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Design and Implementation of personal cloud network Using Network Attached Storage(NAS)

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Abstract

Middleware is a key enabler of advanced digital transformation, simplifying the process of creating and managing smart applications, although its development poses significant challenges. The adoption of cloud software solutions has seen a significant increase, driven by their scalability, cost-effectiveness, and ease of deployment. As companies adopt these solutions to meet their software needs, the importance of customization within these cloud solutions becomes very important but somewhat complex and expensive. Customization may allow applications to be designed according to the specific requirements of the organization, enhancing user experiences and overall efficiency, but it does not enhance the capabilities of devices and personal use. NAS systems include user management capabilities that allow administrators to create user accounts, set up groups, and grant permissions on a per-file or per-share basis. This ensures that sensitive data can be kept secure while still allowing essential access to authorized users. Hence, the need for dedicated storage that facilitates cloud software-as-a- service solutions and a comprehensive examination of the benefits and challenges of customization within the cloud comes into play. As is well known, real-time resource-intensive applications require low latency, large data rates, and high computing and storage resources. Mobile cloud computing systems cannot meet the requirements of these applications due to high communication latency. For this reason, newly acquired edge computing applications are in dire need of a new design or a fundamental redesign. In addition, edge computing does not use the legacy capabilities of cloud computing. However, despite the many benefits, customization also poses challenges that must be addressed. The problem that will be discussed in this research paper is to enable the capabilities of mobile devices through more flexible and convenient uses of cloud resources through privacy in the process of information storage. This paper presents the motivation for using private networks.

To overcome the challenges of cloud computing and mobile edge systems, propose a private mobile edge cloud in which mobile and fixed devices such as sensors, robots, home appliances, and smartphones are interconnected via wireless local area networks, based on the related infrastructure, creating a cloud data center in a small area with network storage space for ease of use. Also provides a general background and reviews with previous papers. Finally, the research is guided by a systematic exploration of interconnected private network storage solutions.

Keyword: NAS, Cloud-Network, Resources, Benefits, DSM.

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1. Introduction

1.1 NAS Software and User Interface

The versatility of a network-attached storage (NAS) device depends not only on its powerful hardware, but also on its sophisticated software and user interface (UI). NAS software turns physical hardware into a smart, intuitive storage solution that can do more than just store files. NAS devices can run proprietary software or open source software that can be customized by the user. Proprietary solutions, such as Synology's DiskStation Manager (DSM) or High-quality network providers of qualified teacher status (QNAP's QTS), are designed to be user-friendly and often come with dedicated support. Open source solutions like FreeNAS (now known as TrueNAS CORE) offer more customization but rely on the support of a community of developers [1].

In a smart city, urban traffic is intelligently engineered. In this way, there will witness uniform traffic in all parts of the city. Citizens of a smart city follow administrative procedures electronically and do not visit in person except for essential cases. In a smart city, houses are also smart and manage energy consumption in such a way that peak energy consumption is minimized. In fact, a smart city includes many smart components. Smart home, smart transportation, smart government, smart public safety, and smart health are some of the components of a smart city. Thus, until the components of a city are not smart, the city has not been smart [2].

1.2 Smart Health and the Internet of Things

In smart health, the current and historical condition of individuals is examined and their future health status is estimated. Also, in case of physical and mental problems, the nearest medical center is immediately notified.

To use smart health services, it is necessary to connect gadgets that measure physical condition to individuals. These gadgets monitor the physical condition and physical changes of individuals at any time and report the problem in case of abnormal conditions. The central system, geting historical data on the physical condition and diseases of individuals, is able to predict the occurrence of diseases or identify them in the early stages. In this way, with the smartization of health, there will witness a significant improvement in the general health of society [3].

Seven technologies have led to the emergence of the "smart" attribute for cities. These seven technologies are as follows:

1- Control and instrumentation: Tools are used to control and monitor existing technologies. In fact, these control tools are the eyes and ears of the city. Some of these tools include [4]:

1. Smart water, electricity and gas meters
2. Air quality sensors
3. CCTV cameras (closed-circuit television)
4. Road sensors

These tools are very suitable for remote control and management.

