COMPUTER ARCHITECTURE OUTCOMES 3 & 4

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Course : **Computer Architecture Outcome 3 & 4**

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Summary

This report essay is a crucial resource that aims to help students understand the concept of computer architecture. It is designed to complete the assessment outcomes three and four requirements and engage and motivate students in their learning journey.

The Sixth Layer of a Modern Operating System and Popular OS Versions

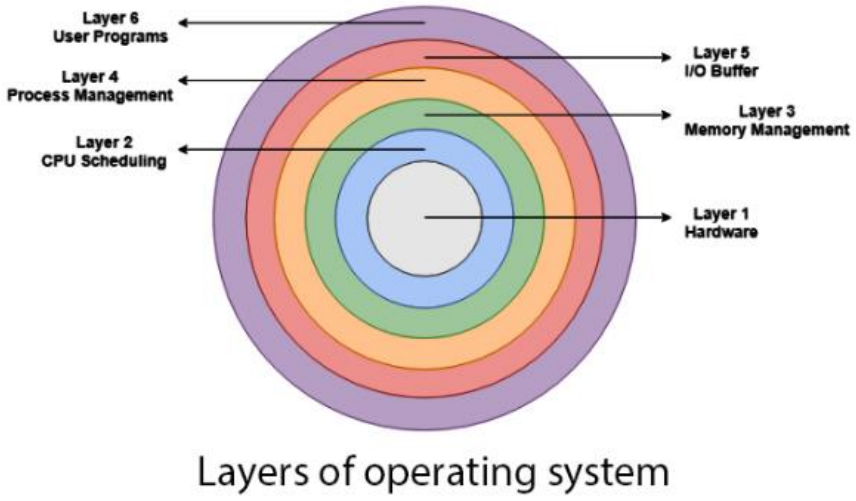


Figure 1: The Six Layers Diagram

An operating system is not just essential software but a powerful manager that efficiently handles the resources of a computing device and connects software to hardware. It controls and monitors all programs, including applications and system software, such as Windows, Linux, macOS, Android, and iOS.

Furthermore, a modern operating system has several layers, with each layer handling specific functions that help the system run efficiently. These layers work together to manage hardware and software resources, ensuring smooth interactions.

Firstly, the Hardware layer, the lowest layer of the operating system, is responsible for managing hardware components. The key to the task hardware layer is to connect them directly to devices like the keyboard,

mouse, hard disk, and CPU. It provides important drivers that help communication between hardware and software. Lastly, it allows the operating system to work with the system's core parts.

The CPU scheduling layer helps manage CPU resources and assigns them to different processes. Its key task is scheduling, which processes run on the CPU, using scheduling methods such as Round Robin and first come, first served. This layer aims for the best CPU usage and allows multiple tasks to run at the same time.

Layer 3 is the memory management layer, which is responsible for managing the allocation and deallocation of memory resources. The key task of the memory management layer is to manage the usage of RAM for active processes. Overseas virtual memory, including swapping and paging, allocates memory dynamically to various methods, prevents memory leaks and ensure efficient utilisation of memory.

The process management layer is responsible for managing and scheduling processes, which is programs that currently run the key task of this layer, for example, decides which process to run next, manages the creation, ending, and coordination of processes lastly, controls the order of execution and manages to wait for queues for processes.

The fifth layer is the I/O Buffer. This layer manages input and output operations, including buffering. Its key task is facilitating communication between the CPU and I/O devices such as the keyboard, mouse, or printer. It uses buffers to temporarily store input and output data and ensure smooth interaction between hardware and software components.

The user program layers are the topmost layers on the operating systems, also known as the Application Layers. This layer provides interfaces and functionalities that allow users to perform various tasks. Applications The layer contains different programs such as word processors like MS Word, Web browsers, and Multimedia players. For instance, when you open a website in Chrome, the user uses the browser to view the page. However, the HTTP protocol does the behind-the-scenes work of talking to the server and getting the webpage.

The Contemporary Operating Systems and Their Supported Versions

The two widely used operating systems, along with the latest supported versions:

- **Windows OS**
  Current versions: Windows 11 (Versions 23H2)
  Supported Devices: Desktops, laptops and tablets.

