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ASSESSING THE VIABILITY AND DEPENDABILITY OF NEXTCLOUD DEPLOYED ON RASPBERRY PI FOR NETWORK-ATTACHED CLOUD STORAGE

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Abstract: This work aims to create a secure personal cloud storage solution leveraging the Raspberry Pi 4 Model B. By configuring the Raspberry Pi as a personal cloud server and connecting it to the internet via a router, users gain control over their data, addressing the privacy concerns associated with third-party cloud services. The server accommodates additional storage through an optional USB hard drive, offering flexibility in data capacity. Utilizing the Raspberry Pi's wireless network capabilities, it interfaces with open-source cloud computing platforms like Personal Cloud. Administrators manage the server remotely through local tunnels, configuring and overseeing services such as SSH, HTTP, and VNC, ensuring stringent access control and efficient system utilization. This research work proposes a practical alternative to relying on commercial cloud storage services like Dropbox or Google Drive. By establishing personal cloud storage using Raspberry Pi and an external hard drive, users retain data sovereignty and bolster security measures. The integration of platforms like NextCloud facilitates seamless access to stored data across various devices with internet connectivity, providing convenience without compromising control or incurring substantial costs. The outlined steps demonstrate how Raspberry Pi can transform into a personal cloud storage solution, offering cost-effectiveness, reliability, and enhanced control over data, all crucial factors in ensuring a secure and personalized cloud storage experience.

Index Terms - Raspberry pi, Cloud Storage, Next Cloud, Jellyfin.

I. INTRODUCTION

Raspberry Pi-based Network Attached Storage (NAS) refers to a storage system that utilizes the Raspberry Pi single-board computer to provide centralized and network-accessible storage within a local environment. It typically involves connecting external storage drives to the Raspberry Pi, creating a cost-effective and compact solution for file sharing and data management shown in Figure 1. In the age of digital information, the need for efficient and accessible storage solutions has never been more critical. Whether you're a home user looking to centralize your multimedia collection or a small business in need of secure data management, NAS and cloud storage have become indispensable tools. While the market offers a plethora of options, building your own NAS system can offer unparalleled customization, cost-effectiveness, and security. In this work, we embark on a journey to create a Raspberry Pi-based NAS and Cloud Storage solution, utilizing the innovative CASA OS.

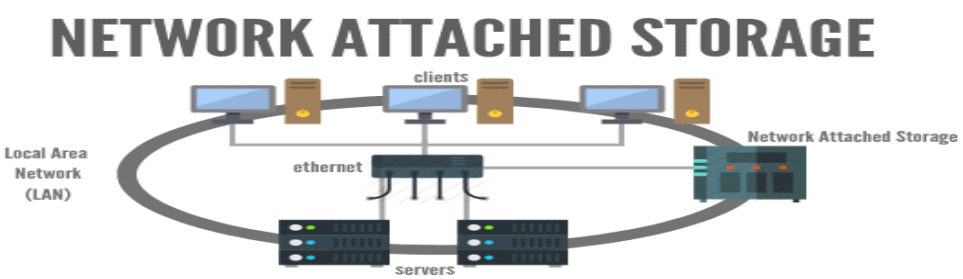


Figure 1: Network Attached Storage

Cloud Computing(CC) is just one of the several networking trends that are shaping the future of technology. These trends will bring about changes in software-based technologies, mobile devices, and skill sets, transforming businesses and suppliers. Cloud storage typically involves storing data on hard drives, which can be more secure than traditional storage methods. The cloud storage apart is that instead of storing data directly on a computer or mobile device, it is stored on servers owned by large companies, which are

