Chrome OS

ITP51

Operating System

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

The Google Chrome OS is an operating system that is developed and designed by Google, it is a Linux kernel-based operating system. It is a simple, fast and secure operating system that runs on Chromebooks. Chromebook is a portable computer running ChromeOS. Netbooks are the primary aim of Google Chrome OS, an operating system that is Linux-based and lightweight and open source. Google announced that the operating system will be an open-source project and will be called Chromium OS, on July 7th,2009. The Google Chrome OS then plans to release its code as open source later this year, and in the second half of 2010, consumers will be able to purchase netbooks running Google Chrome OS. The versions of ChromiumOS and ChromeOS allows web browser extensions that may imitate native programs and progressive web apps like Google Docs and Microsoft Office 365. From 2016 onward, Android apps from Google Play can also be run on ChromeOS but not ChromiumOS. As of 2018, Linux apps running in a thin virtual machine running a Debian environment are supported by ChromiumOS/ChromeOS version 69 and onwards.

History

In the year 2009, Matthew Papakipos, the engineering director for the ChromeOS, announced that ChromeOS would only support solid state storage. In the same year, Google made source code for ChromeOS as the ChromiumOS project. November 19,2009 at the news conference, the Google's vice president overseeing Chrome, Sudar Pichai, demonstrated an early version of operating system. He gave a glimpse of a desktop that resembles the Chrome browser on a desktop computer, it also had application tabs that takes less space and can be pinned to access easily. During the conference, the operating system booted up in just 7 seconds.

As part of test program, Google released the unbranded Cr-48 Chromebook in 2010. The retail hardware featuring the ChromeOS was supposed to arrive in the late 2010, but was delayed until the next year.

In May 2011, Google revealed two Chromebooks from Samsung and Acer during the Google I/O. Samsung model was the 1st to be released on June 15, 2011, followed by the Acer model in the mid-July. Netflix announces official support for the ChromeOS, allowing the Chromebooks to watch movies and tv shows through Netflix, because at that time some devices needs to use Microsoft Silverlight to watch videos from Netflix. Citrix released a client application for ChromeOS that will allow Chromebook to access Windows application and desktop remotely.

By 2012, Google announces a new range of devices, designed and manufactured by Samsung. In this year, the first Chromebox, which was ChromeOS way of entrance into the world of desktop computers. After couple of months, Samsung and Google released a new Chromebook with a lower price. This Chromebook has ARM processor, one from Samsung's Exynos line. Acer, then followed quickly with C7 Chromebook, with even lower price than Samsung's. In April 2012, the first update to ChromeOS's user's interface since it had launched. Introduces also a hardware-accelerated window manager with a

conventional taskbar called “Aura”. Later on, Lenovo and HP followed Samsun and Acer manufacturing Chromebooks in the early 2013. The Lenovo models specifically targeted their Chromebook for students.

On July 2012, google drive was released, in ChromeOS version 20, they included the Drive. Previously ChromeOS had supported Flash since 2010, by the end of 2012 to prevent issues with Flash from affecting other parts of ChromeOS, it had been fully sandboxed.

In 2013, ChromeOS devices being designed, manufactured, and marketed by third party manufacturers, but Google is the one who’s controlling the software. In February 2013, everything changed, Google released its very own Chromebook Pixel. The Chromebook Pixel was entirely Google branded and contained an intel i5 processor, a high-resolution touchscreen display.

At the end of the year 2013, there had been multiple articles predicting the demise of the ChromeOS ever since 2009. The sales of Chrome OS continued to increase over time. Later, Intel announced the Intel-based Chromebooks, Chromeboxes, and an all-in-one from LG which will be called the Chromebase. In the year 2020, ChromeOS devices outsold the Apple Macs worldwide.

Versions

Some of the versions of Chrome OS

Figure 1.1 Version 19

Version 19- Stable Channel for Chrome OS updates are; redesigned UI ever since the release and updated window manager, a new modes for multiple monitor handling, New open source trackpad stack, also updated scratchpad app, new files types supported, functional and visual refresh of the ChromeOS settings, in this version Japanese fonts were introduced.

Version 33- notable changes in this version are; Folders can be created, renamed, and deleted in google drive offline mode, Contact search now enabled in app launcher. Admins can allow and set avatar for public sessions. Content protected videos in HD supported on ARM devices.