- **macOS**
  Current versions: macOS Sonoma version 14
  Supported devices: MacBooks and iMacs

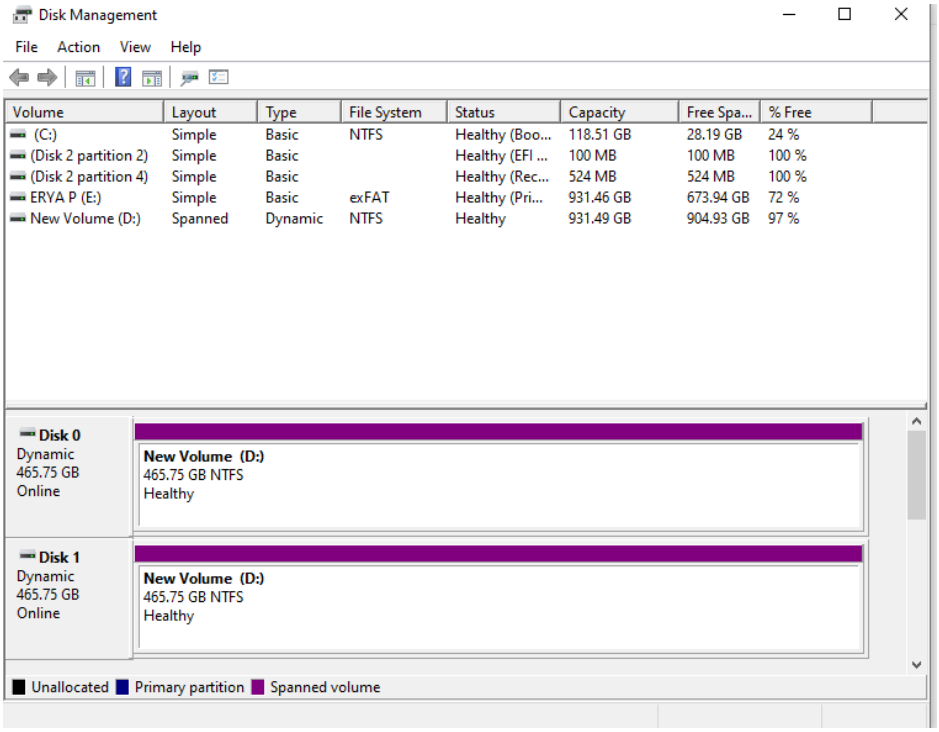
- **Other popular OS options** include Linux, Ubuntu 22.04 LTS, Android 14, and iOS 17.

Understanding the term File Allocations Table (FAT)

The file allocation table, or FAT, is a file system created by Microsoft and designed to manage small disks and straightforward folder hierarchies. It is named file allocation table because it uses a table that monitors the clusters on a storage volume and how these clusters are connected via their corresponding files and directories. Since this table is necessary, people sometimes refer to FAT specifically as the table itself rather than the entire file system. However, it is common to see both meanings used together.

The aim of FAT in Digital Storage is that the FAT system tracks where file pieces are located on storage devices. This helps the operating system find and manage files efficiently.

It also organises data to prevent data loss. The system uses a table to show which file parts are connected and where they are. Lastly, FAT is commonly used in older systems, external storage devices, and embedded systems.



Screenshot 1: Erya's Disk Management Computer

The screenshot from Disk Management shows that the only FAT-based file system present is exFAT, which is utilised by the volume named ERYA P (E:). This volume is 931.46 GB, with 573.94 GB available for use, indicating it is healthy and active as a primary partition. exFAT, also known as the Extended File Allocation Table, is a file system created by Microsoft to improve FAT32. It works well with large storage devices like USB flash drives, external hard drives and SD cards. The benefit of exFAT is that it supports large file sizes, removing the 4GB limit of FAT 32. In addition, exFAT has a lower overhead than NTFS, which can lead to faster performance in some situations. The screenshot shows the storage setup. Drive C: shows the primary systems partition, which has a capacity of 118.51 GB and is formatted with NTFS (New Technology File System). It contains the Windows operating system and currently has 24% of its space free, amounting to 28.19 GB.

In addition, an EFI System Partition is 100 MB in size and formatted as FAT32. This partition is used for boot management and contains no user files. There is also a Recovery Partition that is 524 MB, formatted with NTFS, and stores Windows recovery files for system repair. This partition is not available for general storage.

Lastly, the New Volume D is another spanned volume, combining two dynamic disks (Disk 0 and Disk 1) to create a single drive totalling 931.49 GB. It has an impressive 97% of its space free or 904.93 GB.

