IOT-NAS Using Raspberry Pi

Sindukuri Teja
Department of Computer Science
Amrita School of Engineering
Amrita Vishwa Vidyapeetham,
Amritapuri, Kollam, India
am.en.u4aie22049@am.students.amrita.edu

Vaigandla Hemanth Kumar
Department of Computer Science
Amrita School of Engineering
Amrita Vishwa Vidyapeetham,
Amritapuri, Kollam, India
am.en.u4aie22053@am.students.amrita.edu

Mittapalli Santhosh kumar
Department of Computer Science
Amrita School of Engineering
Amrita Vishwa Vidyapeetham,
Amritapuri, Kollam, India
am.en.u4aie22033@am.students.amrita.edu

Pathuri SriRam
Department of Computer Science
Amrita School of Engineering
Amrita Vishwa Vidyapeetham,
Amritapuri, Kollam, India
am.en.u4aie22040@am.students.amrita.edu

ABSTRACT— The amazing call for for storage potential movements with an more and more netestablished global and a good exertions market, which has pushed the boom of networked storage solutions. amongst those techniques, communityconnected storage has taken the lead. NAS structures are essentially defined by means of the creation of the file machine and alternate with the emerging technology that seem to blur conventional differences. these developments allow NAS devices to embed an awful lot of the report gadget inside the garage devices themselves, thereby growing their focus on specialization. on the identical time, SBNAS structures leverage the ease and capability of SBC devices just like the Raspberry Pi to give cheaper, lowstrength, and scalable garage answers for applications as broad as nonpublic record sharing through small agency garage. This paper gives a top level view of the architecture, benefits, and limitations of SBNAS implementations, putting an emphasis on their function in imparting capability extensions to small computing structures. On NAS technology, that is speedy catching on, understanding of the core and new networked storage technology is essential for the stopconsumer to hold tempo with the growing yearning for potential and efficient get admission to to statistics.

key phrases— Storage Appliances, iSCSI, NASD, and Petal

1.INTRODUCTION

In the wake of the modern digital generation, the want for an effective, dependable, and scalable answer for storing information has in no way been so essential. The exponential boom in facts volume, now not most effective created with the aid of enterprise companies and consumers but additionally through a diversity of digital packages, necessitates robust storage systems. along side many different solutions for garage, NAS profits recognition because of its simplicity, low fee, and performance. This paper is dedicated to the improvement and deployment of a NAS system the use of most effective one board of Raspberry Pi, outlining its relevance, benefits, and viable packages in both private and small business environments.

networkattached storage, or NAS, is a tool in particular designed simplest for storage; it's miles a dedicated record garage device that enables LAN users to have a crucial, handy garage device via a general Ethernet connection. unlike traditional storage systems, NAS gadgets are built for storing recordprimarily based data and as a result very effective in handling huge amounts of data, together with documents, pix, and videos. Key advantages of NAS encompass simplicity of management, ease of get entry to, and scalability of garage without complexities inherent in extra superior technologies for information garage, which includes garage location Networks.

In this NAS venture, the choice to go together with the Raspberry Pi dictates all the way down to the subsequent very key reasons. This small, pocketpleasant laptop, the Raspberry Pi unmarriedboard pc, is available in as a super model for overall performance versus price and simplicity of use. With its low energy intake, top notch network of builders, and huge sources, it stands proud for DIY NAS initiatives. moreover, flexibility in the Raspberry Pi permits for large customization to tailor the NAS machine as according to person requirements.

These days, there is a surprising amount of virtual information. corporations generate massive forms of data every day: from purchaser facts and financial facts to digital belongings and operational data. On the alternative aspect, personally, a number of private facts is accumulated, along with photographs, movies, files, and multimedia documents. records explosion has also ensued with efficient approaches of garage, permitting now not simply voluminous statistics but also accessibility, protection, and reliability of the data. NAS structures help solve such issues via a centralized garage answer, without problems doable and on hand by using many gadgets over a community.

possibly it is in the location of centralized facts garage that NAS offers the greatest gain. due to the fact data storage is It

means data is easily stored, filed or retrieved from a single site, which is centrally situated. In a business environment, it promotes teamwork and efficiency within extraordinary workers who may require accessing and sharing any number of files. For an individual, NAS provides a less complex method of managing none public documents in a way that consequently aids easy retrieval of necessary papers at all times.

Other areas of great focus in the digital landscape of today are the issues regarding data protection and the threats of cybersecurity. These have advanced widely, making the safety of all your stored data of avid importance. Most wholly designed NAS systems incorporate some natural security capabilities into the system, enabling your data to be kept safe from unauthorized access and probable loss. These include features that allow user authentication, encryption, and daily backups of the stored data. Security should, once again, be facilitated through a secure boot system; a firewall set up in the event of a Raspberry Pi taken with the NAS mission. One of the very qualities of NAS structures in scalability.

