Installation. The researchers followed the following guide for the smooth installation of the OS.

Creating the USB installer with the ChromeOS Flex image.

Booting device using the USB installer.

Install ChromeOS Flex on the device.

Set up and enroll ChromeOS Flex devices.

Only one unit was initially installed to verify the compatibility and efficiency of the ChromeOS Flex. There were no observed problems during the installation, and multiple attempts were made to reboot and restart the unit. Since there were no observed issues in the first installed unit, the researchers installed ChromeOS Flex on the remaining 19 units in the Internet Room of the Library Section. Individual installation was conducted to record any issues encountered for each unit. Each unit's

Recorded installation time has an average installation time of 12.94 minutes.

Test. Testing was conducted upon the installation of ChromeOS Flex in all 20 units in the Internet Room of the Library Section. To verify that the installation was successful, test the unit covers from the bootup, connect to the Internet, sign a Google account, open the Google browser, log out, and shut down the unit. No errors or problems were observed when testing the installed ChromeOS Flex in the computer units. All 20 units successfully booted up, connected to the Internet, signed in Google Account, opened a Google Browser, logged out, and shut down.

Turn-over. The final stage of the deployment is turning over the units to the Library Section staff. Researchers conducted a brief orientation on how to operate the newly installed OS. Frequently Asked Questions found in the Chrome Flex Help Center were shared with the library staff for future reference. A logbook was also provided to list problems encountered while using the OS.

Evaluation. After successfully installing ChromeOS Flex in the Internet Room of the Library Section, a comprehensive performance evaluation was conducted using Online BenchMark. Online BenchMark is a robust tool that performs a series of tests to assess the performance of computers, employing sophisticated algorithms to provide accurate and meaningful performance metrics. Methodology of Online BenchMark includes (a) Multiple Test Suite: Online BenchMark runs various tests designed to stress different components of the computer system, including the CPU, GPU, Memory, and Storage. These tests simulate real-world usage scenarios to thoroughly evaluate each component's performance under load (b) Deep Learning Analysis: The results from these tests are analyzed using deep learning algorithms. These algorithms compare the current results with a vast database of previous results from other users. This comparative analysis allows the generation of a meaningful performance rating, offering insights into how the evaluated system stacks up against similar systems and (c) Browser and OS Specific Comparison: To ensure the accuracy and relevance of the performance evaluation, the scores generated by Online BenchMark are only compared with other results obtained using the same type of browser and operating system. This ensures that the evaluation is meaningful and reflects the actual performance of the stressed components in a similar environment. The components evaluated are (a) CPU (Central Processing Unit): The CPU is tested for its ability to handle multiple tasks simultaneously, processing speed, and efficiency under heavy computational loads. These tests provide a clear picture of the CPU's performance capabilities and limitations (b) GPU (Graphics Processing Unit): The GPU evaluation focuses on rendering capabilities, graphics performance, and the ability to handle high-definition visuals and complex graphics tasks. This is particularly important for video playback, graphic design, and gaming tasks. (c) Memory (RAM): Memory tests assess the system's RAM speed, efficiency, and capacity. This includes evaluating how quickly data can be accessed and processed, directly impacting the computer's responsiveness and multitasking capabilities. (d) Storage: Storage performance is assessed based on read/write speeds, access times, and overall storage capacity. These tests help determine the efficiency of data retrieval and storage operations, which are critical for system boot times, application loading, and file management.

All of the units are performing well with 86%, which means that out of 100 PCs with the same operating system and browser, 14 performed better. The overall PC rating is the average CPU, GPU, Memory, and Storage rating. Higher-performance rating scores higher; the table shows all units scored 99% CPU rating, 95% Memory Rating, and 97% storage rating, which indicates the units' performance using ChromeFlex OS. Meanwhile, in terms of GPU performance, all the units performed 53%, indicating that the units using ChromeFlex OS have lower GPU performance. This means that units may slow down or crash when the units use integrated graphics, effects, or videos. The device's graphics processing unit (GPU) helps handle graphics-related work like graphics, effects, and videos.

Conclusions

This paper successfully deployed ChromeOS Flex in the computer units of the Internet Room in the University Library Section and evaluated the performance of the computer units. By following the stages in the deployment, researchers identified the following:

ChromeFlex OS requires minimum hardware components. One will only need 4 GB of RAM, 16GB internal storage, and processor and graphics. This study proved ChromeFlex OS can revive slow or old computers. All the units were acquired 8 years prior to the study, and on average, desktop computers will live at peak performance for 3-5 years, but all the units performed well after the installation of ChromeFlex OS.

Installation time may vary, but the average installation time is 12.94 minutes. Successful installation was verified by testing each unit from the bootup, connecting to the Internet, signing a Google account, opening a Google browser, logging out, and shutting down the unit. Problems were observed and recorded by the researchers.

All of the units performed well, with an average of 86% using Online Benchmark. The computer units performed well overall with ChromeFlex OS but had lower GPU performance.

Recommendations

Based on the study's conclusion, the following recommendations are hereby forwarded.

Although ChromeFlex OS requires minimum hardware components, components made before 2010 might result in a poor experience. Therefore, it is still recommended that ChromeFlex OS be installed in devices made in 2010 and beyond to avoid system crashing.

Depending on the speed of the computer units, Installing ChromeFlex may take longer than 12.94 minutes. To ensure a successful installation, it is recommended that each unit be verified from the bootup, connected to the Internet, signed into a Google account, opened a Google browser, logged out, and shut down.

ChromeFlex OS is recommended for computer units using Internet-based applications for daily tasks. However, ChromeFlex OS is a new operating system with limited compatibility, and most productivity tools compatible with old operating systems, such as Windows OS, MAC OS, and LINUX, will not run in ChromeFlex OS. Therefore, ChromeFlex OS works efficiently when the computer is connected online. Furthermore, GPU performance in ChromeFlex OS is lower in applications requiring graphics-related work like effects and videos.

Since ChromeFlex OS was introduced recently, there are limited offline and online benchmark applications available. This limits the researchers' ability to compare results based on other benchmark platforms. It is recommended that benchmark results from various platforms be compared to concretize the performance evaluation of ChromeFlex OS.

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