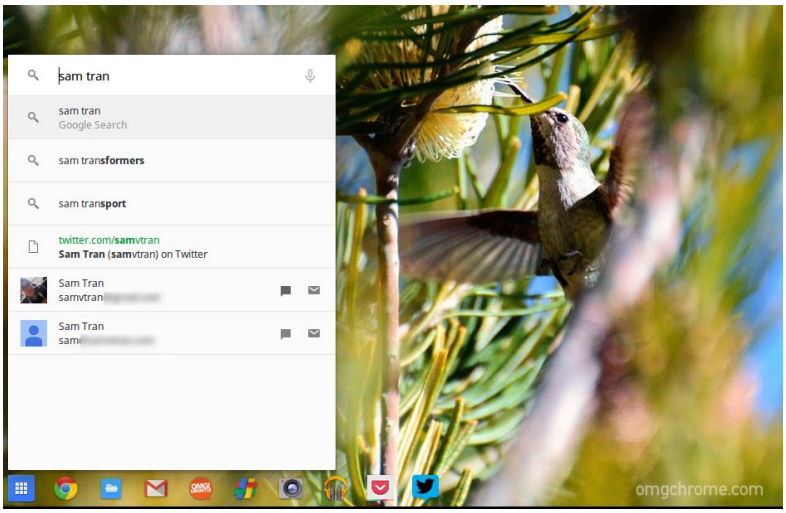

Figure 1.2 Version 33

Version 35- some of the updates are; App list folders, with these folders you can group installed apps however you like from the google folder. They also improved window controls, from the previous versions Google removed the minimize window control, google returned it. This version also includes an enhanced method for "snap" windows to the left and right corners of the screen. You can move the app window to a different size by pressing the maximize button and dragging it in that direction. You can experiment with the "Ok Google" hot word recognition feature in the app launcher and on the Google.com new tab page if you're in the US or if US English is your default language. Not only does Google.com offer site results, but you can also speak the name of installed apps to activate them.

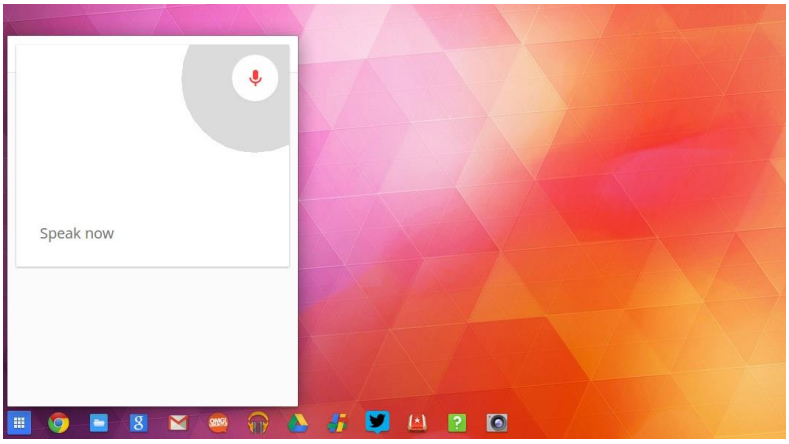

Figure 1.3 Version 35

Chapter 2

PROCESS MANAGEMENT

Figure 2.1 ChromeOS

The ChromeOS is Linux-based and requires hardware that has been specially designed to run it. The Chrome OS's process management function is in charge of monitoring the way in which different processes are carried out to guarantee effective resource use, a responsive user interface, and general system stability. The goal of Chrome OS is to provide a lightweight, web-focused operating system. This is how its process management is broken down:

Linux Kernel Foundation:

The Linux kernel is the foundation of Chrome OS. The kernel is the primary part of the operating system, handling system control, hardware interfacing, and low-level process management.

Boot Process:

When a device running Chrome OS is started, the Linux kernel is loaded, and the boot process initializes necessary hardware components.

Chrome Browser as Central Component:

The core component of Chrome OS is the Chrome browser, every tab, extension, and program in the browser operates as a separate process. Because individual processes do not affect the browser as a whole or other processes when one breaks, process isolation helps maintain system stability.

Sandboxing:

One of Chrome OS's most important security features is sandboxing, which keeps tabs, extensions, and apps apart and keeps them from interfering with one another. Because possible dangers are contained, security is improved.

Task Manager:

A task manager included into Chrome OS lets users keep an eye on and control active tasks. Viewing resource utilization, ending processes, and identifying problems impacting system performance are all possible for users.

Automatic Updates:

Chrome OS is known for its self-updating features. To guarantee that users have access to the newest features, security updates, and enhancements, both the operating system and the Chrome browser are automatically updated in the background.

Security Features:

Strong security measures including sandboxing, automated upgrades, and a verified boot process are all included in Chrome OS. The operating system's general security and dependability are enhanced by these characteristics.

Android App Integration:

Android apps are supported by Chrome OS, and they all operate in their own environments. Because of this integration, Chrome OS can run a wide range of programs while still being stable and secure.