2-Communication networks and establishing connections: The communication of devices with each other and with the data center is of great importance in smart cities. The data collected by these devices is processed and examined. Various communication networks are used for this purpose, including the following [5]:

- Urban Wi-Fi network
- Rf-mesh networks
- Cellular networks

3- Cooperation between institutions and members of the city: This system ensures the cooperation of all city technologies. One of its advantages is preventing the city's activities from interfering with each other and being blocked. It also allows a city to select and start construction activities by calculating the reliability factor.

4- Security and Concealment: Among the methods and policies of data security is their concealment. Data security plays a vital and important role in creating security between people in smart cities [6].

5- Data Management: Data is one of the main pillars in the formation of smart cities. It is correct classification has a significant impact on the formation of smart cities.

6- Computing resources: It primarily includes powerful computers and then the collected data and the needs requested by the smart city. Today, smart cities are moving towards the development of cloud computing. Using cloud computing, there is no need to provide systems with high processing power.

7- Analysis: The data collected in the data center must be analyzed [7]. Data collected in the data center must be analyzed. Data analysis in data centers is critical to identifying potential security threats, utilizing a variety of methodologies to detect, assess, and respond to vulnerabilities.

The concept of NAS, which stands for Network Attached Storage, emerged in the early 1980s as network systems began to become common in business environments. The 1990s marked a significant turning point in data storage technology, particularly with the emergence of companies like NetApp and Auspex Systems. These organizations refined storage solutions, making them more manageable and scalable compared to previous methods. This evolution was driven by the increasing demand for efficient data management in various applications [8]. While the advancements in storage technology during the 1990s were significant, some critics argue that the rapid evolution of cloud storage solutions in the following decades has overshadowed these early innovations, leading to a shift in focus towards more decentralized storage models. Since then, NAS has evolved significantly, becoming both more affordable and easier to operate, opening its doors beyond large enterprises to small businesses and even home users, given its benefits. Innovation in NAS systems has kept pace with the evolution of network technology and protocols, ensuring that as businesses grow and need more sophisticated data storage and retrieval solutions, NAS can grow with these demands [9].

In this study, a general framework is presented on which data is received from a cluster of edge computing devices. This information is modeled using a direct data flow to a NAS as a network-attached storage unit. Appropriate actions are taken via the Internet for users in these clusters. An approach is devised using fast online automatic clustering algorithms.

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2. The concept of network attached storage

In a world that increasingly revolves around data, the ability to store, manage, and access large amounts of information efficiently and securely is critical. Network Attached Storage (NAS) servers directly address this essential need, offering a compelling way for individuals and businesses to access and share data. Let's explore why NAS is so important in today's digital landscape.

Businesses are not alone in this trend, as consumers are also generating and consuming data at unprecedented rates. NAS addresses this issue by providing ample space that can expand with user needs, making it a viable way to accommodate dynamic data growth.

One of the key benefits of NAS is centralization, and when you're dealing with large amounts of data, it's not easy to keep it all in one centralized location. Centralization simplifies data management, reduces the risk of data loss, and facilitates backup and disaster recovery practices. It allows users from different devices and locations to access information reliably and consistently (Fig 1. show Cloud NAS).

