Practical Cloud Computing

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Abstract— This paper discusses the functionality of the Proxmox server, highlighting its extensive use in the industry to address various memory management challenges and facilitate efficient server backups. Proxmox provides us a very robust virtualization platform that enhances us to allocate resouces and ensure high availability of services. As part of this setup I setup a Ubuntu live server to support the installation and evaluation of two content management systems, WordPress and Typo3. These systems were chosen to demonstrate Proxmox's capability in managing and optimizing resources for diverse applications, showcasing its effectiveness in real-world scenarios. This research underscores Proxmox's critical role in improving server performance and reliability.

Keywords — Proxmox, interface, server, users, Clusters, Groups, organizations, roles, permissions, access methods, Ubuntu, CMS, Content management, Wordpress, Php, MySQL, phpMyAdmin, Typo3,templates, MFA, security, website.

I. INTRODUCTION TO PROXMOX

Proxmox Virtual Environment is an open source server virtualization management solution based platform that works entirely under Debian, A full-featured Linux platform. I can manage Virtual machines, various clusters, variety of storages and different networks with an integrated, Web UI or CLI. Proxmox manages network infrastructure, Storage systems, operations of VM's and their associated on the host system by creating plenty of users to handle the information easily for an instance creating admins.

II. INSTALLATIONS AND SETUPS

A. Oracle Virtual Box 7.0.14

In order to Operate and use Proxmox VE I set up the VB which was compatible with current version of Proxmox. The Virtual box is installed on my system having windows 11.

B. Proxmox Virtual Environment

In order to proceed with Proxmox VE installation I ensured that Virtual box is fully and correctly setup. I then downloaded the iso file (Proxmox 7.4-1) compatible with virtual box 7.0.14 from the Proxmox Website, during the process I allocated 4.096 Gb Base memory, 15Gb Disc, 2 cores for the VE in my Virtual Box.

C. Virtual Environment Proxmox Setup

After the Virtual machine was setup up I had configured the environment, set the system time and language, network configuration to go ahead. Since Proxmox deals with real time and internet connection (Server and hosts) if our internet isn't connected we wont be able to access and use Proxmox. Also the internet we are connecting the ip should be maintained or else there would be clashes during several connections. After this process we set up secure passwords and a root to the environment.

D. Clusters

I setup a total of 3 servers (s01, s02, s03) and each server had a different Ip. I kept s01 as my main Cluster and named it Merwin-DC ,further I joined the information of s02 and s03 to my Cluster (s01) in this way I setup a cluster.

E. Users

Each Server may have multiple Users under it and each user may have multiple Access permissions such as all access, storage access, editing access and more. In one of the servers I setup two users (user1 and user2-admin) in which user1 is a normal user and doesn't have access and can only view whereas user2-admin has administration access ,user can edit and do any activity on the server. Each of the User logins are protected with passwords and are working under the Proxmox Authenticator.

Abbreviations— VE - Virtual environment, UI - User interface, OS - Operating system , CLI - Command line Interface, , Mb - Mega bytes, Gb - Giga bytes, DC – Data center, CMS – Content Management System, MFA – multifactor Authentication.

III. USERS ROLES AND PERMISSIONS

A. Defining Pools, Roles, Groups, Users, Permissions

Pools help to use multiple VM's at once and its easy for admins to access the storages at a glance, it even helps to give permissions to a group of VM's at once. User roles are the ones responsible for operating and working with a few restrictions, Groups are the ones that decides on which organizations are currently running in the server, Users are the ones who work under the organization called groups, Permissions and roles are given to the users to enhance security and confidentiality of the data on the servers and in majority of cases the Roles are different for most users, roles and permissions depends on various factors such as Storage access, User handling, Admin privileges, group access and no access methods too.
Thus, defining Pools, groups, permissions and users are very crucial when handling with the server.

B. Defining Organisations

I created two Company organizations called AgriBros and Coolparadise and both of them are created in the section called groups where a group consists of various different users. My organizations consists of 4 to 5 users in Each Business. And some users share their roles in both the Organizations like the owners and customers and are even a part of other organizations.