accessible over the internet. In cloud storage, data is stored on remote servers owned by cloud service providers, such as Amazon Web Services, Google Cloud, or Microsoft Azure. These servers are in data centres worldwide, and users can access them via the internet[1][2]. CC is an important instrument that reflects the digital computing paradigm and business models for both software and hardware resources. Its economic advantage is that it provides an efficient way to minimize operating expenditures and capital expenditure. Despite CC providing solutions to most problems faced by individuals and organizations, it has exposed many businesses to security and privacy threats and issues. Various research has been done on privacy and security in CC. Security issues are based on the cloud provider, service user, and instance. The security issues are based on the delivery model, PaaS(Platform as a service), IaaS(Infrastructure as a service), and SaaS(Software as a service).There exist four cloud deployment models namely: public cloud, private cloud, hybrid cloud, and community cloud and each has its own security and privacy concerns[3]. Most of the cloud computing services are providing limited storage to the users, at the same time the risk of your data to store at third party is a big issue. Example is the recent incident of exposed nude pictures of the celebrities from iCloud. example if our data is not safe, to overcome these problems this research will come up with the perfect solution with unlimited cloud data storage by the help of "Raspberry Pi" [4]. Personal cloud storage using Raspberry pi services will allow to synchronize local folders with raspberry that act as servers in the cloud. Personal cloud storage offering for free services, synchronizing devices, and sharing content. Personal cloud storage also can be referring the way to access software and storing data in the cloud representation of the internet. CC services models has three types of namely SaaS, PaaS and IaaS. SaaS is a cloud computing offering that provides users with access to a vendor's cloud-based software. PaaS is a CC offering that provides users a cloud environment in which they can develop, manage, and deliver applications. IaaS is a cloud computing offering in which a vendor provides users access to computing resources such as servers, storage, and networking. Our work is to provide a private Cloud Storage for every individual user such that data privacy is being maintained and most important thing is that our data is only with ourselves and no one has the permission to access our data and we can easily backup our data if it is lost and retrieved easily where it is necessary and it is separately stored in the material cloud so it will not add up our internal storage and we can also be able to extend the storage size if needed and can store the data from any location. In this work, we will use an open-source platform like Next-cloud which is used to create and host file services. The proposed service will be accessible to users via the internet, allowing them to store their files online and access them from anywhere with an internet connection.

II. MOTIVATION

Exploring the intersection of Raspberry Pi-based NAS and CC, this work endeavors to create a cost-effective and customized data management solution using the innovative CASA OS. In today's digital landscape, where demand for accessible storage is paramount, the integration of NAS and cloud services is crucial. Leveraging the Raspberry Pi single-board computer, the work aims to transcend physical storage limitations, ensuring secure file sharing and ubiquitous data access. As cloud computing reshapes technology trends, the endeavor addresses privacy and security concerns, contributing to the discourse on efficient data management in the dynamic cloud era.

- The small form factor of Raspberry Pi allows for a compact and space-efficient NAS setup, ideal for home users or small-scale deployments with limited space.
- Building your NAS system provides the flexibility to customize configurations based on specific storage and performance requirements.
- Raspberry Pi is known for its low power consumption, contributing to energy efficiency and reduced operational costs over time.

The primary aim of implementing a Raspberry Pi-based NAS solution is to provide a cost-effective, customizable, and efficient data management.

III. CONTRIBUTION

Most of the studies in literature is to create a Raspberry Pi-based personal cloud server, serving as your private cloud storage. This solution addresses contemporary privacy concerns, utilizing the Raspberry Pi 3 model B module configured as a cloud server connected to the internet via a router. The server connects to the Personal Cloud open-source platform through the Raspberry Pi's wireless network card Configuration of the Raspberry Pi server is accessible remotely from any device, like a smartphone, using a local tunnel. The local tunnel manages various services such as SSH, HTTP, and VNC.

- Remedy for the dependency on third-party cloud storage services like Dropbox, Google Drive, and iCloud.
- To ensure that our data remains in our possession rather than being entrusted to unfamiliar Cloud Storage providers, all while maintaining cost-effectiveness.
- Its primary motivation lies in the economic advantages it offers, seeking to minimize both capital and operating expenditures.
- The core concept behind the cloud is the ability to access information over the internet without requiring an in-depth understanding of the underlying communication mechanisms.