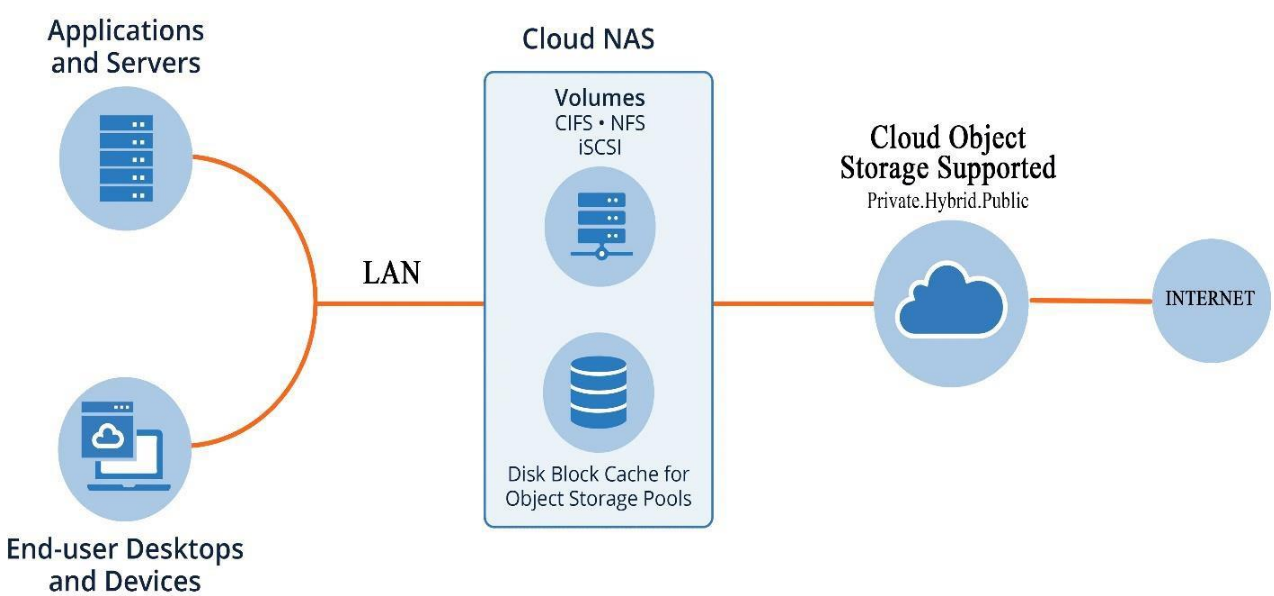

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Fig 1. Cloud NAS

NAS servers are not limited to traditional file storage and sharing, and have become multimedia hubs, providing a centralized platform for storing and streaming media content such as photos, music, and movies across multiple devices.

A NAS is a stand-alone network appliance that consists of storage drives, typically arranged in arrays and connected directly to a network switch or router, and operates at its core using a specialized network-centric operating system (OS) designed for file storage and sharing. Unlike DAS (DAS is a system used to distribute wireless signals throughout a defined area), which is connected to a single computer, NAS serves multiple clients and devices over a network. NAS devices communicate using the following protocols. (Fig 2. show Abstract model of a network)

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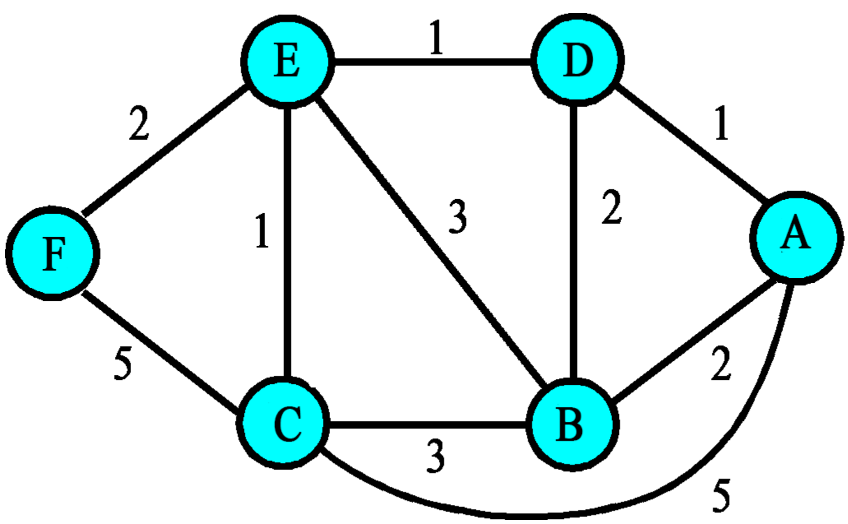

Fig 2. Abstract model of a network

To be able to do all of this, a centralized storage system for edge computing is required to deliver the data to the many clients connected to the network via a LAN.