C. Defining the roles each user is assigned with

Assigning various roles to users of any organization is a very important task, as it reduces maintenance of one user. There are various different roles assigned to the users in my organizations such as Administrator ,PVEAuditor, PVEDataStoreAdmins, PVEDatastoreuser and PVEVMUsers, are some of the roles and permissions I decided for each user. Some users like Owners will have administration privileges for both the Agribros and Coolparadise organizations so they are given entire access unlike normal users are given read only Access methods as anyone just cant change and edit the confidential data.

IV. CREATION OF LAMP-BASED WEBSERVER

I created a VM for my webserver which was lamp stack based as instructed and also found out about groupings, pools, various roles which I used on the Ubuntu 22.04.4 Live Server ISO file [3]

A. ISO file

To upload my ISO file I went through one of the server in our clusters ie in my case is server 1 which was named s01 and the server had enough space for the iso file to get uploaded and the server allocated 15 gB of storage during my installation.

B. Ubuntu VM Creation

On uploading the ISO, I accessed the VM creation option to create a virtual machine (VM) in Proxmox. During this procedure, I used VM default ID ie 101 and then choose my ubuntu iso file, selected Linux as the operating system, and mentioned proper kernel version to ensure smooth way.

System configuration was set at its default. disk size 40GB. CPU configuration, sockets at the default, cores - 2. RAM allocation - 4096MB. Network section – bridge adapter And did several checks and started the VM

C. VM Assignment

For the VM assignment I had assigned the VMs to users within selective pools such as admins and users

First, I ensured that the pool was created and all the necessary permissions were given permission to the users within each of our organizations. In the 'DataCenter' view I selected "Permissions." Option and could manage user access and setting specific permissions to desired pools.

V. CONTENT MANAGEMENT

To create our Content management system ,I used a MySQL database and WordPress Content Management System.

A Content Management System (CMS) is a software application designed to help users create, manage, and publish digital content on a website without needing advanced technical skills. It serves as a centralized platform where various types of web content, including text, images, videos, and other media, can be easily handled. CMS is very essential for modern website management, significantly improving efficiency by simplifying the processes of creating, editing, and publishing content. It enhances effectiveness by optimizing content for search engines and social media, boosting visibility and engagement. A CMS ensures consistency in branding by maintaining a uniform look and feel across the website. Additionally, it promotes sustainability through content revision

CMS Core features are as follows, it helps users to create, edit, and publish content using intuitive text editors. The system supports efficient content repository searches and manages user roles and permissions to control access. It provides tools for organizing website navigation, structure, and taxonomy. Content can be tagged and categorized for better organizations.
A CMS also manages media files, ensuring consistent design across the site. Additionally, it optimizes content for search engines and social sharing, enhancing visibility and engagement. These features collectively improve efficiency, scalability, and brand consistency.

WordPress

[4] WordPress is a very flexible web development tool which is, extensively utilized for various purposes, including academic works and activities. WordPress acts as a great platform at creating and management of various tasks, websites, blogs, and portfolios, making it an excellent choice for academic projects. Its enables flexibility and is a very innovative tool in modern technology
Website Content: My website is a dynamic hub of information, featuring a brief overview about me as a Student at Hof university and creating as project on Cloud computing

VI. LAMP BASED WEBSERVER

[6] This is an open-source program frequently used by many to enable a server to host dynamic webpages ie LAMP stack. "LAMP" represents to the following
Linux operating system, a Stack base
Apache HTTP Server, Web process and request
MySQL, a database management tool ie relational database management system
PHP is a Scripting language for server side scripting.

LAMP (Linux, Apache, MySQL, PHP) stack on my Ubuntu 22.04 live server was setup correctly and is now ready for web development and deployment. I developd a web server

that would be able to help stand the demands of todays web applications meaning reliable, efficient and secure.

Overview of LAMP Components

A. Linux

Ubuntu our linux operating system having version 22.04's was had fantastic reviews with its stability thus after analysis it was deemed sufficient for us to use for our server environment. Ubuntu provides long-term support not only that but Linux is fully open source and is very simple to use when it comes to deal with webservers and servers, it makes handling such servers easy. New users will also find it easier to run and maintain since it is having a very user-friendly interface and extensive documentation.