It enables the storage of data on multiple third-party servers, relieving users of the need to manage or be aware of the specific locations where their data is stored

IV. RELATED WORK

The research works discussed revolve around the innovative integration of Raspberry Pi into personal cloud storage solutions, addressing various aspects such as privacy, security, cost-effectiveness, and educational applications. Each work offers a unique perspective on utilizing Raspberry Pi's capabilities to create personal cloud storage systems tailored to individual needs. Personal Cloud Storage using Raspberry Pi proposes the creation of a Raspberry Pi-based personal cloud server, designed to serve as private cloud storage. The Raspberry Pi 3 Model B module is configured as a cloud server connected to the internet via a router. The server integrates with the Personal Cloud open-source platform through the Raspberry Pi's wireless network card. One notable feature is the remote accessibility of Raspberry Pi server configuration from any device, such as a smartphone, through a local tunnel. This local tunnel manages various services like SSH, HTTP, and VNC [5][6]. Access to the Personal Cloud account is restricted to the admin, who can, through the local tunnel, offer users a range of services. The work emphasizes efficient space utilization, enabling users to store data for free while maintaining tight system control, addressing contemporary privacy concerns. Own Cloud Storage Using

Raspberry Pi proposes a solution to reduce dependency on third-party cloud storage services like Dropbox, Google Drive, and iCloud. The work entails establishing a personal cloud storage system using a Raspberry Pi and an external hard drive. This approach provides users with complete control over their data and the ability to determine their storage needs[7]. The personal cloud storage system created with Raspberry Pi ensures data security and limits access to the user, addressing security concerns associated with third-party services. The recommendation to use own Cloud facilitates convenient access to data from any internet-connected device. Overall, the solution offers a practical and cost-effective alternative to relying on third-party cloud storage services. Raspberry Pi as a Personal Cloud Server with Next cloud outlines the process of creating personal cloud storage with Raspberry Pi, guiding users to activate cloud storage mode for their external hard drive. The utilization of open-source cloud storage applications like Next cloud and own Cloud enables seamless storage and retrieval of files, photos, and digital assets from any internet-connected device. The primary aim is to provide users with personal cloud storage in a cost-effective manner, ensuring higher reliability compared to other commercial cloud services. The key components include Raspberry Pi 3 Model, Next cloud, and storage, showcasing the work's commitment to leveraging open-source technologies for personal cloud storage [8].

Security and Privacy Issues in CC delves into the challenges and concerns associated with security. The research recognizes the economic advantages that cloud computing offers but emphasizes the persistent concerns regarding security and privacy. Despite extensive research efforts, these concerns remain unresolved, impacting cloud adoption and deployment. The paper [9] conducts a detailed survey, exploring underlying issues and concerns while presenting countermeasures. As a significant contribution, the paper introduces a framework designed to tackle security and privacy apprehensions in cloud computing. The proposed framework employs a hybrid authentication mechanism to enhance cloud computing security, providing valuable insights and practical countermeasures for researchers and practitioners. Raspberry Pi-based Secured Cloud Data positions cloud storage as a pivotal component in the expanding digital landscape. While acknowledging the preference for cloud storage, the research highlights the drawbacks of relying on private cloud storage services due to their expense and the need to relinquish control over data. The proposed solution involves utilizing hard disks as personal cloud storage, controlled by a Raspberry Pi accessible from any location. This approach enhances security by keeping cloud storage within the user's domain and proves more cost-effective than relying on private cloud storage services.The implementation of suitable security measures ensures data safeguarding, and the work's compact and portable design offers a significant advantage in terms of mobility.

Cloud-based Architecture of Raspberry Pi Personal Cloud Storage provides a comprehensive study on the necessity of personal cloud storage and offers a step-by-step guide for constructing it using a credit card-sized Raspberry Pi. The work empowers users to activate cloud storage functionality for their external hard drives, enabling the utilization of larger storage capacities compared to other cloud storage services. The research also explores the substitution of laptops with Raspberry Pi for lecturers in university classrooms. This transition aims to enhance efficiency and versatility in educational settings by seamlessly playing PowerPoint slides and videos [10]. Private Cloud Data Storage Using Raspberry Pi focuses on establishing a cost-effective cloud computing environment with Raspberry Pi-based systems, particularly for libraries and classrooms in schools and universities in developing countries where financial constraints are a constant challenge. The research employs Weaved for remote access, allowing the setup of Raspberry Pi from any device, including smartphones. Various services, such as SSH, HTTP, and VNC, are configured on Weaved for control [11].