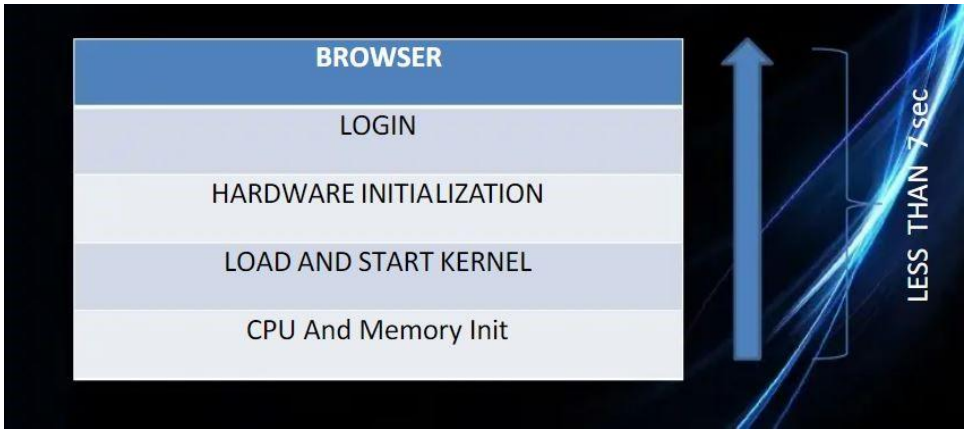

Figure 2.2

According to Sundar Pichai, vice-president of product management for Google's Chrome OS, said that computers running Chrome OS will be able to start in less than seven seconds.

"From the time you press boot you want it to be like a TV: You turn it on and you should be on the Web using your applications," Pichai said.

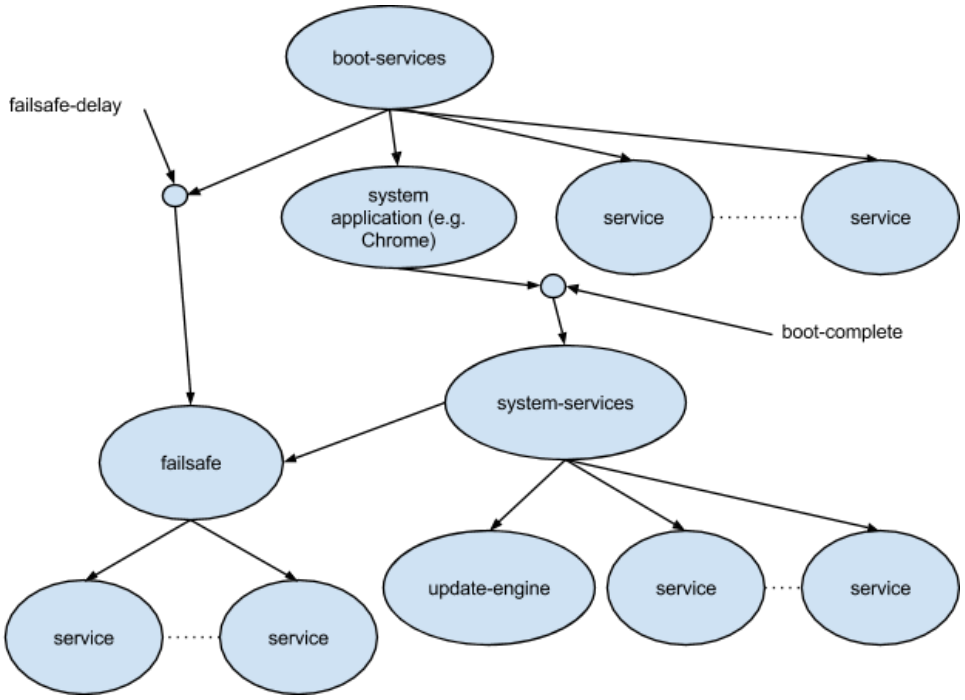

Figure 2.3 boot flow

The figure shows an outline of the Chrome OS Core boot flow. Boot divides into three sequential phases with four publicly defined Upstart events. Basic services are required to the application system and other systems. Usually services do not operate until the basic services run normally. System application startup, the foundation of Chrome OS Core is a single, specialized program that is essential to system initialization. The Chrome browser is the application for Chrome OS. The way that the Chrome OS sources are organized permits a platform to select an alternative system application to utilize. The system application is in charge of sending out the event that initiates the boot-complete task, enabling the launch of system services. System services, everything that was not needed in the previous boot phases is included in this step. In this phase, most tasks are completed simultaneously. This stage does not affect system performance because the system is regarded as having already booted. The system is in a failing condition and many services will serve no use at all without a system application. Even though the system has failed as a whole, some services might need to start at some point. A service may rely on the started

failsafe event to meet this requirement. A 30-second timer is started by the failsafe-delay job after boot-services have been started. When the timer expires or system services are started sooner, the started failsafe event takes place. Failsafe are used to test and develop images, failsafe jobs are frequently used for services that are required to troubleshoot or recover from errors.

