

# PERSONAL/PRIVATE CLOUD STORAGE USING RASPBERRY PI

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**Abstract**— Cloud storage has become an essential part of modern digital life, yet existing cloud services pose privacy risks, impose storage limitations, and require recurring payments for additional space. This project aims to develop a secure, cost-effective personal cloud storage system using a Raspberry Pi and Next cloud to provide users with full control over their data. The proposed system will enable users to store, manage, and access files remotely without relying on third-party cloud providers. The Raspberry Pi will act as a mini cloud server, integrated with an external hard drive for expandable storage. To address security concerns, the system will incorporate Next cloud encryption to protect stored data and a real-time notification system via the LINE app to alert users of unauthorized access or file modifications. The implementation involves setting up a Raspberry Pi with Next cloud, configuring an external storage device, and ensuring secure remote access through encrypted connections. Key applications include file sharing, data backup, multimedia streaming, and remote file management from any device. This project offers an affordable and customizable cloud storage alternative, empowering users with enhanced security, privacy, and flexibility over their digital data.

**Keywords:** *Personal Cloud Storage, Raspberry Pi, Nextcloud, OwnCloud, Secure Data Storage, Encryption, Remote File Access, Expandable Storage, Privacy, Real-time Notifications, LINE App, Cost-effective Cloud Solution, Data Security, Cloud Server, File Sharing, Multimedia Streaming, Unauthorized Access Alerts*

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## I. INTRODUCTION

This project focuses on developing a private cloud storage system using a Raspberry Pi as a secure, cost-effective alternative to third-party services. By integrating an external storage device and cloud software like Nextcloud or OwnCloud, users can store, manage, and access their data remotely while maintaining full control over privacy and security. Unlike commercial cloud providers, this system eliminates storage limitations and recurring costs, offering a customizable solution for individuals and small businesses.

Key features include file sharing, data backup, multimedia streaming, and remote access, all protected by encryption and real-time security alerts for unauthorized access. The Raspberry Pi acts as a mini-server, ensuring data integrity and expandability without reliance on external providers.

Additionally, built-in monitoring and notification systems enhance security, making it a reliable and flexible option for digital storage needs. This self-hosted cloud empowers users with greater privacy, control, and adaptability in managing their personal and professional data.

## II. LITERATURE SURVEY

Cloud storage has evolved with various models enhancing accessibility, security, and scalability. Wang et al. (2010) analyzed public, private, and hybrid cloud models, noting cost-effectiveness, security, and flexibility, but also challenges like security risks and high infrastructure costs. Malik and Nazir (2012) explored SaaS, PaaS, and IaaS, emphasizing service flexibility while highlighting cost variations based on usage.

Research by FairuzRauf et al. demonstrated the feasibility of Raspberry Pi-based personal cloud storage using Raspbian OS and OwnCloud, offering scalability and affordability but requiring constant internet access. Similarly, Maksimović et al. (2014) implemented an ARM-based Raspberry Pi cloud, noting security benefits and customization but highlighting hardware reliability concerns.

While traditional cloud models provide scalability, they pose security and cost issues. Raspberry Pi-based personal cloud storage presents a secure, customizable, and cost-effective alternative, though network and hardware limitations must be addressed for better reliability.

## III. DESIGN

## 1) Hardware

- a) Gather the required hardware: Raspberry Pi (e.g., Pi 5, 8GB RAM), MicroSD card, USB hard drive, power supply, and network connection.
- b) Install Raspberry Pi OS on the MicroSD card using Raspberry Pi Imager or Balena Etcher.
- c) Insert the MicroSD card into the Raspberry Pi, connect power, storage, and network, then boot and complete the initial setup.
- d) Ensure the USB hard drive is detected, format it if necessary, and mount it for permanent use.
- e) Install cloud storage software such as Nextcloud, OwnCloud, or OpenMediaVault.
- f) Configure security and remote access by setting up a static IP or Dynamic DNS (DDNS), enabling encryption, and activating real-time alerts via the LINE app.
- g) Test remote access, upload and manage files, and expand storage as needed.

## 2) Software

- a) Install Raspberry Pi OS (Lite version) on your Raspberry Pi.
- b) Set up the Apache web server to host Nextcloud.
- c) Install PHP (version 8.2) to support Nextcloud's web functionality.
- d) Set up the MariaDB database to manage Nextcloud data.
- e) Download and install the latest version of Nextcloud for cloud storage access.

## 3) Setup Steps

- a) Update and upgrade system packages to ensure the latest security patches and software versions.
- b) Install Apache and PHP to set up the web server for Nextcloud.

1. To get started let's first update our package repositories with the following command:

```
C:\Users\HP>sudo apt update
```

```
C:\Users\HP>sudo apt upgrade
```

2. With that done, let's now install apache with the following command:

```
C:\Users\HP>sudo apt install apache2
```

You can check to make sure Apache2 is successfully up and running by going to your Pi's IP address, this should load a default Apache Page.