NAS systems include user management capabilities that allow administrators to create user accounts, set up groups, and grant permissions on a per-file or per-share basis. This ensures that sensitive data can be kept secure while still allowing essential access to authorized users.

Network-attached storage is not just about software and networking, it’s also a hardware-based solution. Well look at the key components that make up a NAS device and consider drive selection and connectivity options. A NAS device typically houses one or more hard drives in an array, and these devices come in a variety of shapes and sizes, but the core hardware components remain largely the same across models:

Storage drives: The primary media in a NAS are hard disk drives (HDDs) or solid-state drives (SSDs). HDDs are favored for their higher capacity and lower cost, while SSDs offer faster access speeds and reliability at a higher price.

Processor (CPU): The CPU is the brain of the NAS, managing the device's operations and responses, and can range from basic processors for simple file storage to powerful processors for more demanding tasks like media encryption or running multiple applications. Memory (RAM): RAM helps with data processing and the ability to perform multiple tasks at once, and more RAM allows for faster data access and the ability to serve more users simultaneously.

Motherboard: The motherboard connects all of the NAS components and has an embedded system that is optimized for file storage and network communications. Power Supply Unit (PSU): Ensuring smooth operation, PSUs are built to be efficient and reliable, and are often designed to operate 24/7 without interruption.

Data sets can be organized in a NAS environment regardless of architecture, with data served through a standard conversation between the client and the NAS services, relying on efficient, low-cost, and scalable storage. NAS file servers provide faster access to data, and are easier to manage and configure. They offer a number of benefits compared to other storage solutions. They are specifically designed to connect to a network, allowing multiple users to access them simultaneously. This makes NAS devices an ideal solution for small businesses or home offices that need to share data between multiple computers.
In case using a Synology NAS and a Cisco Catalyst 8-port switch. Only the server PCs and their hard drives will run the virtual drivers. They are connected via the switch to the Synology NAS. Inside the NAS are the virtual machines and the backup. This setup allows all PCs to be used as a cluster which increases high availability and their resources are combined and used efficiently.

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3. Materials, Methods & Configuration of the Synology

This section will cover the hardware configuration and operation process. The hardware topology for the project is shown in Fig 3.