The Difference Between FAT16 and FAT32

Features	Fat16	Fat32
Cluster Size	Size up to 32 Kb	It does not support drives smaller than 512 MB
Max Partition Size	2 GB standard OS	Supports over 2GB of Storage
Max File Size	2 GB	The largest drive is 4GB
Compatibility	Supported only older OS and Windows 95	Supported Microsoft, Linux, macOS
Efficiency	It takes up more space because of those significant clusters	More efficient storage usage
Performances	Slower with larger drives	Better performance with large drives

Table 1: The Difference Between FAT16 and FAT32

Another Common File System is NTFS (New Technology File System)

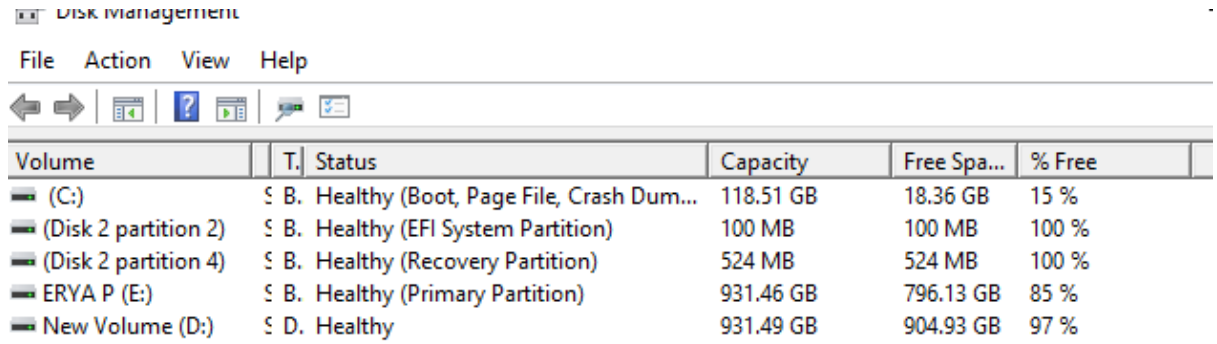
NTS is known as the New Technology File System. It is a file system created by Microsoft, starting with Windows NT 3.1 and used in many other versions, including Windows 2000, Windows XP, Windows Server 2003, Windows 7 and 8. NTFS offers various advantages. FAT and HPFS mean High-Performance File Systems. The characteristics of NTFS include Compatibility, Scalability, efficiency, and Attributes.

The several key points of NTFS include.

1. Large support files could handle up to 4GB
2. Journaling: NTFS maintains a journal of modifications, allowing easy recovery if your computer shuts down unexpectedly.
3. NTFS allow compressed files to save space and encrypts them to keep them secure without additional software.
4. Granular Permissions: You can control who can do what with each file or folder, which is better for security and reliability.
5. Improved recovery: NTFS includes features that make data recovery easier.

EFI Partition and FAT

The EFI System Partition is an important part of the old BIOS. This special partition contains key files, such as bootloaders and device drivers, needed to start up the system. It is usually formatted with a FAT file system, most often FAT32, which keeps things simple and ensures that different operating systems and UEFI firmware can read it. For example, the screenshot two explanation



Screenshot 2: Erya's Disk Management Computer - Partition

The system has several important partitions that each serve a specific purpose. The EFI system Partition is important for starting up the system. It is 100 MB in size, labelled as healthy, and helps UEFI firmware boot operating systems. This partition contains necessary bootloaders, drivers, and files and is formatted with a FAT32 file system, making it accessible by UEFI firmware.

Furthermore, the main Windows boot partition is labelled C: and has a total size of 118.51 GB. This is where the operating system and applications are installed. There is also a healthy Recovery Partition of 524MB. This partition stores system recovery tools and data to help restore the system if it fails.

Additionally, there are two main data partitions. The first, E: is about 931.46GB and is likely used for storing data. The second, D: is also 931.49 GB but is mostly empty, with 97% of the space free. Together, these partitions support the system's operations and manage data effectively.

Location and Function of BIOS

The BIOS, or Basic Input and Output System, is a chip on user's computer motherboard. Most modern computers use EEPROM or flash memory, which lets the user to update the system. The BIOS has three main jobs, firstly, it runs a self test called Power on Self Test (POST) when the user turn on computer. This test checks important parts like the RAM, CPU, Storage drivers, and peripherals to make sure they work correctly before the operating system starts. Also, the BIOS finds and loads the operating system from storage devices like a hard drive, SSD, USB drive into the computer's memory RAM. It searches for the Master Boot Record MBR or GUID Partition Table GPT to begin loading the operation system.