Access to the private cloud account is restricted to the administrator alone, offering a secure and controlled environment. The paper showcases the outcomes of an experimental setup, providing cost-free data storage tailored to specific requirements while allowing flexibility in space utilization and achieving savings [12]. Study on Cloud Storage and its Issues in Cloud Computing explores the prominent term of cloud computing, highlighting services like Gmail, Facebook, Dropbox, Skype, PayPal, and Salesforce.com as examples. The core concept behind the cloud is the ability to access information over the internet without requiring an in-depth understanding of the underlying communication mechanisms [13]. Cloud storage stands out as a key service, enabling data storage on multiple third-party servers, relieving users of the need to manage specific locations. The article delves into various approaches for storing data in the cloud, recognizing the challenges associated with handling, managing, and storing growing data sizes. Personal Cloud Storage using Raspberry Pi caters to users seeking a personal cloud storage service utilizing Raspberry Pi. The primary objective is to demonstrate how Raspberry Pi 3 can function as a server, employing open-source software to develop it into a personalized cloud storage service. The development process involved extensive research, findings incorporation, and integration of additional features such as the LINE notify add-on. This system aims to emulate the functionalities of existing commercial cloud services, offering personal cloud storage with free services, device synchronization, and content sharing [14]. Leveraging Raspberry Pi for personal cloud storage enables the synchronization of local folders with cloud servers, accessible over the internet. All actions within the system are initiated through user login. Furthermore, this work allows users to mount USB or external storage, providing seamless access to these resources. In conclusion, these research works collectively contribute to the evolving landscape of personal cloud storage solutions using Raspberry Pi. The innovative approaches address contemporary concerns such as privacy, security, cost-effectiveness, and educational applications, making significant strides in empowering users to have greater control over them.

Traditional NAS systems have provided local storage solutions for years, enabling users to share files and centralize data within their networks. However, the integration of cloud storage services has become increasingly essential, offering users the ability to transcend physical storage limitations and ensuring ubiquitous access to their data.