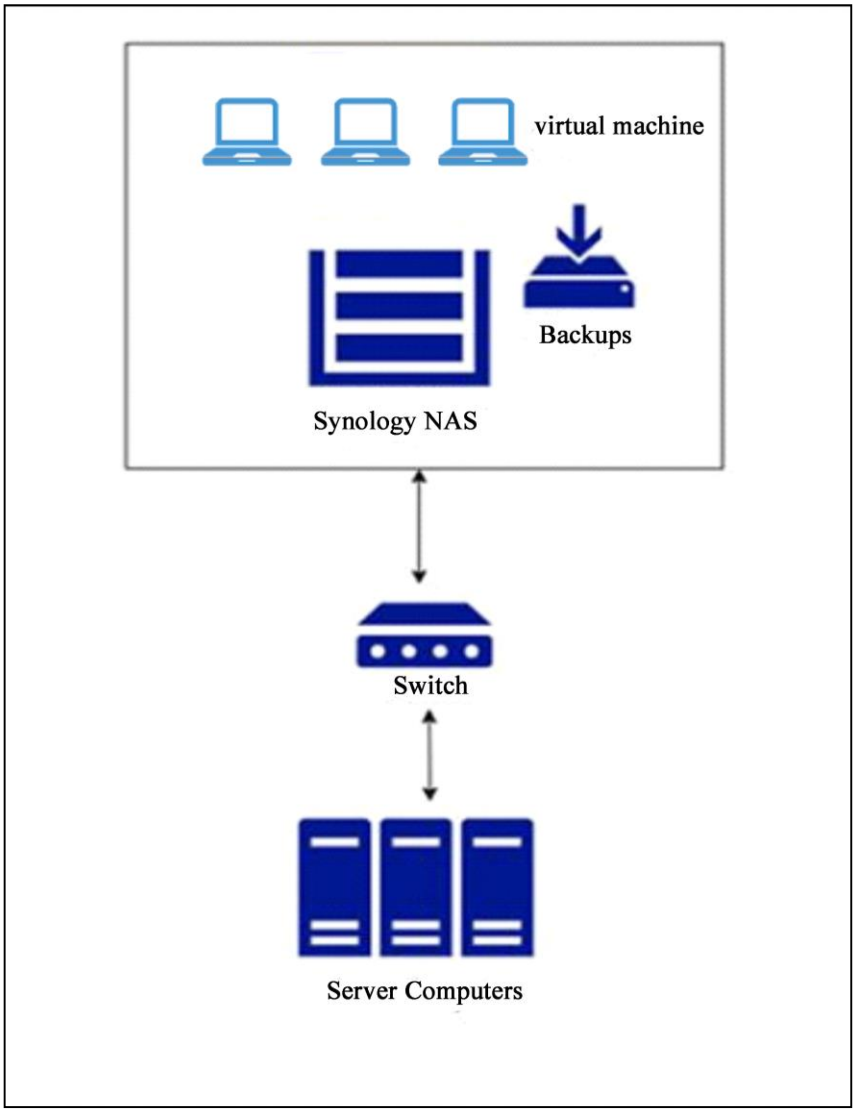

Fig 3 Hardware Topology

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The network is segmented using VLANs (VLAN is an emerging data exchange technology for virtual workgroups to divide LAN devices logically rather than physically into segments) to allow users to access only the necessary services.

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They will have access to VLAN 10, so they will only be able to access the virtual machines. Behind VLAN 30 is the management panel. For the identity management service VLAN 20 is reserved for the Identity Management service because it will maintain a list of all users authorized to access the server. VLAN 40 (dedicated to the Synology NAS system) enables the server devices to take advantage of the hard drives and virtual machines of the NAS system stored there as indicated in Fig4 show VLAN Topology.

