

# Design an efficient personal cloud storage system

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## ABSTRACT

Recently, many cloud storage services have become available for customers looking to store their data on external infrastructure. However, these services have several drawbacks, such as the high cost, remote location, and less security protection. To do that, we propose an efficient personal cloud storage system (PCSS), where a private cloud storage is built at home to store personal data without exposing it to a third-party provider. In PCSS, users can access a restricted personal cloud account as administrators. Also, in PCSS, the storage capacity is increased manually as needed, and data can be stored for free. Additionally, PCSS can offer better performance in terms of data integrity, availability, and fast data storage. An experiment scenario has been performed to validate the proposed storage approach.

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## 1. INTRODUCTION

Cloud computing is presented as a service provisioning model that provides global on-demand access to a shared pool of physical and virtualized computing, networking, and storage resources (1). It enables high resource utilization with large scalability and flexibility. Cloud computing offers three distinct service provisioning models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) (2). IaaS provides access to powerful resources such as physical and virtual machines, virtual storage, etc., PaaS provides a platform for developers to build applications and services by using a communication network, and SaaS offers software to perform a specific activity to the users (3). These services can be accessed anytime from anywhere on a pay-as-you-go basis, in which the payment billing is formulated based on the time and resources capacity required (4). Cloud Storage is an important service that is rented out to others from many cloud computing providers, such as Amazon S3, Amazon EBS, CTERA portal, etc. This service enables users to store and back up data remotely on physical and virtual servers, accessible via Internet-linked devices. However, the storage space available to users may be limited by cloud providers, and exceeding the storage quota may incur additional costs or data deletion (5). PCSS is a suitable solution to address the drawbacks of cloud storage, offering a free storage service, on-demand storage size, and convenient data access (6). PCSS is a type of small private cloud storage that allows for flexible and scalable data storage without exposing private data to a third-party provider. The hardware requirements for PCSS vary according to the amount of data users intend to store. In other words, more data requires more storage capacity in hardware. The PCSS can be an external physical storage or a dedicated virtual part of a personal computer. Despite the popularity of PCS, some studies have employed the PCS paradigm to reduce storage costs and increase the availability and privacy of personal data. The costs and Benefits of Content Sharing in PCS are studied in (7). In this study, the tradeoffs between the cost-benefit and content-sharing service in PCS for both the provider and user are analyzed together. Based on the proposed analytical mathematical model, the investigation experiments showed that the incentive for the user leads to greater satisfaction for both parties. However, no network architecture or scenario is followed in the proposed mathematical model. Moreover, several simplifying assumptions have been made. (6) Utilized the Raspberry Pi as a Personal Cloud server to store data and increase the integrity. An unknown open-source cloud computing platform is used to configure and manage the resource storage. However, the limitation of

the proposed PCS was the small and non-expandable storage size of the Raspberry Pi. The opportunities and challenges of using PCS by academic staff are investigated in a questionnaire(8). Additionally, the impact of demographic characteristics for users, such as gender, age, field of study, and place of residence, on the usage of PCS is also examined. In (5), the advantages and disadvantages of personal data storage and sharing are explored through a comparative analysis. This comparison ensures that the high capacity, convenient sharing, and backup ability are the advantages of cloud storage, whereas the high cost, privacy, and security risks are its drawbacks. However, the PCS is not considered or discussed as a solution to address these drawbacks. In this paper, we design a PCSS using a storage server installed on a Linux virtual machine and managed by the Nextcloud platform (9), which is a client-server software for creating and using file hosting services.

The main contributions of this paper can be summarized as follows:

1. Designing a new network architecture for PCSS, such that the main components of the PCSS and the interaction between the admin, users, and the PCSS environment are explained.
2. Introducing an efficient procedure to set up a PCSS that is compatible with the available storage space and the required size of data.
3. Performing a practical scenario to validate the effectiveness of the proposed PCSS approach.

## 2. METHODOLOGY

This section consists of three parts: the proposed network architecture, the sequence of steps for configuring PCSS, and an implementation scenario that explains the scenario of utilizing PCSS.