V. METHODOLOGY

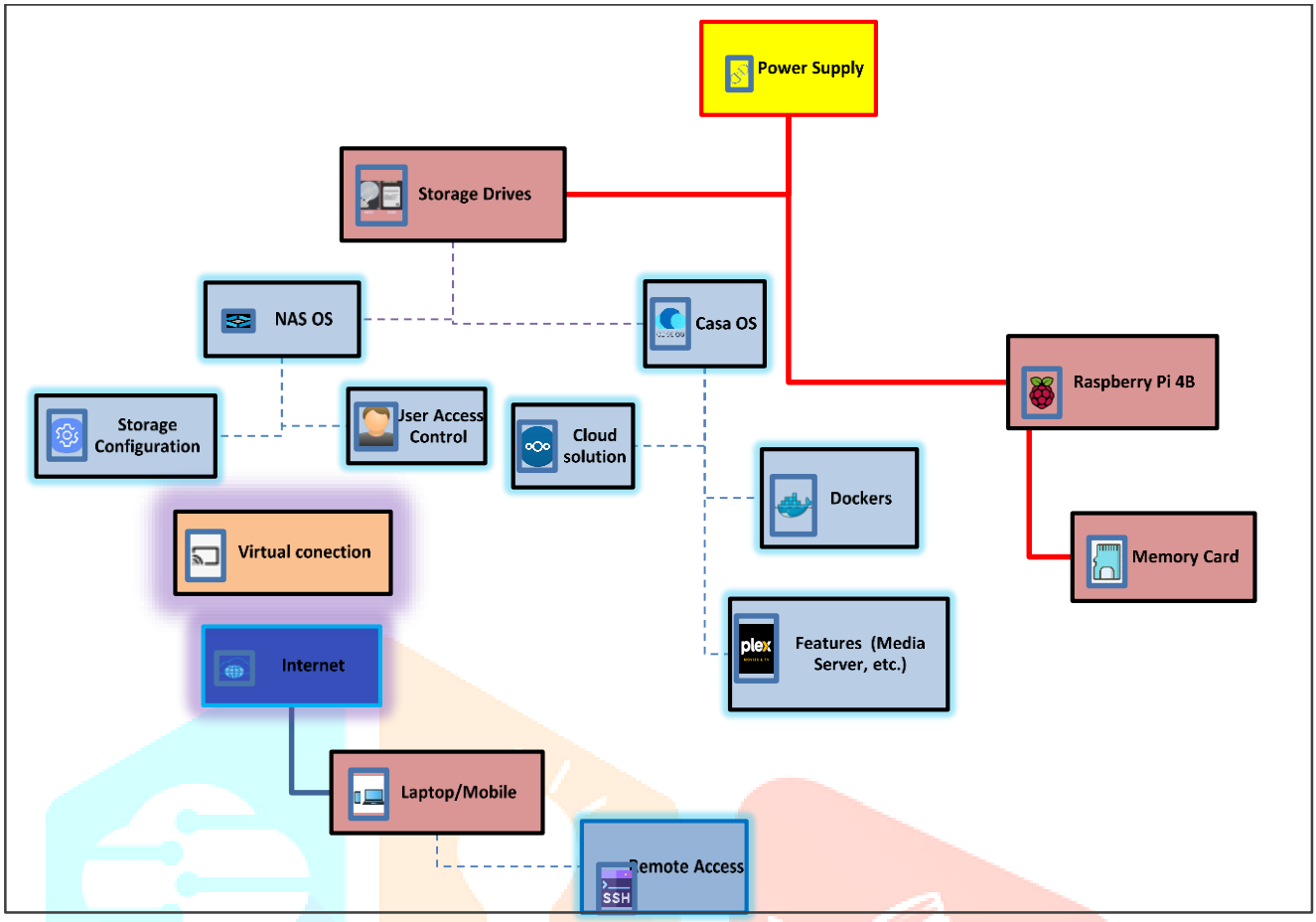


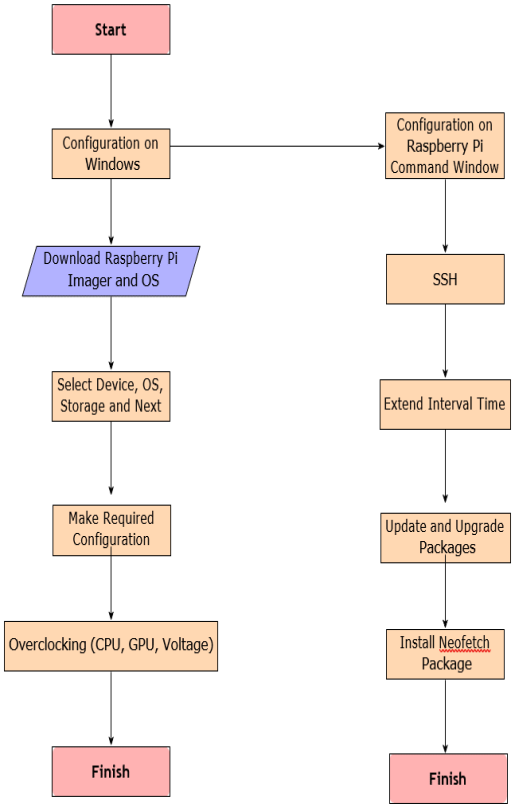
Figure 2. NAS Model

Power Supply: Input Power: AC power is supplied to the Raspberry Pi through a standard power adapter. Power Distribution: Power is distributed to the Raspberry Pi and other connected peripherals. Raspberry Pi 4 Model B: Processor: Quad-core ARM Cortex-A72 processor for enhanced processing power. RAM Available in 2GB, 4GB, or 8GB configurations for multitasking and performance-intensive applications. Virtual Connection: Gigabit Ethernet for faster wired networking. Dual-band wireless LAN (2.4GHz and 5GHz) and Bluetooth 5.0 for improved wireless connectivity. USB Ports: Two USB 3.0 ports for faster data transfer. Two USB 2.0 ports for additional connectivity options. Memory Card: A microSD card is used as the primary storage for the Raspberry Pi's operating system (OS) and applications. External Hard Drive/USB Drive: Connected to the USB ports on the Raspberry Pi, serving as the local storage for the NAS. To enable remote access for a Raspberry Pi-based NAS cloud storage solution, configure a dynamic DNS service to map a domain name to the Pi's changing IP address. Open port forwarding on the router to direct external traffic to the Pi's local IP. Install and set up software like Nextcloud or ownCloud on the Raspberry Pi for cloud storage functionality. Implement secure practices, such as using HTTPS, strong authentication, and regularly updating software, to ensure data privacy. Access the NAS remotely using the assigned domain name and configured port, providing convenient and secure cloud storage access. Docker Containers: Docker is used to containerize applications and services on the Raspberry Pi, ensuring easy deployment and management. NAS Services Container: Hosts the software for managing the Network-Attached Storage, handling file sharing, and access control. Media Server Container: Runs a media server application for streaming and sharing multimedia files. Cloud Storage: Internet Connection: The Raspberry Pi is connected to the internet, enabling communication with cloud storage services. Cloud Solution Service: Represents services like Google Drive or Dropbox, where data can be synchronized and accessed remotely. User Devices: Devices such as laptops, desktops, or smartphones connected to the local network or the internet for accessing files from the NAS or cloud storage. Figure2 illustrates the interconnected components of a Raspberry Pi-based NAS with cloud storage providing a local and remote file-sharing solution. Users can access their data locally through the NAS or remotely through cloud service.