Chapter 3

CPU SCHEDULING

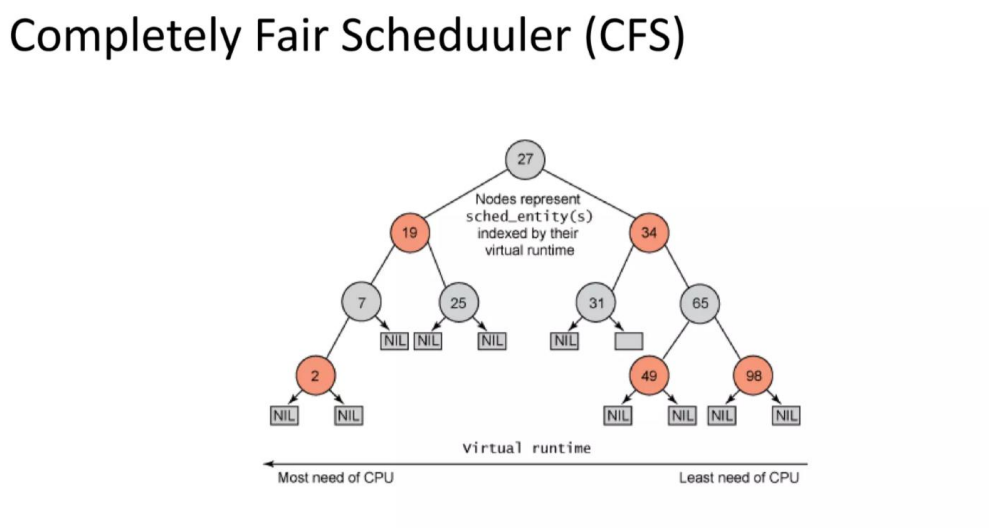

Figure 3.1 CFS

The Completely Fair Scheduler (CFS) distributes CPU time among jobs evenly so that each gets a fair amount, with the goal of achieving proportional justice. The number of jobs that are in the ready condition determines how much CPU time is allotted to them by the Completely Fair Scheduler, not the total number of tasks in the system.

Chromebooks and Chromeboxes, are the only devices with which the Chrome OS is intended to function. Users that spend most of their time online are the target audience for it. That's why the Chrome OS comes pre-installed with just a file manager, media player, and browser.

The Completely Fair Scheduler operates by the Linux 3.4.6 kernel running on the Chrome operating system. This maintains fairness by giving each process an equal portion of the CPU. In order to accomplish this, the scheduler uses a virtual runtime to record how much time each process has spent on the CPU. Group scheduling is also allowed with the Completely Fair Scheduler. Although it may decrease

scheduling efficiency with small time slices, the Completely Fair Scheduler ensures fairness in task execution by balancing CPU consumption among jobs by choosing the work with the smallest turnaround time. Also, assigns time slices to tasks based on priority, with higher priority tasks receiving more CPU time, but lower priority tasks still being able to execute with a smaller slice of CPU time.

Chapter 4

Memory Management

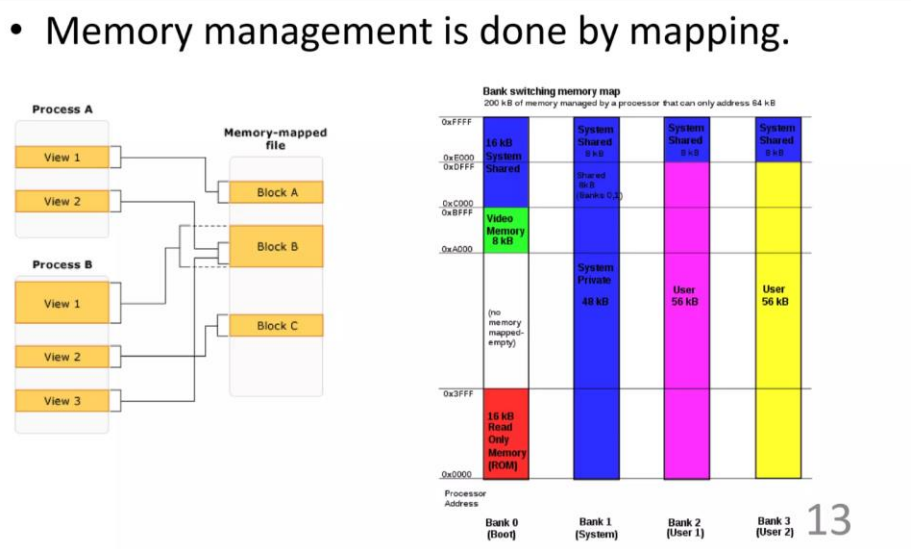

Figure 4.1 Memory management

Memory-mapping is a technique that associates a range of addresses in an application's address space with a specific section or whole file on disk. Then, the application can use disk files in the same manner that it uses dynamic memory. A method like virtual memory or memory-mapped files can be used to accomplish this mapping. The virtual memory is implemented by the Linux kernel, which powers Chrome OS. The OS can give each process the appearance of having its own address space, even if it is bigger than the actual RAM that is available, thanks to virtual memory. This virtual memory is managed in part through memory mapping. The Operating System uses page tables as data structures to control how virtual addresses used by a program are mapped to physical addresses in RAM. Page tables are used by Chrome OS to translate virtual addresses to physical addresses when a process accesses memory.