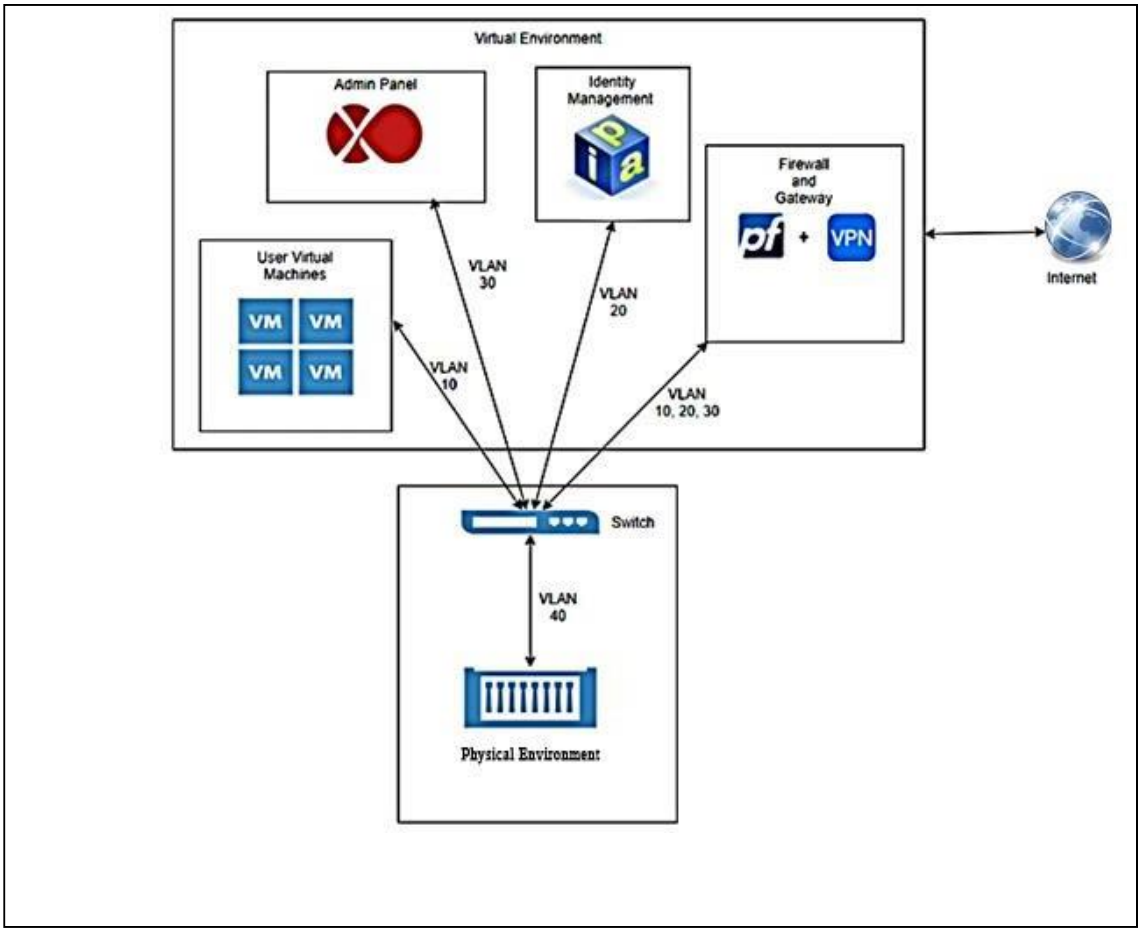

Fig 4 VLAN Topology

The Synology disk station is the network storage unit of choice here. Five 2TB WD Red SA500 SSDs have been added to the network storage unit. The last one is used for backups and four of them are used to set up a RAID 10. RAID 10 is a storage technology in case of disk failure that is used to prevent data loss. The name is short for RAID 1+0, as level 1 and level 0 are two different

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technologies. RAID 10 uses both at the same time. RAID 0 is called disk partitioning for performance savings and uses two or more disks at once by dividing the data equally among all the drives. It is usually combined with RAID 1, which provides disk mirroring as it will not provide any fault tolerance, so if one drive fails, the entire array will fail. Therefore. This will create two identical disks that work at the same time. If one fails, it will not disable the other. This technique would require at least two disks and would cut the available storage space in half. [10] Two of the four disks were stripped and then cloned with the other two, leaving a total of 4 TB for the virtual machines. Using this method, one drive per cluster could fail over without affecting server operations. Figure 5 is a screenshot of the Synology NAS Storage Manager.