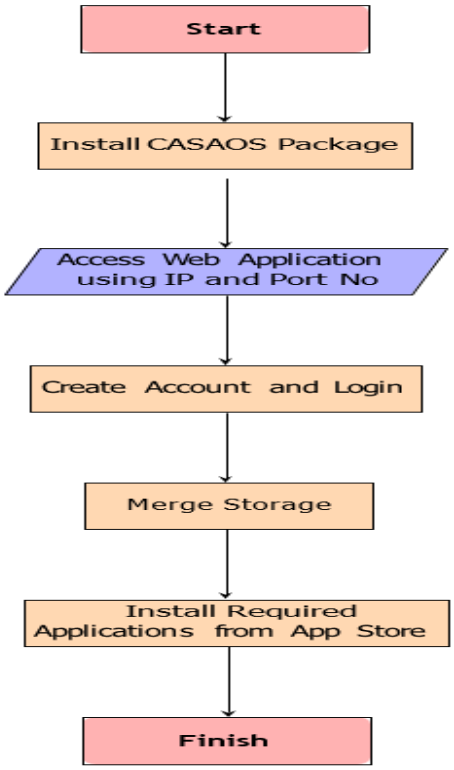
VI. IMPLEMENTATION

To create a powerful home server, we'll need to complete four phases:

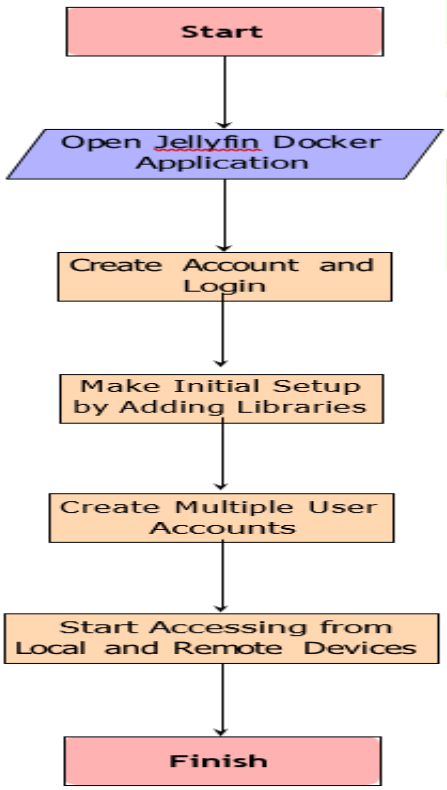
Phase 1: Raspberry Pi Installation & Setup