B. Apache

Apache server is one of the most popular and best server tool for creating websites which can handle both Http and Https requests providing us with the most suitable content in the most easy and fastest way possible.

C. MySQL

[5] MySQL is database management system, particularly used for small projects, It is an open-source relational database management system (RDBMS) that stores data in structured tables and organized way, helping in data retrieval and data manipulation using various queries used in SQL. MySQL supports various applications, it stands as an important tool for database management and analyzing structured data in various projects, which contributes to ideal processes which is the most crucial for any project.

D. PHP

PHP is a server-side scripting language used within HTML documents to create dynamic content. It's popular for web applications on LAMP stacks due to its compatibility with MySQL and Apache. PHP is the best choice for web development, supported by numerous frameworks and libraries.

Installation and Configuration

A. Apache

I installed Apache on my server, set it up, and confirmed it was running smoothly. I made changes to Apache's configuration files, This involved enabling necessary modules and creating new configuration files for each virtual host. set up logging to monitor server and help with troubleshooting it. I chose Apache because of its secure features and its ability to hold high volumes of data traffic efficiently.

B. MySQL

After installing MySQL, I set up the database server by creating a strong password for the root account and made sure everything was safe. Then, I made new users and databases with specific permissions to fit website needs. This setup helped me to manage data well and keep it secure.
I had to create a database named Merwin then created a root user to access this database apart from this also gave access of the databases to the user I created.

C. PHP

I connected PHP with Apache so they could work together smoothly. I adjusted PHP settings to make it run faster and set it to handle various types of files. I installed Phpmyadmin to handle the database easily, we can even edit or delete information from the website using phpMyAdmin edit and delete tools.

Testing and Deployment

I tested the setups and status of each of the LAMP and made sure they were active. Made sure Apache description and php description files were present made sure MySQL was able to create, retrieve and delete data present in databases
Finally moved on to the Wordpress installation

VII.   WORDPRESS INSTALLATION AND CONFIGURATION

A.   Installation

[8] Once I downloaded the wordpress installation file, I further extracted the WordPress files into the correct directory and made sure the directory was within the server's root directory so wordpress files were easily accessible.

B.   File Permissions

I gave read and write permission to my wordpress file directory so when I would run the website I could view and retrieve the data from the mysql database along with this folder, below are the command snippets

Commands:
sudo chown -R www-data:www-data/var/www/html/
Merwin.com

sudo chmod -R 755 /var/www/html/Merwin.com
I moved the wordpress contents into my file called
Merwin.com

C.   Configuration File Setup

To set up WordPress, I renamed a file called wp-config-sample.php to wp-config.php. Then, entered details like the database name, username, and password to connect to the database. Additionally,I generated special keys and made sure the installation was secure. These keys played a crucial role in protecting our site's session data and cookies, making everything safer.

D.   Apache Configuration

For Apache to recognize the WordPress site, I configured my virtual host file. This file was specifying the domain name, document root. In which the website would reference to this document root directory during run of website
Some important settings which we modified to run on ports

I modified this file: merwin.com.conf
This file was present in the director /etc/apache/sites-available/

```
<VirtualHost *:80>
    ServerName merwin.com
    ServerAdmin walu@localhost
 DocumentRoot /var/www/html/merwin.com
 ErrorLog ${APACHE_LOG_DIR}/error.log
 CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>
```

I restarted apache after editing this file

E. Final Wordpress Web installation

With the configuration setup correctly, the final step was to to navigate the installation wizard which would guide me through the creation of my wordpress account, language setup and other important factors like wordpress databases from mysql, site title and tagline.
After completing installation we can see our dashboard!

Working of WordPress:

During the process of setting up wordpress, there were various different themes in which I could select and start making my website. I picked up a sample template and could edit the website to make it look more attractive. The website was named merwin.com the name was of the server as mentioned earlier in the paper was set by me during the configuration setup of wordpress. While editing themes there is another option of creating a website from scratch too even that is possible

User roles:
While editing and figuring out wordpress I found out we can create users too there are different users available to choose or add to the website such as Subscribers, admins, editors or even authors each have their own purpose of handling the website.
I took an example user as a subscriber, as a subscriber I can see recently uploaded posts on the website, browse website or even add comments on the website. Once a comment is put up it will be under review and it will be waiting for the owners or administrators to approve the comments which is a good way to filter out good and harmful comments for the audience. Other roles such as admins can handle most of the websites and check requests by people when owners are not available thus in this way we learnt how to create users, give permissions to the users on the website

VIII.   ABOUT TYPO3

Overview of TYPO3
TYPO3 is a website management tool designed to operate on web servers such as Ubuntu. It's well-known and widely used, making it an excellent choice for both small blogs and large corporate intranets. TYPO3 stands out as a top alternative for businesses and organizations due to its versatility and popularity.