If you are unsure on what your Raspberry Pi's local IP address is then type in hostname -I into the terminal.

3. For this tutorial, we will be using **PHP 8.2** as at the time of writing that is the recommended version for Nextcloud. To gain access to this version of PHP you will need to add a third-party PHP repository by following our guide.

4. With Apache2 now installed onto the Raspberry Pi, we just need to install PHP and several of its packages. To install PHP and the packages we need, run the following command

```
C:\Users\HP>sudo apt install php8.2 php8.2-gd php8.2-sqlite3 php8.2-curl php8.2-zip php8.2-xml php8.2-intl php8.2-smbclient php8.2-imap php8.2-gmp php8.2-bcmath libapache2-mod-php8.2
```

5. With Apache and PHP now installed there is one final thing we need to do, and that is to restart Apache.

You can do this now making use of the following command:

```
C:\Users\HP>sudo service apache2 restart
```

- c) Setting up MYSQL on a Raspberry Pi
- a) The next step is to install the MySQL server software to your Raspberry Pi.

```
C:\Users\HP>sudo apt install mariadb-server
```

- d) With the MySQL server software installed on the Raspberry Pi, we will now need to secure it by setting a password for the "root" user.

```
C:\Users\HP>sudo mysql_secure_installation
```

- e) The first thing we need to do is open the MySQL command line tool by running the following command.

```
C:\Users\HP>sudo mysql -u root -p
```

- f) You will be prompted to enter the password that we just created in step b for MySQL's root user.
- g) You can now enter MYSQL commands to create, alter, and delete databases. Through this interface, you can also create or delete users and assign them the rights to manage any database.

- h) There are two different ways you can quit out of the MYSQL command line. The first of those is to type “quit;” into the MySQL interface. The other way of quitting out of the MYSQL command line is to press CTRL + D.
- i) At this point, you will now have successfully set up MySQL on your Raspberry Pi. Our next few sections will go into making better use of this database.
- j) Set up MySQL database and user to store and manage Nextcloud data.
  - a) Before we proceed to create a MySQL user and database on our Raspberry Pi, we must first log back into the MySQL command-line tool.

```
C:\Users\HP> sudo mysql -u root -p
```

- b) Once you have logged in to the tool, we can start by creating a database.
 

We will be creating this database called “nextcloudodb” by running the following command.

```
CREATE DATABASE nextcloudodb;
```
- c) Our next step is to create a user that we will be using to interact with our new database.

We will be creating a user called “nextclouduser” by running the command below. Make sure that you replace “<PASSWORD>” with a secure password and make note of it for later.

```
CREATE USER 'nextclouduser'@'localhost' IDENTIFIED BY '<PASSWORD>'
```

For example, if you were to create this user with the password “123456789”, the command would look like what we have shown below.

```
CREATE USER 'nextclouduser'@'localhost' IDENTIFIED BY '123456789'
```

- d) With our user created we need to now give it permissions to interact with our database.

```
GRANT ALL PRIVILEGES ON nextcloudodb.* TO 'nextclouduser'@'localhost';
```

This command grants the user “nextclouduser” all privileges on the “nextcloudodb” database and all of its tables.

- a) Our final task is to flush the privilege table.
 

To flush the privileges all we need to do is run the following command.

```
FLUSH PRIVILEGES;
```

With this done, we can now proceed to install Nextcloud on our Raspberry Pi.

  - a) Download and configure Nextcloud for cloud storage access.

- 1) To get started let’s first move to our html directory with the following change directory command.

```
C:\Users\HP>cd /var/www
```

- 2) Now we can download the latest version of Nextcloud to our device. To do this we will use wget to download the latest release to the current folder.

```
C:\Users\HP>sudo wget https://download.nextcloud.com/server/releases/latest.tar.bz2
```

- 3) With Nextcloud now downloaded to our Raspberry Pi, let us extract the archive. To extract the archive using “tar” we need to use the command below.

```
C:\Users\HP>sudo tar -xvf latest.tar.bz2
```

- 4) We now need to create a data directory for Nextcloud to operate in, for the initial setup of Nextcloud we must make this folder in our “/var/www/” directory. Create the directory by using the mkdir command as shown below:
- 5) Now let’s give the correct user and group control over the entire Nextcloud folder and everything inside it by running the following chown command.

```
C:\Users\HP>sudo mkdir -p /var/www/nextcloud/data
```