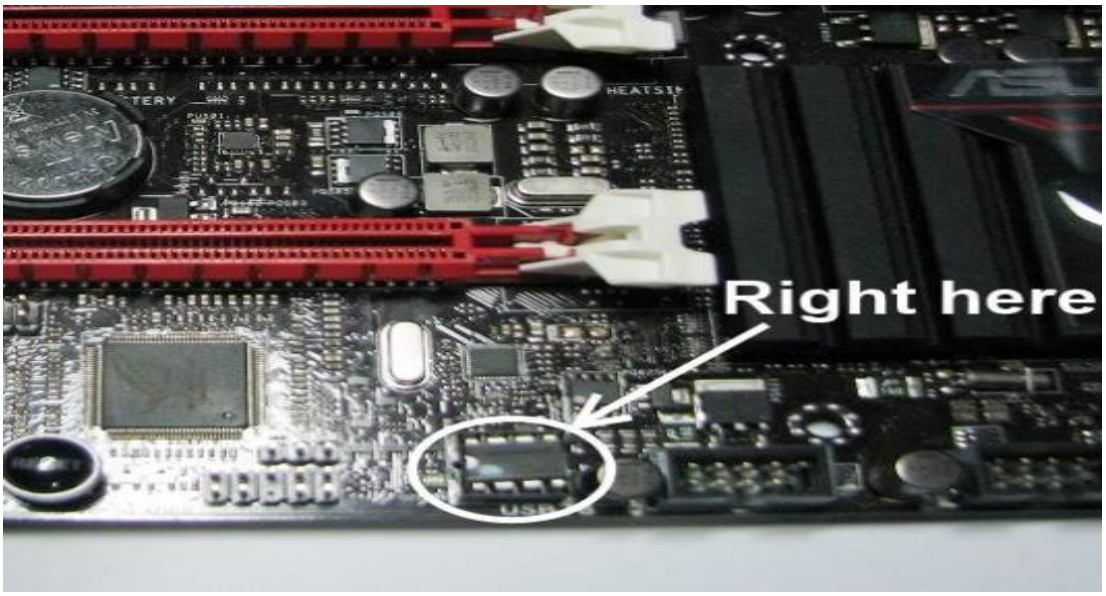


Figure 2 BIOS

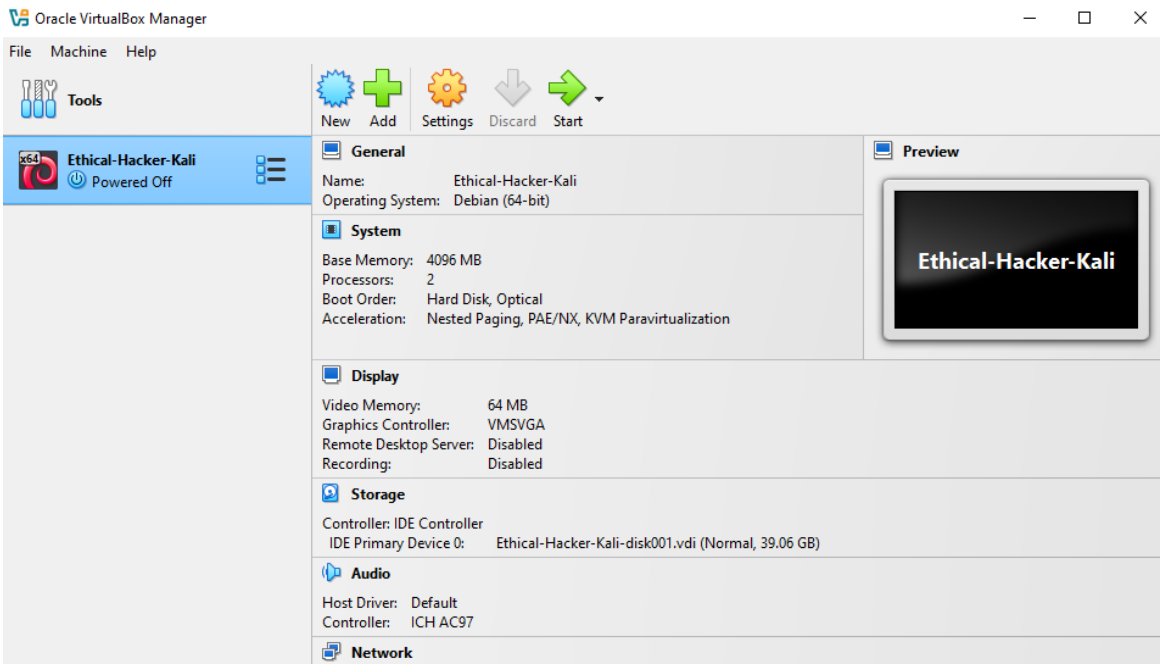
Lastly, the BIOS includes a system configuration and hardware management setup utility. This utility allows you to change system settings, such as boot order, CPU settings, memory timings, and power management. It also helps the operating system communicate with hardware components.