ZRAM, it is frequently used by Chrome OS to compress data from RAM, making more space available for data. This is especially helpful for devices with less RAM in the physical domain. Google also

uses a special technique to prevent browser tabs and installed programs from failing as a result of low RAM. Tab discarding is a function of the Chrome browser, which is a key component of Chrome OS, that allows it to automatically unload or discard tabs that are not being used. This facilitates memory resource release. Sandboxed Architecture, because of Chrome OS's sandboxed architecture, every tab and numerous apps operate in separate processes. Process isolation improves security and facilitates fine-grained memory management. Garbage collection is used in web applications to locate and retrieve memory that has been consumed by things that are no longer required. This guarantees effective memory use and helps stop memory leaks. Chrome OS is made to function well on a wide range of hardware, even those with comparatively little RAM. Because of this emphasis on optimization, the operating system operates effectively even on Chromebooks, which are more affordable. Android apps can run on Chrome OS, and the Android Runtime (ART) and the underlying Chrome OS infrastructure work together to manage memory for Android apps. To keep one rogue software from taking down the entire system, apps are segregated from one another.

Chapter 5

Storage Management

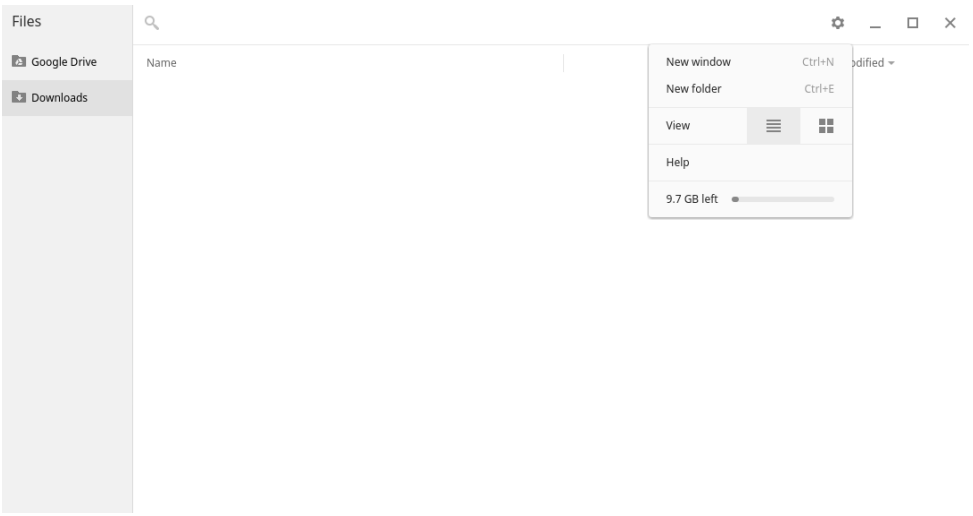

Figure 5.1

Chrome OS is similar to Android. Chrome OS only offers very little file management capabilities, compared to other computer-level operating systems like Windows and OS X, which grant the user complete access to system files.

The user can only access the Google drive and downloads folder, and in these two the downloads folder is the local folder because Google drive relies on the cloud storage, although the google drive also has offline functionality. There are no other ways to create additional folders, to store locally, it should be stored on the downloads folder.

Figure 5.2 cloud storage

With the operating system installed, the 16GB SSD has roughly 9.7GB remaining, thus in the normal setup, there isn't much place for offline storage. Upon installing the 256GB SSD, the available space rises to approximately 204GB.