### 2.1. Network architecture

Figure 1 shows the proposed network architecture. From the figure, it can be seen that the connection between the admin and the personal cloud storage server enables the admin to manage and grant access to users on the PCSS. Admin manages the PCSS using the Secure Shell (SSH) protocol, allowing configuration and updates to storage resources (physical or virtual) to be performed remotely via an SSH connection. Authorizing users to access PCSS is done by the admin through the NextCloud configuration, allowing some users to view only, while others can view and update the content of PCSS. Both admin and users can be connected to NextCloud's dashboard over the Internet by sending an https:// request, where HTTPS is a Hypertext Transfer Protocol Secure that provides a secure connection to the PCSS. This protocol protects sensitive information, such as passwords, via encryption using Secure Socket Layer/Transport Layer Security (SSL/TLS) protocols (10).

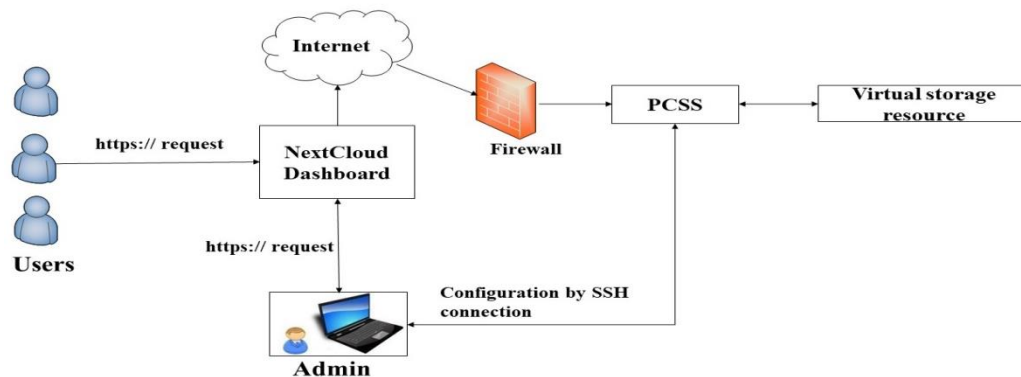


Figure 1. Network architecture of PCSS

### 2.2. Configuring steps of PCSS

In this subsection, we will list and explain in detail the configuration steps of PCSS

#### 2.2.1. Selecting a cloud management platform

Initially, to manage the physical or virtual resources of the PCSS, we have to determine the software platform. This software acts as an interface between the storage resources and the user. There are various open-source platforms designed for this purpose, such as ownCloud, Nextcloud, and Seafile.

#### 2.2.2. Selecting a physical or virtual hardware device

Choosing the hardware storage device is the next step in the setup process. Certainly, the selected storage hardware device must be compatible and support the software storage platform intended to be used. For small data, a laptop

may suffice, whereas for storing large volumes of data in terabytes, a more powerful machine, such as a small server, is required. To avoid expenses, we used a dedicated computer; it's easier to install a cloud storage server on a Virtual Machine (VM). The laptop has the following resources:

- CPU Intel Core i7, 2.92GHz, and Windows 11.
- 8GB RAM, where 4 GB of RAM is dedicated to the VM.
- 1 Terabyte SSD hard disk, where 10 GB is dedicated to the VM.

### 2.2.3. Installing an operating system

Some cloud storage platforms are compatible with one type of operating system, such as Windows or Linux, while others support both of them. In other words, some cloud storage platforms support both operating systems as clients, whereas they support one type of operating system in server mode. Here, to host a personal cloud storage on a server, the Linux operating system has been utilized.

### 2.2.4. Installing the cloud storage platform

After preparing the hardware and operating system, the selected cloud storage platform can be installed now. The installation process will vary depending on the type of cloud storage platform and the operating system. Generally, the installation process isn't more difficult than installing any other application.