Understanding Virtual Machines and the Common Use of Virtual Machines

A virtual machine, also known as a VM, is software that acts like a physical computer. It runs in a separate space within a host system and uses technology to mimic hardware parts such as the CPU, RAM, Storage and Network Connections. A VM behaves like a real computer, with its operating system (OS) and applications, but it shares the host machine's physical resources.

One of the main uses of a VM is software testing and development. Developers and cybersecurity professionals often use VMs to test applications or try different operating systems without affecting their central system when running a virtual machine for software testing.

Another example is that a cybersecurity student might use Kali Linux on a VM to practice penetration testing without changing their main OS. Developers may use Windows, Linux, or macOS VMs to check if their software works on different platforms.



Screenshot 3 Virtual Machine

The purpose is to use a VM instead of a real machine.

The aim is to use a virtual machine instead of a physical machine for isolation and security. Any issues with the VM, including malware or security threats, do not affect the host system. The VM can be reset or deleted without risk if something goes wrong. Secondly, running multiple VMs on a single physical machine is cost-efficient, meaning you do not need to purchase numerous computers, which saves money.

Furthermore, in terms of flexibility and convenience, a virtual machine allows users to swiftly switch between different operating systems and environments, making it ideal for testing, training, and development. Lastly, regarding snapshots and recovery, VMs can create snapshots that save the system's state, enabling users to return to this state, if necessary, thereby preventing data loss from crashes or unsuccessful updates.

Stored Program Concept in the Context of Von Neumann Architecture

The stored program concept is an essential idea in computing. It means that both program instructions and data are kept in the same memory unit. This concept is necessary to Von Neumann architecture, which is the basis for most modern computers.

John von Neumann introduced the concept of stored programs in the 1940s. A stored program includes instructions and data, which means program instructions, the code that tells the computer what to do, and data, the information the programs work with, are stored in the same memory (RAM). The CPU retrieves, decodes, and executes instructions one at a time from memory.

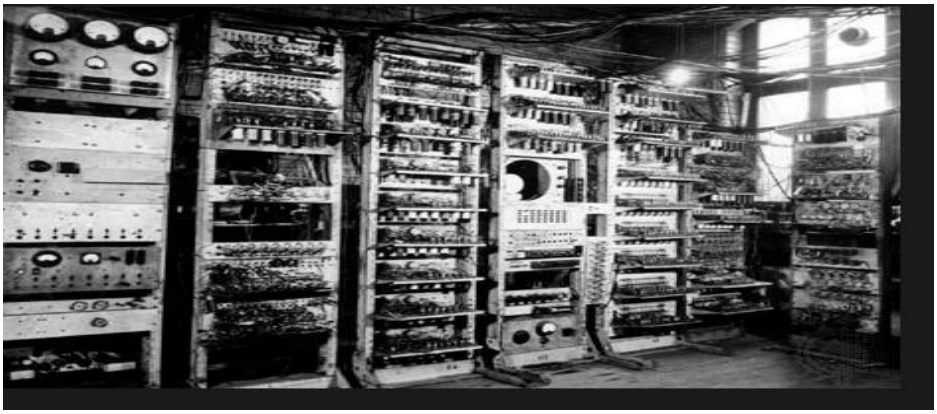


Figure 2 Stored Program in the 1940s

The program can change in memory, and since instructions are stored like data, they can be changed while the program runs. This provides flexibility and allows for self-modifying code. Lastly, it supports general purpose computing, enabling computers to perform various tasks without needing hardware changes, allowing for software updates and adaptable program execution.

Furthermore, a Von Neumann machine has several key parts.

1. Central Processing Unit (CPU): this part runs instructions using the Control Unit (CU) and the Arithmetic Logic Unit (ALU)
2. Memory (RAM): This holds both instructions and data.
3. Input/Output/(I/O) Devices allow users to interact with the system.
4. Buses (Data, Address, Control) enable communication between the CPU, memory and other devices.