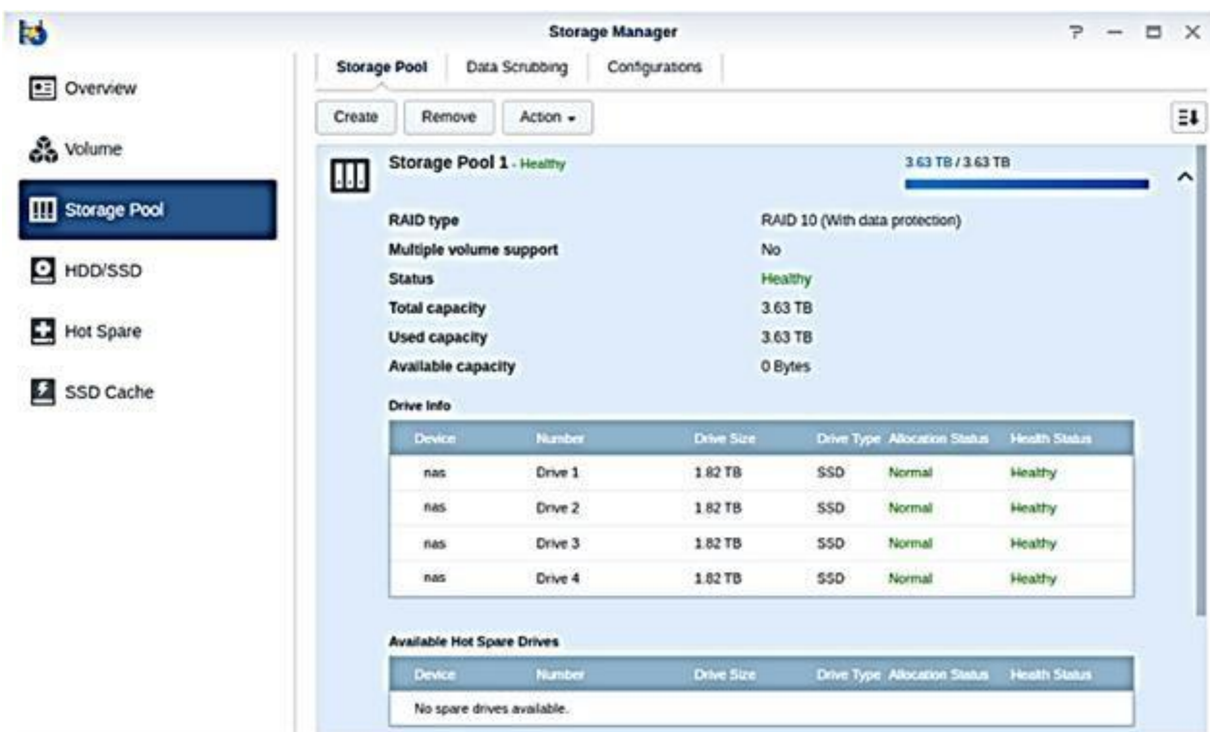

Fig5. RAID 10 Setup on Synology NAS

Other VLANs are created for management and login credentials, and for segmentation. VLANs help divide the network into manageable sections. Here, traffic is divided into management, user, shared services, and storage VLANs, as can be seen in Table 1. Even though the VLANs use the same infrastructure, devices operate as if they were on their own network [11].

Table 1. VLAN Information

Vlan Name	IP Address	Number
User	192.168.10.1/24	10
SHARED Services	192.168.20.1/24	20
Admin	192.168.30.1/24	30
Storage	192.168.40.1	40

As shown in Figure 6, the switch has eight Ethernet ports which can all handle 1 Gigabit per second speed. cables from ports 2-5 are connected from switch to NAS, cables from ports 6-8 are connected from switch to server PCs and one cable from switch to the Internet.

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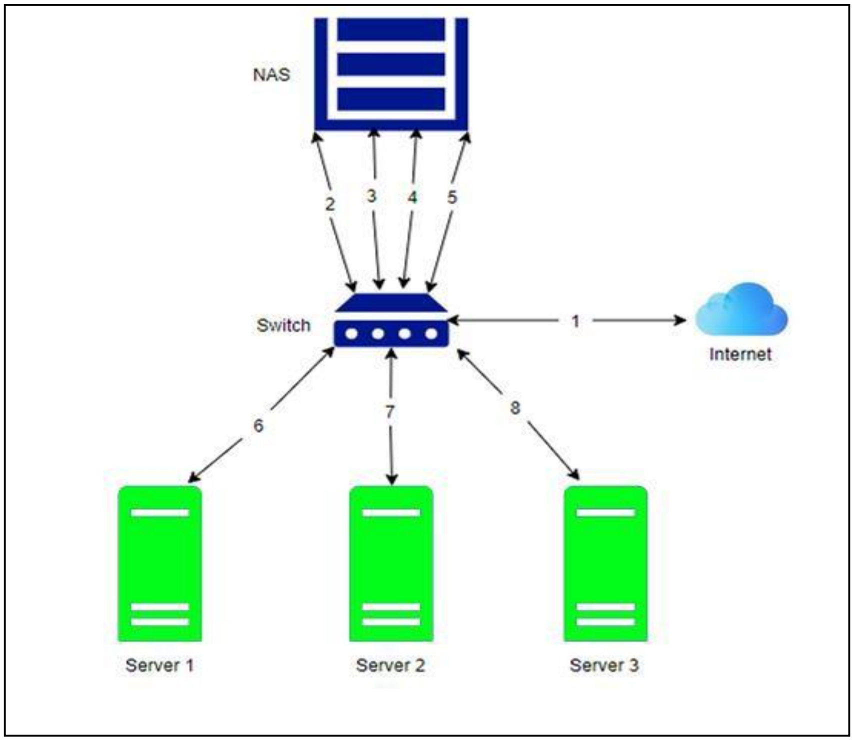