Installation

Typo3 Environment creation
Before installing TYPO3, we made sure that the LAMP stack was fully in working condition. Which involved installing and configuring Apache, MySQL, and PHP. We also added specific PHP modules phpMyAdmin.

Downloading TYPO3
I downloaded the TYPO3 version 11.5.12 from the official website. After that, I extracted the downloaded package version 11.5.12 directly into my directory typo3 which was in my document root This setup allows TYPO3 to be accessed through our domain. To ensure smooth installation and also created a directory FIRST_INSTALL as per requested Typo3 Installation Php file

We created a new MySQL database Merwin specifically for TYPO3, along with a dedicated user 'walu'. The new user was granted appropriate privileges to manage the database effectively.

Configuration
After extracting the files, I further continued to the TYPO3 installation wizard

A.   Initial Setup
I accessed the TYPO3 setup wizard through my browser by typing localhost/typo3, and followed the step wise tutorial by typo3 download and setup documentation

Backend Configuration
After the setup process, I accessed the TYPO3's backend using the admin login which was created during installation and setup the backend environment.
We could create various templates and designs from typo3's amazing flexible interface

B.   User Permission and Management
TYPO3 excels in its user and permission management as well ,we could tailor to the specific roles individuals would fulfill within the organization.

IX.   COMPARISON OF WORDPRESS AND TYPO3

Creating a web based project on both TYPO3 and WordPress allowed for a direct comparison of their capabilities. While WordPress offers a user-friendly and straightforward approach to website creation, the installation process and configuration process of TYPO3 provided a good flexible and user friendly interface. However, configuring TYPO3 required a deeper understanding of its structure and capabilities since it was much more advanced than the way wordpress works. Despite its complexity, TYPO3's robust features, such as detailed permission management, multilingual Contrary to TYPO3, we encountered a low barrier to entry, making setup straightforward, especially for smaller websites or blogs. Its intuitive administration interface facilitated easy management, even for less experienced users. The extensive ecosystem of plugins provided seamless expansion of functionality without the

need for extensive coding or configuration. Overall, WordPress user-friendly interfaces and simplicity make it an ideal choice for those seeking a hassle-free content management experience.

In my project, this allowed me to accurately install and set up a webpage showcasing course information and task lists. The ability to quickly access various themes and plugins facilitated rapid deployment of the website, tailored to our specific needs.WordPress's user-friendly approach and extensive plugin ecosystem cater to a broader audience, particularly those interested in developing smaller websites or blogs.

X. INSTALLING TYPO3 INTRODUCTION PACKAGE

In this task we were supposed to install the official TYPO3 Introduction Package.

About This package: The Introduction Package of TYPO3 is a pre defined and congfigured for us to use, it was a ready to use package that provides us with setup for TYPO3 Content Management System (CMS). The package served as a great representation of TYPO3's capabilities, and website sampling templates, and configurations that would help in guiding me, in how to make a website and what elements to add, how to control user slides, languages for users. The package provided us a website with subtrees already inbuilt in it. It includes various types of themes provided by Typo3 specifically Bootstrap 3 based, and an amazing editor to customize our file and data. The Introduction Package helps many users to become more familiar and user friendly with typo3 with in dept plenty of explanations on features of TYPO3,

Installation: To install Package, Firstly we had to make sure TYPO3 was fully and correctly installed and made sure that any important templates like Imagemagic directories or templates weren't missing during installation, and the TYPO3 CMS was correctly and perfectly downloaded on our ubuntu server server environment. Once the Setup was completed we accessed the Extensions manager and selected predistributed instructions. After that we get a popup which says 'Introduction package' We install that package and then access it via Page option which was visible on the right handside.