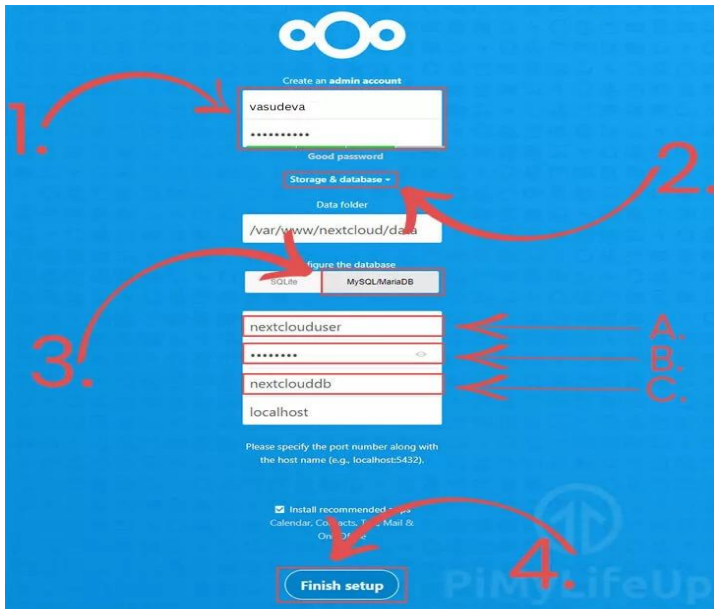
- 6) Finally we need to give it the right permissions, again run the following chmod command.

```
C:\Users\HP>sudo chmod 750 /var/www/nextcloud/data
```

- b) Configure Apache for Nextcloud to enable proper web hosting.
- 1) To get started let’s create a file which will store our configuration changes for Nextcloud. You can begin to write this config file by using the following command in the terminal. Here we are using Nano as it is one of the easiest to use.

```
C:\Users\HP>sudo nano /etc/apache2/sites-available/nextcloud.conf
```

- 2) Now before you proceed any further you will need to decide whether you want Nextcloud to run under the “/nextcloud” directory or on its own domain or subdomain.



For running under a directory

If you want NextCloud to be accessible whenever someone goes to `"/nextcloud"` then all you need to do is type in the following lines into the file.

This configuration is simple and means whenever someone goes to your Pi's IP address, followed by `"/nextcloud"` they will be greeted with its interface.

```
Alias /nextcloud "/var/www/nextcloud/"
<Directory /var/www/nextcloud/>
Require all granted
AllowOverride All
Options FollowSymLinks MultiViews
<IfModule mod_dav.c>
Dav off
</IfModule>
</Directory>
```

For running NextCloud on its own domain

If you would prefer Nextcloud to be run under a separate domain name or a subdomain, then you need to create a virtual host as shown below.

When typing in these configuration lines make sure you replace `"<DOMAINNAME>"` with the domain name you plan on using. For example, we would replace this with `"nextcloud.mine.com"`.

```
<VirtualHost *:80>
DocumentRoot /var/www/nextcloud/
ServerName <DOMAINNAME>
<Directory /var/www/nextcloud/>
Require all granted
AllowOverride All
Options FollowSymLinks MultiViews
<IfModule mod_dav.c>
Dav off
</IfModule>
</Directory>
```

`</VirtualHost>`

- 3) These lines basically tell Apache2 how to handle itself within the `"/var/www/nextcloud/"` folder. These changes will allow Apache2 to read and utilize the `".htaccess"` files within the Nextcloud directory.
- 4) Now we can save and quit out of the file by pressing `CTRL + X` then pressing `Y` and then `ENTER`.
- 5) With the file created we now need to tell Apache to make use of it. We can do this by utilizing the `a2ensite` command followed by `"nextcloud.conf"`.

```
C:\Users\HP>sudo a2ensite nextcloud.conf
```

- 6) Now we need to restart Apache2 to force it to read in the updated configuration file. We can do that easily with the following command:

```
C:\Users\HP>sudo systemctl reload apache2
```

## IV. CONCLUSION

Setting up a Raspberry Pi as a Nextcloud server is a practical, efficient, and budget-friendly approach to creating personal cloud storage. This solution grants users full control over their data, eliminating the dependence on third-party services that often come with privacy concerns, storage limitations, and recurring costs. By leveraging open-source software, users can build a secure and scalable storage system tailored to their needs.

The setup process involves installing and configuring a web server, database, and the Nextcloud application, which can be accomplished with moderate technical expertise. Once deployed, the system enables seamless file sharing, data synchronization, and remote access across multiple devices. Users can manage documents, photos, and multimedia files with ease while ensuring data privacy through encryption, user authentication, and access control mechanisms.

Moreover, the integration of SSL encryption and real-time alerts via messaging platforms enhances security, protecting against unauthorized access and data breaches. The flexibility of a Raspberry Pi-based Nextcloud server allows for expandable storage options, making it a sustainable and long-term alternative to commercial cloud solutions. With the ability to customize settings and features, users can optimize their cloud environment to fit personal or business requirements.

In conclusion, setting up a Nextcloud server on a Raspberry Pi is an excellent choice for individuals and small businesses looking for a secure, cost-effective, and self-hosted cloud storage solution. This approach not only ensures greater privacy and control but also provides a reliable and scalable platform for managing and safeguarding valuable data.



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