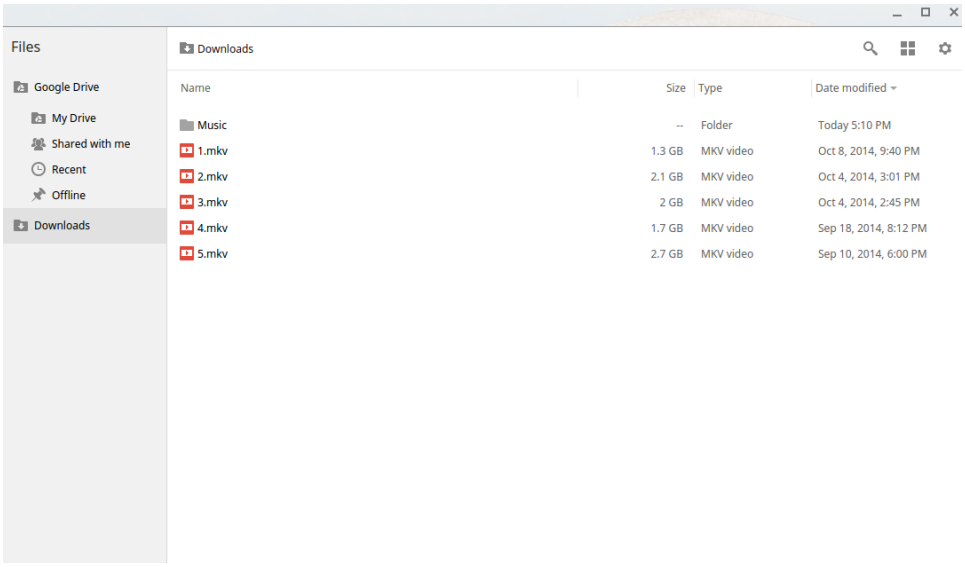

Figure 5.3

It is possible to have to manage your local files to some extent by creating folders inside the Downloads folder. Playback software for music and video is included into Chrome OS. Regarding the file management of Chrome OS, there is not much that can be said. For someone who is used to Windows or OS X, it is quite restrictive and not user-friendly, but if you can get past the obstacles, it can be functional even with a larger internal disk. Since Chrome OS rarely uses storage, upgrading isn't primarily necessary for the performance gains.

Chapter 6

I/O SYSTEMS

A system for processing information called I/O or Input/Output is made to send and receive data from a network, device, or piece of computer hardware. Through a network, data can be sent between devices. Computers could not communicate with other systems or devices without input/output (I/O).

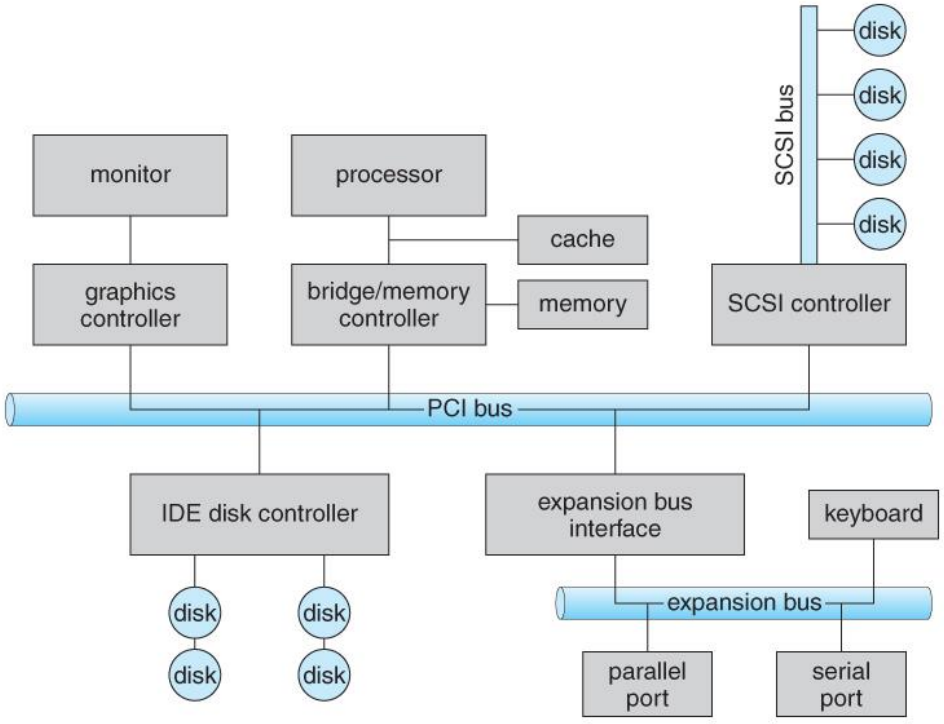

Figure 6.1 PC bus structure

Input systems in ChromeOS, keyboard and Mouse/Touchpad, standard input devices, like keyboards, mouse, and touchpads, are supported by ChromeOS for program interaction and navigation. Touchscreens are a common feature on Chromebooks, enabling touch gestures for system and application interaction. Certain Chromebooks allow stylus or pen input for activities like taking notes, sketching, and using touchscreen apps. Voice recognition is a feature of ChromeOS that lets users carry out operations with voice commands. ChromeOS has Google Assistant built in for voice-activated interactions.