Editing the Package Website: As per our semester work we had to edit information on the site and represent our data on the website. Thus began editing the information and added information about Proxmox, cloud computing, ubuntu, wordpress and typo3. I learnt how to add Sub pages for the website using add subtree option, Learnt how to delete pages and how to change languages on the website. In this way I setup my Website and the website name was www.merwin.com and the webpage was Practical cloud computing.

XI. TYPO3 MFA (2FA) SECURITY

MFA, or Multifactor Authentication, is an essential security measure for user authorization and authentication in today's digital world. It significantly boosts security by adding an extra layer of protection. In this Task I created the MFA for the user also after creation we even have secret codes just in case if MFA couldn't get logged in we have an alternative code to login into the system

During User Login attempt the user logs in with their usual credentials. Then, as a second step, they must enter a one-time password (OTP) sent to their phone, which was set up during the MFA process. This two-step verification process makes it much more difficult for hackers to gain unauthorized access to the user's account. In this way MFA provides a robust defense against unauthorized logins and enhances overall security.

XII. EXTENSION MANAGEMENT INSIDE TYPO3

Extension management inside TYPO3 explains all the different kinds of extensions for us to use. There are different extension options such as install extensions, composers, support of extensions, get extensions, and get preconfigured distribution extensions. The one we used for the introduction package downloading was get preconfigured distribution. However, there are other options such as extensions downloading and getting instructions. The composer installation option is not needed since we did not install Composer, making that option irrelevant to us, but the other options can be relevant in some way.

In the main extension management tab, we have different kinds of extensions such as bootstrap packages, web viewing, web, template editors, view options, and more. We have to download the extension from the TYPO3 website from the one we have created, and we just have to click on the required extension, and it will automatically get installed on our website. That is the extension management inside TYPO3.

XIII. MAINTENANCE SECTION

The next task we were given was to explore the maintenance section of the TYPO3 interface. The maintenance section deals with 8 sections in total, but 7 important ones. The first section explains about flushing TYPO3 and PHP cache. When we use the website, cache is generally generated in the back end and thus for new data to be visible, the old cache has to be deleted. Thus, the flush cache option can be used to delete the old web cache. The second option was to analyze database structure. It just displays if the database structure is fine. Temporary Files Removal or Deletion deletes the cache generated so it can be flushed, allowing newer assets to be generated from all the website pages or the web pages. They are temporarily stored and not permanently stored. Only after deleting the temporary files should we flush all the cache, or else it would result in some problems on the website. The Rebuild PHP Autoload Information is nothing but a dump load generated by website and web cache. The next option was analyzing database tables. It scans all the tables required for our website. We can even log on to PhpMyAdmin to view all the tables from our merwin.com website.

Administrative User: This particular option is very crucial because if the owner is not free to make changes, the administrator can easily access and check out the problems for the users or manage the website with administrative privileges.

Backend User: The reset backend user option resets all the preferences and settings of backend users. Manage Language Packages helps to manage all the languages which can be used on our website. In this way, the maintenance section is very important for us during TYPO3 website creation and CMS management.

XIV. SETTINGS TAB

The Settings tab has 6 sections in total: Extension Configuration, Changing Install Tool Password, Managing System Maintainers, Configuration Presets, Feature Toggles, and Configuring Installation-Wide Options. Extension Configuration helps us configure the code and snippet for Extensions so they can work as needed. The Password Change Tool is for setting a new password for the install tool when in standalone mode. System Maintainers help maintain the system when the owner is away; it is more or less similar to Admins. Configuration Presets is used when associating with image processing, allowing us to debug. Feature Toggles help us enable and disable features of TYPO3. Configuring Installation-Wide Options helps us modify settings written to the local configuration php file.

XV. ENVIRONEMNT IMAGE PROCESSING PART

Environment Image processing is an essential part of typo3 it helps us understand what is lacking in picture quality in our system and how we could improve it to help users view our site with better quality. Examples were given such that in some figures the problem of staircase problem was present in which pixels were looking incomplete and the images didn't have smoot lines or curves but my system showed better figures that means our system is compatible with current web Visibility

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