Advantages and Disadvantages of The Stored Program Concept

There are several key points, including the advantages and disadvantages.

Advantages	Disadvantages
Since instructions and data share the same memory, there is no need for separate storage.	The shared memory bus can slow processing because instructions and data are fetched separately.
Increased flexibility: Programs can be updated or changed without needing new hardware.	Risk programs change since instructions are stored like data, and harmful code like viruses can potentially change programs.
It allows advanced software development, making it possible to use complex programming techniques like loops, conditional execution, and multitasking.	Lack of version control, which might cause the stored procedures not to have version control

Table 2: The Table of Advantages and Disadvantages of the Program Concept

Advantages and Disadvantages of Harvard Architecture

Harvard Architecture is a computer design that separates program code and data into memory areas, each with its data bus. This differs from Von Neumann Architecture, where program and data share memory and a data bus. This separation in Harvard Architecture can improve performance and efficiency in task processing.

There are several pros and cons of Harvard Architecture. The table below explains both advantages and disadvantages.

Advantages	Disadvantages
Faster execution means Harvard architecture uses separate memory spaces for instructions and data. This allows the system to access both at the same time, making data access faster and more efficient.	More complex hardware, using different types of memories and buses, makes things more complicated and costs more.
The bandwidth utilised for memory is more consistent and predictable	Control unit development takes more time, and it is relatively expensive.
Programmers can create the memory unit based on what they need	This method is not commonly used, which may cause its development to become outdated.

Table 3: The table of Harvard Architecture

Contemporary Development in Computer Systems: Quantum Computing Advancements

Firstly, in the last five years, significant developments in computer systems have progressed in quantum computing, particularly with the introduction of a new chip called Ocelot by Amazon Web Services (AWS), launched on 27 February 2025. Ocelot aims to reduce the time needed to create practical quantum computers by up to five years. This chip uses 'cat' qubits, which means it can produce one effective logical qubit using just nine physical qubits, requiring around 100,000 instead of the typical one million used in the industry. The announcement came with a study published in Nature, marking a significant step forward in the race for advancement in quantum computing. Other companies like Google, Microsoft, and PsiQuantum have also made significant strides recently. Oskar Painter, the director of quantum hardware at AWS, noted that innovation in materials and processing could speed up the development of this technology even more.

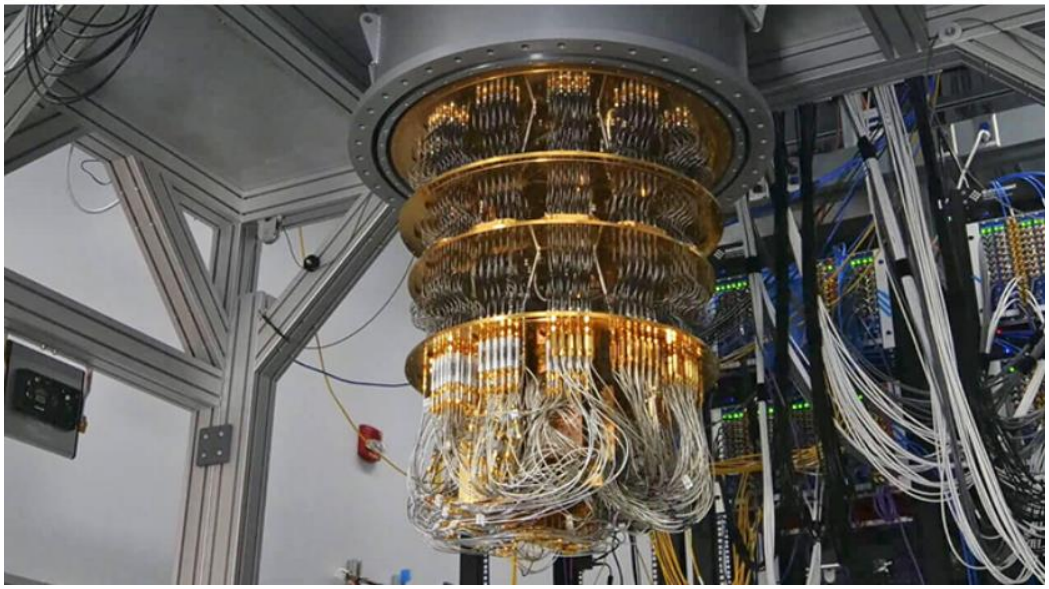


Figure 3 Google Quantum Computer is 47 Years faster.

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