Chromebooks come with built-in cameras, they can be used for photo editing, video conferences, and other camera-related tasks. ChromeOS accepts a wide range of external input devices, such as USB mice, keyboards, and other accessories. Keyboards, mouse, and headphones are among the other Bluetooth devices that work with it.

Output systems, the display is ChromeOS's main output system. The majority of Chromebooks have LED-backlit screens, and some are capable of supporting touchscreens and high resolutions. Built-in speakers or audio connectors can be used to output audio on Chrome OS. Through Bluetooth or the audio jack, users can pair external speakers or headphones. Users can print documents straight from their Chromebooks to suitable cloud-connected printers thanks to ChromeOS's support for cloud printing. With the HDMI or USB-C video output connections found on many Chromebooks, users can connect additional monitors to extend their desktop experience. Google Drive and Chrome OS have a strong connection when it comes to online storage. Users can sync files and documents between devices and access them from any cloud-based storage location.

Chapter 7

FILE SYSTEMS

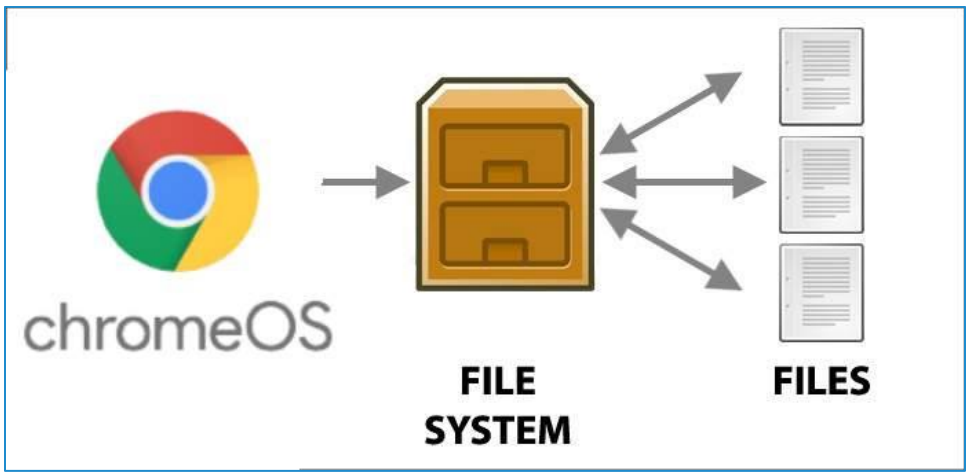

Figure 7.1 File system

The operating system's file system is the component in charge of handling files. It offers a way for data to be stored and applications and data to be accessed within files. Ubuntu is one of the operating systems that handles everything like a file. Multiple types of structure exist in a file. File system is an integral part of the operating system. File system is a data structure that makes information and data easily retrievable from storage devices like hard drives.

Several file systems are supported by Chrome OS for external storage devices. It is capable of reading and writing to cross-platform file systems like exFAT and FAT32 in addition to the Windows NTFS file system. MacOS uses the HFS+ file system, which is readable (but not writeable) by Chrome OS. You can run Linux apps for development alongside your regular ChromeOS desktop and apps with Linux on ChromeOS, often known as Crostini.

ChromeOS uses a unique file system that is designed to align with its cloud-centric approach and lightweight operating system. The "Downloads" folder on the device's local storage is where files that you download from the internet are normally kept. This is a conventional file storage section, similar to those seen in other operating systems. ChromeOS's connection with cloud storage provider Google Drive is one of its primary features. Users are encouraged to store their data in the cloud by using the "Files" app to access files and folders stored on Google Drive. This guarantees the backup of crucial data and enables smooth file access across many devices. The primary tool for managing files and folders on ChromeOS is the "Files" app, which offers an intuitive interface for managing files and folders both locally and on Google Drive. With this software, users can move, rearrange, copy, and delete files. External storage devices like SD cards and USB drives are supported by Chrome OS. Users can view and manage files on external storage devices by connecting them and seeing the device listed in the "Files" app. Applications written for Linux can be executed on Chrome OS through a feature called Crostini. A Linux container with its own file system is generated within Chrome OS when you activate Linux (Beta) in the settings. Through the Linux terminal, users can communicate with the Linux file system.

References

File Systems in Operating System:

- URL: https://e115.engr.ncsu.edu/file-systems/os-file-systems/#:~:text=An%20integral%20part%20of%20an,but%20all%20have%20similar%20features.

OS File System in Operating System:

- URL: https://www.sitesbay.com/os/os-file-system-in-operating-system-os

Formatting and Partitioning for Chrome OS:

- URL: https://www.seagate.com/as/en/manuals/mobile-drive/optional-formatting-and-partitioning/#:~:text=Chrome%20OS%20supports%20a%20number,file%20system%20used%20by%20macOS.