### 2.2.5. Configuring the network

Configuring the network is a crucial step in creating a PCSS. Because it ensures that the right ports are open and the cloud server's IP address is known to devices that need to connect. For more protection, we need to adjust the firewall rules that allow access to the personal cloud server from the Internet. For instance, an admin may wish to set up access controls to restrict who can view or modify data from within the home network, or they might want to create slices of storage for different users of the personal cloud. Configuring some of these settings may require making some modifications within some devices, such as the router or the firewall.

### 2.2.6. Starting the service of PCSS

Now, the devices are ready to connect with PCSS, so data uploading and downloading are available. Typically, PCSS settings can be updated over time, including increasing the storage size and allowing or restricting access for users. Like any traditional server, a PCS server requires a monitor and management; therefore, utilizing a monitoring tool that can generate an alert when the server is unreachable. Moreover, configuring backups is required, especially if the data stored on the PCS is critical.

## 3. IMPLEMENTATION PCSS SCENARIO

The following scenario is performed to demonstrate the effectiveness of the proposed storage system.

- Inserting the IP PCSS in the surfing website by HTTPS request, then creating an admin account in the nextcloud platform. Figure 2 explains that.

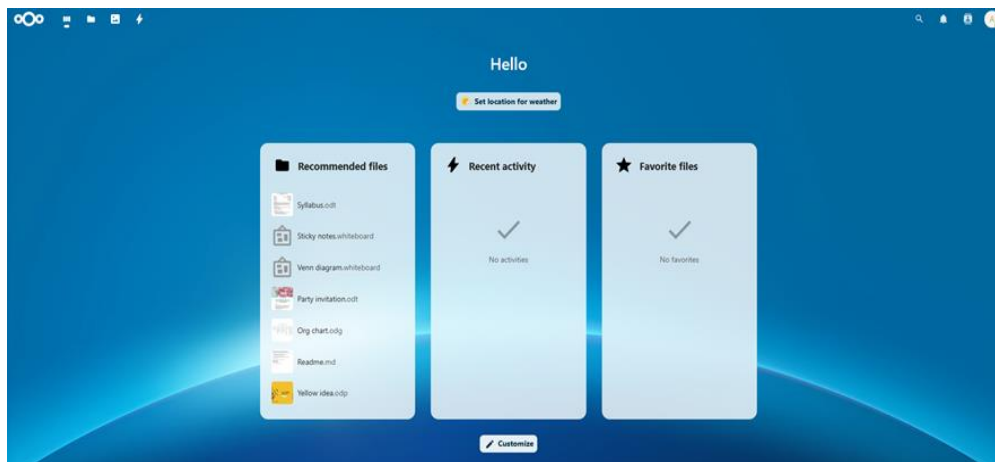


Figure 2. Creating an admin account

- As shown in Figure 3, the admin can create one or multiple user accounts that grant privileges such as updating, sharing, or viewing, as well as the storage size.
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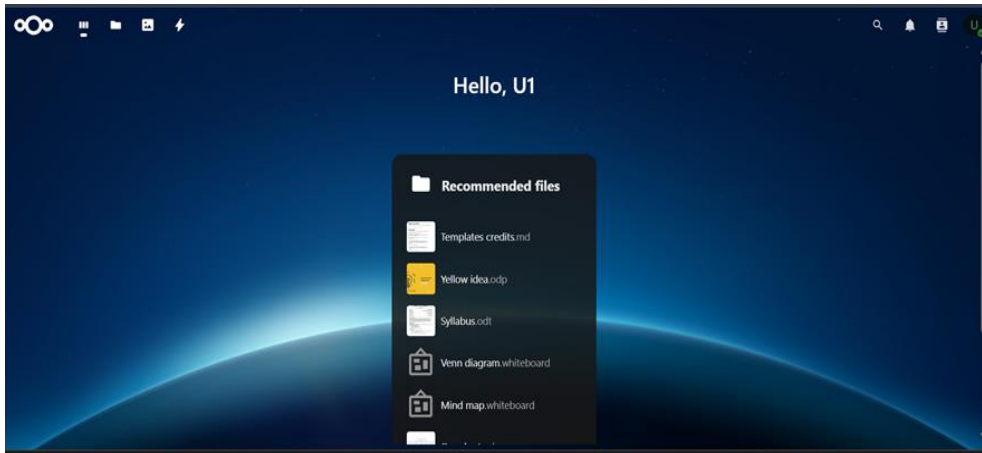
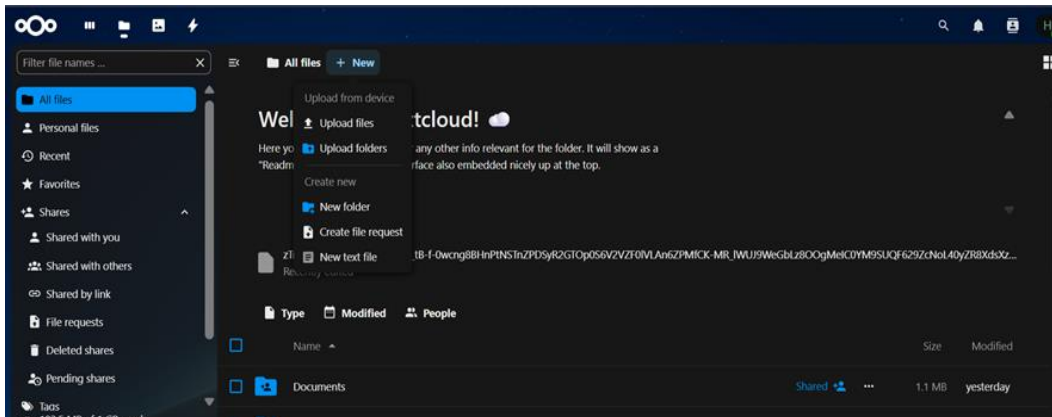
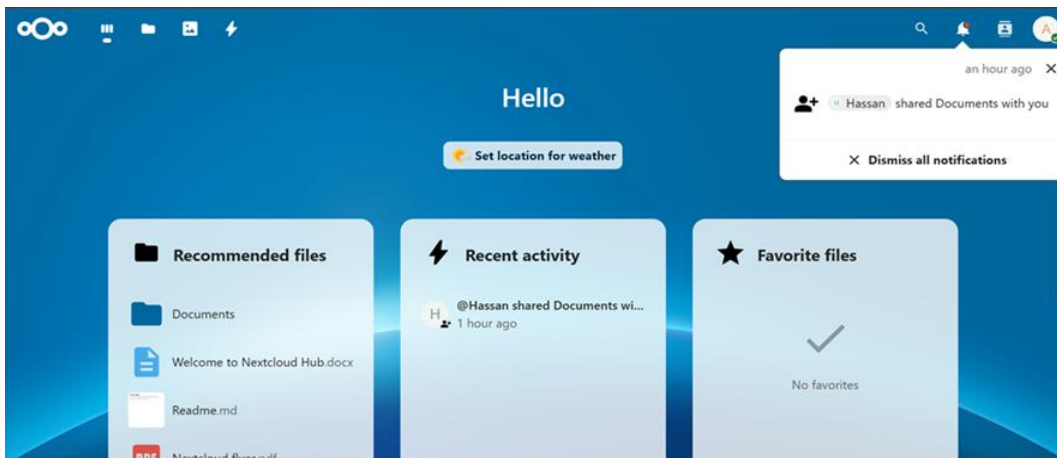


Figure 3. Creating a user account

- Users who have been created can upload and download data over the internet, or without. Additionally, sharing files and folders with others is available based on the privileges granted by the admin. Figure 4(a) shows the uploading, downloading data whereas and Figure 4(b) shows sharing data of users with the admin.