Fig6. Switch Cabling

It requires a reload of the firewall, and after adding everything when the installation is complete, it is possible to log in to the identity management via the web UI, the address is the domain name that was used during the installation. The web UI for identity management is relatively easy to use.

Initially, a user group is created. It is for all clients that connect to the switch. When a new user appears, he will need a user account to access the system in order to be able to access the Synology NAS. This account is created in the Users tab by adding a new user.

To improve performance, parallel processing techniques are used. When data processing tasks are distributed across multiple threads or nodes, the workload can be split and processed simultaneously, resulting in faster processing. The bounds on the resources (for example, time & space) required by a sequential

algorithm is measured as a function of the input size, which reflects the amount of data to be processed [10].

These bounds are expected asymptotically using following standard notation:

1. $T(n) = O(f(n))$ If there exist positive constants c and n_0 Such that $T(n) \leq c\, f(n)$, for all $n \geq n_0$

2. $T(n) = \Omega(f(n))$ If there exist positive constants c and n_0 Such that $T(n) \geq c\, f(n)$, for all $n \geq n_0$

3. $T(n) = \Theta(f(n))$ If $T(n) = O(f(n))$ and $T(n) = \Omega(f(n))$.

The running time of a sequential algorithm is by the number of basic operation required by the algorithm as a function of the input size . This relationship is crucial for understanding algorithm efficiency and complexity. The time complexity, often denoted as T(n), is expressed in terms of the input size n, allowing for the analysis of how the algorithm's performance scales with larger inputs. [12].

4. Conclusion

This research presented a method for building a virtual environment that can be used to achieve an efficient method of data storage. Network-attached storage (NAS) represents a significant evolution in how data is stored and accessed. From its inception to its transformation into a staple in homes and businesses alike, it has proven to be a versatile and essential technology in our data-driven world. It combines hardware and software to provide an easy-to-use storage solution that meets the needs of a wide range of users. The potential of NAS is seemingly limitless, with developments such as ever-increasing network speeds, advances in storage technologies, and intelligent software integration promising to further enhance its capabilities. Proximity of data to the strategic location of users or frequently used services reduces the physical or logical distance between the data and its users, ensuring rapid access with improved responsiveness. Server configurations offer multiple possibilities when used for penetration testing. While efficient configurations improve penetration

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test results, the inherent complexity and potential for human error in server configurations can lead to security vulnerabilities being missed. This underscores the need for continuous monitoring and evaluation of configurations, as these configurations can either enhance or hinder vulnerability detection. Future studies may shed light on the importance of proper configuration management and the effects of misconfigurations on security assessments. The complexity of server configurations in penetration testing can significantly impact the effectiveness of vulnerability detection. Effective configurations can improve security assessments, while misconfigurations often lead to missed vulnerabilities. NAS systems are likely to become smarter and integrate with IoT devices and AI technologies, providing better user experiences. In general, a server functions by enabling its users to perform the required tasks. The integration of each component provides efficient availability and resources for users. Configuring multiple virtual machines to run simultaneously is sufficient. However, some changes are still needed in the future. Therefore, continuous monitoring and evaluation of server configurations is essential to reduce human error and ensure robust security in the future.

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