Chrome OS Linux Support:

- URL: https://chromeos.dev/en/linux

I/O (Input/Output) Overview:

- URL: https://www.trentonsystems.com/blog/what-is-i/o#:~:text=I%2FO%20(Input%2FOutput)%20is%20an%20information%20processing,to%20other%20systems%20or%20devices.

Android Input Compatibility in Chrome OS:

- URL: https://chromeos.dev/en/android/input-compatibility

Chromebook Support - Google Help:

- URL: https://support.google.com/chromebook/answer/2766492?hl=en

Chromebook Storage Manager - Google Help:

- URL: https://support.google.com/chromebook/answer/7073299?hl=en

Chromebook Memory (RAM) Information - Google Help:

- URL: https://support.google.com/chromebook/answer/9891704?hl=en

Chromebook Powerwash (Factory Reset) - Google Help:

- URL: https://support.google.com/chromebook/answer/183093?hl=en

Upgrading SSD in a Chromebook:

- URL: https://www.anandtech.com/show/8543/upgrading-the-ssd-in-a-chromebook/3

Chrome OS Storage Manager:

- URL: https://chromeunboxed.com/google-creates-storage-manager-for-chrome-os/#:~:text=You%20can%20access%20the%20manager,button%20in%20the%20devices%20menu.

Chrome OS Overview - SlideShare:

- URL: https://www.slideshare.net/jawadali1297/chrome-os-23188196

Memory Mapping in MATLAB:

- URL: https://www.mathworks.com/help/matlab/import_export/overview-of-memory-mapping.html

Chromebook RAM Requirements:

- URL: https://www.androidpolice.com/chromebook-ram-requirements/#:~:text=Since%20the%20introduction%20of%20ChromeOS,crashing%20due%20to%20insufficient%20RAM.

Tab Discarding in Chrome:

- URL: https://developer.chrome.com/blog/tab-discarding#:~:text=You%20can%20try%20out%20tab,Chrome%20chrome%3A%2F%2Fflags%20page.

Sandboxing in Chrome OS:

- URL: https://promevo.com/knowledge/what-is-sandboxing-in-chrome-os

Completely Fair Scheduler (CFS) Overview:

- URL: https://eightify.app/summary/computer-science/completely-fair-scheduler-cfs-eel770-09

Chrome OS Overview - Bartleby:

- URL: https://www.bartleby.com/essay/Chrome-Os-FKATY5A8J38W

Linux Operating System - TechTarget:

- URL: https://www.techtarget.com/searchdatacenter/definition/Linux-operating-system

ChromeOS - Wikipedia:

- URL: https://en.wikipedia.org/wiki/ChromeOS

Google Chrome Process in Task Manager:

- URL: https://malwaretips.com/blogs/google-chrome-process-why-is-it-running-in-task-manager/

Google Chrome Task Manager - Lifewire:

- URL: https://www.lifewire.com/google-chrome-task-manager-4103619

Google Chrome OS - TechTarget:

- URL: https://www.techtarget.com/whatis/definition/Google-Chrome-OS

Benefits of Chrome OS:

- URL: https://blog.suitebriar.com/7-benefits-of-chrome-os#:~:text=Robust%20Built%2DIn%20Security.,teams%20devote%20to%20security%20measures.

Making Android More Secure with ARCVM:

- URL: https://chromeos.dev/en/posts/making-android-more-secure-with-arcvm

Google Chrome OS Announcement:

- URL: https://www.reuters.com/article/us-google-chrome-idUSTRE5AI4UQ20091120/

Chromium OS Boot Design:

- URL: https://www.chromium.org/chromium-os/chromiumos-design-docs/boot-design/

Introducing Google Chrome OS - Google Blog:

- URL: https://googleblog.blogspot.com/2009/07/introducing-google-chrome-os.html

Google Chrome OS - Google Fandom:

- URL: https://google.fandom.com/wiki/Google_Chrome_OS

Evolution of Chrome OS - Digital Trends:

- URL: https://www.digitaltrends.com/computing/chrome-os-turns-10-here-is-how-it-evolved/#:~:text=On%20June%2015%2C%202011%2C%20the,businesses%2C%20and%20even%20your%20home.

Chromebook vs. Laptop - ZDNet:

- URL: https://www.zdnet.com/article/chromebook-vs-laptop-which-one-best-fits-your-needs/

Chrome OS Stable Channel Update:

- URL: https://www.omgchrome.com/chrome-os-stable-33-released-for-chromebooks/

Chrome OS Stable Channel Update (2012):

- URL: https://chromereleases.googleblog.com/2012/05/stable-channel-update-for-chromebooks.html

Chrome OS 35 Stable Features App Folders:

- URL: https://www.omgchrome.com/chrome-os-35-stable-features-app-folders/