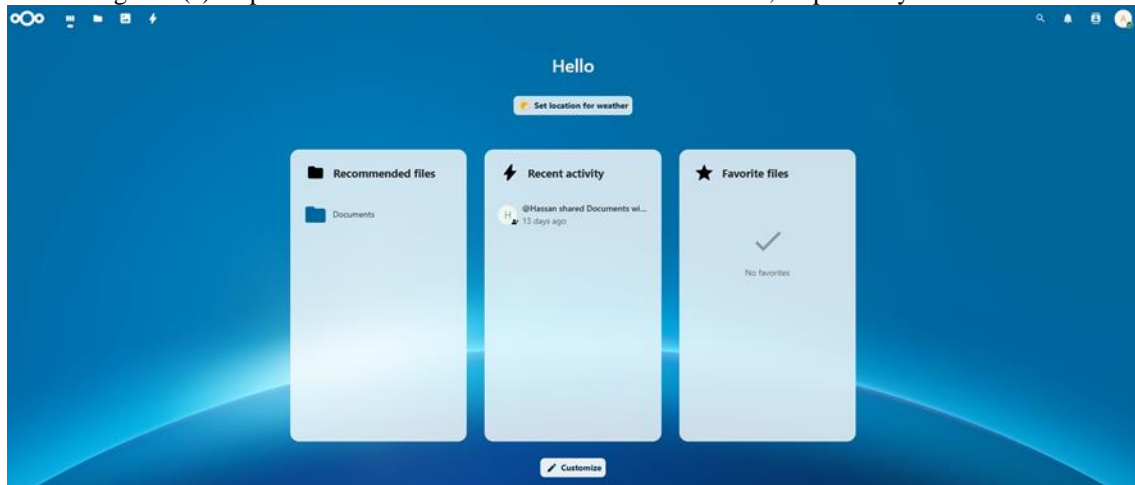
(a)



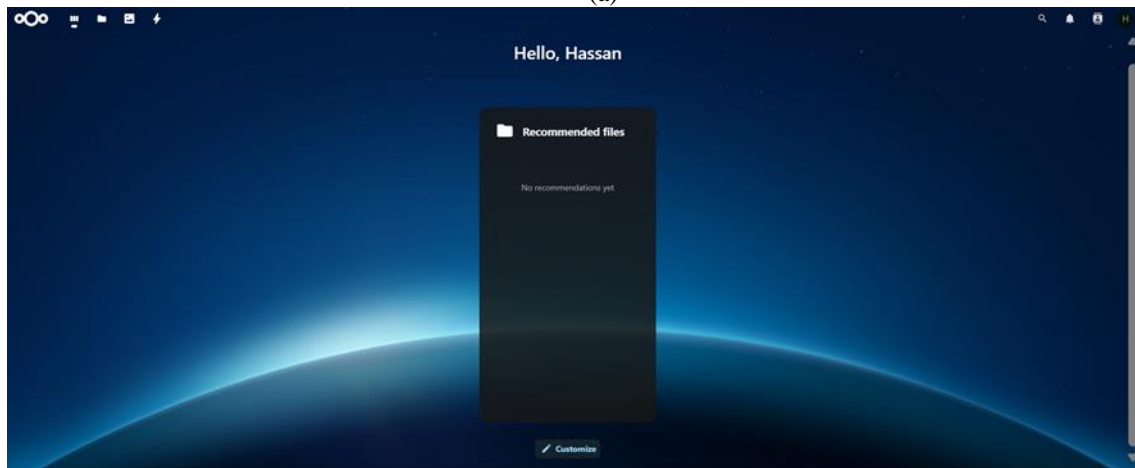
(b)

Figure 4. Scenario of data (a) Uploading and downloading data  
(b) Sharing data

- The admin and users can access the account over the local network and the internet. This feature can ensure the availability of the stored personal data at any time and under different network conditions. Figure 5(a) and Figure 5(a) explain this feature for both the admin and the user, respectively.



(a)



(b)

Figure 5. Accessing account without Internet (a) Admin  
(b) Users

#### 4. CONCLUSION

We have designed an efficient personal cloud storage system (PCSS) to store our personal data without the need to rent storage resources from a third party, such as Amazon Simple Storage Service (S3). Also, availability of these data for users is possible from the local network and the internet. A virtual storage resource has been utilized and managed by Nextcloud, which is an open-source client-server software for creating and using file hosting services. The proposed storage system is efficient in terms of reducing cost, managing data storage, and ensuring security. However, simplifying the configuration and backup processes for PCSS servers may reduce the risk of data loss. Therefore, these challenges can be considered in future work.

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