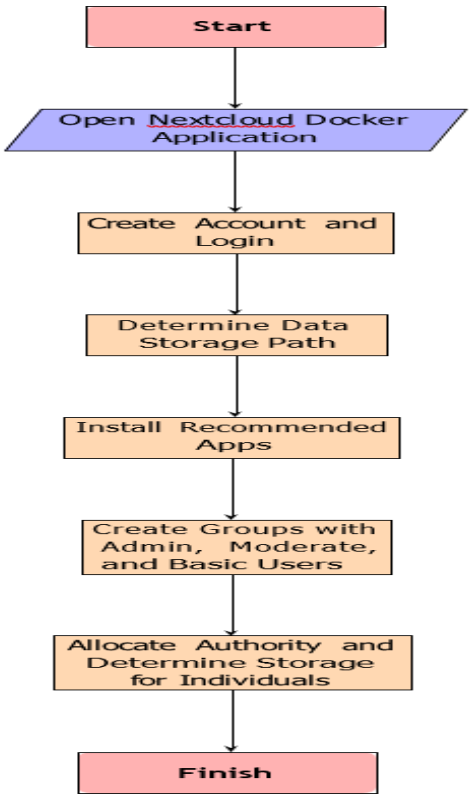
Phase 2: CASA OS Installation & Setup



Phase 3: Jellyfin Installation & Setup



Phase 4: Nextcloud Installation & Setup



In phase 1 Raspberry Pi Imager simplifies OS installation on microSD cards for Raspberry Pi devices. Its user-friendly interface guides users through selecting OS, identifying target SD cards, and initiating installation. In phase 2 Casa OS is an open-source software for home cloud experiences, based on Docker. It facilitates file sharing, media streaming, home automation, and web hosting. Simple to install and use, it's compatible with various devices. With its open-source nature and extensibility, users can contribute and enhance its features effortlessly. In phase 3 Jellyfin, an open-source media server, simplifies multimedia management and streaming. Docker isolates its environment, easing deployment and updates. Users employ Docker commands for efficient Jellyfin instance deployment and management, enhancing scalability and resource utilization. In phase 4

Nextcloud, an open-source file sync and sharing platform, gains portability with Docker. Docker containers encapsulate Nextcloud and its dependencies, easing setup. Through Docker Compose or run commands, users swiftly create Nextcloud instances, accessing file storage, document editing, calendar, and contacts, while benefiting from Docker's deployment and scalability advantages.

VII RESULTS

This is a huge leap forward for single board computing and Benchmarking is a better way to explore it, so we powered one up, run some tests and stress it out.

Table 1: Benchmarking results

Test	RPi 3B+	RPi 4B	Change
Boot Time	39.9	41.7	-4.5%
Idle Power (Amps)	0.505	0.684	-35.4%
Peak Power (Amps)	1.14	1.12	1.8%
CPU - sysbench primes - 1 thread	317.7	250.4	21.2%
CPU - sysbench primes - 4 threads	86.2	62.8	27.1%
RAM Bandwidth - mbw	1420	2983	110.1%
OpenGL - videogl32	30.9	35.8	15.9%
Ethernet - iperf3 (Mbps)	332	933	181.0%
WiFi 2.4Ghz - iperf3 (Mbps)	38.6	39.6	2.6%
WiFi 5Ghz (ac) - iperf3 (Mbps)	98.6	107	8.5%
External USB Drive Write - dd	35	155	342.9%
External USB Drive Read - dd	32	233	628.1%

The work centred on building a robust Raspberry Pi-based Network-Attached Storage (NAS) & Cloud Storage system. After extensive research, we meticulously procured essential hardware and software component offering a tailored interface with specialized applications for example Data management, multiple Web-Applications, and ongoing updates for stability and security as shown in Table 1. The Figure 3 shows us the interface that is available after installing the CASAOS.

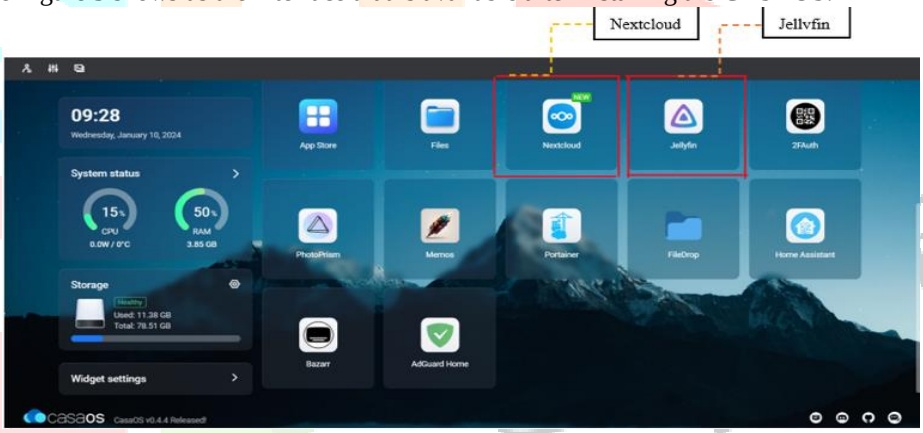


Figure 3: CASAOS Web-Application Interface

Under CASAOS, Nextcloud was smoothly integrated via Docker, facilitating NAS storage volume setup, and fine-tuning of secure file-sharing permissions. Nextcloud, a self-hosted cloud storage platform, ensures file synchronization, collaboration tools, and heightened privacy features, catering to both individual users and businesses. The Figure 4 shows the interface after setting up the Nextcloud.

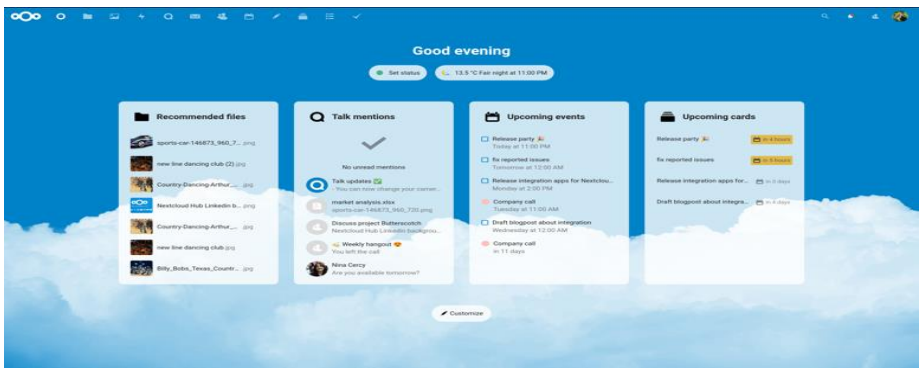


Figure 4: Nextcloud NAS and Cloud Storage Interface

Additionally, Jellyfin, a media server, was set up using Docker within CASAOS. Testing via mobile applications confirmed seamless access and playback, solidifying a comprehensive and accessible NAS and Cloud Storage solution. The Figure 5 shows the customized Jellyfin media server interface with the media content available locally.

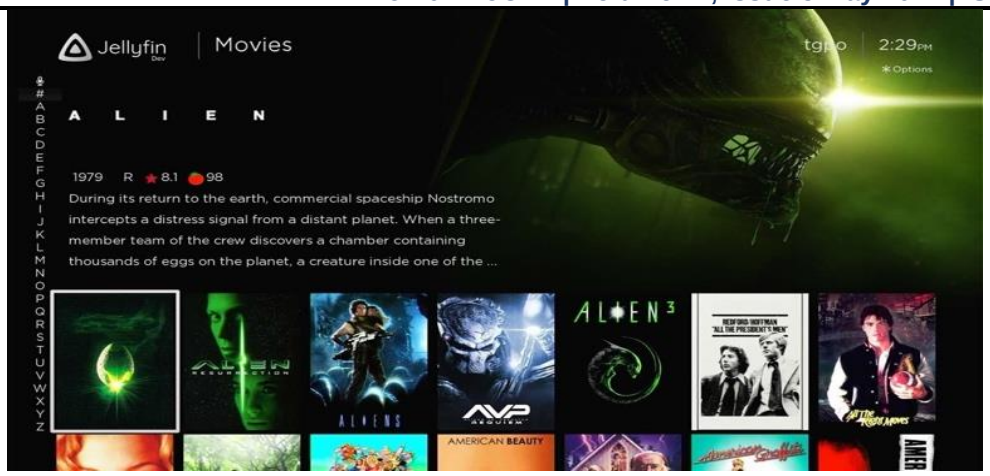


Figure 5: Jellyfin Media Server Interface

VIII. CONCLUSION

The initial phases of establishing a Raspberry Pi-based Network-Attached Storage (NAS) & Cloud Storage system have been diligently executed. Through rigorous research and acquisition of necessary hardware and software components, the groundwork has been laid. The Raspberry Pi NAS operating system has been installed and configured while storage volumes and file sharing permissions have been set up. However, essential testing remains pending, including local and remote file access verification. Additionally, the integration of cloud storage services like Dropbox, Google Drive, or Microsoft OneDrive awaits installation and configuration. The impending phases involve comprehensive testing in real-world scenarios before deploying the NAS system to production, ensuring a robust and reliable storage solution as shown in fig 6.

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