NAS devices can easily be updated to incorporate storage space to meet requirements in information storage, demonstrated both in additional hard drives or sectoring with other NAS devices. This makes NAS quite valuable for smaller agencies and persons who can anticipate growing data storage needs. Its modularity allows such scalability within the Raspberry Pi, which is valuable for starting small and expanding as needed.

2. Background

The moving levels of specialization in storage systems could significantly revolutionize the manner in which computers are assembled and marketed, but it's too early to know for sure.We can make a few educated inferences, however, from 4 architectures in active or recent research and development: storage appliances, iSCSI, NASD, and Petal. storage appliances provide one commercially published example of nonclustered specialized NAS; ISCSI represents the other extreme, the leastspecialized storage interface. Of these, Petal and NASD were two nascent research efforts closer to server bottleneckfree clustering storage. They fundamentally differ in the ways information is written and accessed: each with its special advantages and challenging circumstances that provide a precious insight to relate future storage generation trends.

A. **Storage Appliances**

At one extreme, simplicity; at the other, complexity, NAS systems range from terabyte servers to disk drives with Ethernet plugs. One excellent example of this is Quantum's Snap!A lowcost singleboard computer is merely affixed to one or two disk drives in a simple box—the server has only a power cord and Ethernet connector.

Internal construction need be no more than a few ungainly circuit boards strewn with wires: one for the computer, and another, perhaps, for the diskdrive controller. More integrated garage appliances should embed those boards, processors and their code, saving the cost of extra parts. This, however, may do yet more initially to create loss of reliability and to make hardware design still more complex by moving NAS software into the diskdrive controller. Once the move is made, intrinsic cost advantage could be built into the offering from diskdrive manufacturers over vendors with two board solutions, impelled through demand for low cost file servers.

B. **NASD**

NASD was a project at Carnegie Mellon University from 1995 that recommended how the management of the aggregation of storage devices is likely done with the help of a valuable policy server, yet enabling direct statistics transfers among gadgets and customers. The asymmetry of controls allows for clients to communicate directly with the devices once access is granted through the server, which improves performance; NASD keeps metadata on appliances instead of within clients to reduce opportunity: clients were provided signing credential token by policy servers, which were signed at every request.

Although NASD encouraged report interface abstraction since it kept the report descriptors and oblique blocks at the software, it not at all provided any reinforce for directory listing operations, because of this thereby leaving the parsing of directories to users and with not one intervention from the device.

C. **ISCSI**

But the influence of the net on garage generation is not limited to NAS; layering a blockdegree messages SAN protocol over internet protocols, for example, as illustrated by using USC's information Sciences Institute Netstation assignment considering the fact that 1991, is such an example. Certainly, what it is the IETF's IPS working group is defining is a standard for blocklevel command and data movement over IP with iSCSI, that is, internet SCSI, in any such way that it coordinate security, naming, discovery, and configuration, as well as QoS for IP storage. soon, startup companies intend to embed iSCSI into storage "routers" that are similar in concept to RAID systems.

Although iSCSI interfaces do not provide file device capability, like FCP in Fibre Channel, work is in progress to enable interoperability with other SANs. ISCSI is the first real step in the generalization of storage networking that generalizes the way storage devices network, in the way that IP networks do. How much of the Internet Protocol Suite really can be put to use by members of the IPS Working Group in terms of implementing highspeed data transfer using TCP and proposed alterations to TCP, which have been tuned for storage traffic congestion control, is something of an open question.

D. **Petal**

Petal turned into the call of a Compaq systems research middle research project focused on scalable storage with arrays of disk "bricks." instead of a report interface, this furnished a blockorientated interface. It applied a allotted machine wherein controller functions had been separated throughout a cluster of servers with same access to regular global state. To boom capacity for the Petal device, additional servers could be added to the cluster without losing performance. Although logically speaking it was similar to a RAID system on a symmetric multiprocessor, Petal used distributed consensus algorithms as opposed to shared memory to handle global state. Global state was available on every server; hence, the administration of the Petal systems was quite easy and also allowed servers to be added or removed and devices to be reconfigured dynamically. While Petal ran on top of LAN protocols, the advent of iSCSI standardized a lot of the custom LANbased SAN protocol of Petal, hence providing greater flexibility and interoperability within the storage networking environment.

3. Literature review

NAS plays an important role in data storage in the sphere of digital transformation. The paper considers NAS implementation on a platform such as the Raspberry Pi, with high emphasis on its application to personal and small organizations. NAS has proven to be outstanding in heterogeneous data management, offering advantages in stored data management, accessibility, scalability, and cost reduction, hence improving collaboration and efficiency at work. Research in NAS has concentrated on it because of the strong security features, such as user authentication, encryption, and regular backups that make it safe from any kind of unauthorized access. Modular design in NAS makes it comfortable to upgrade withowing data needs. Setting up NAS with a raspberry Pi for small organizations would be rather low-cost. Research has shown that this is feasible, power-efficient, and supported by communities.

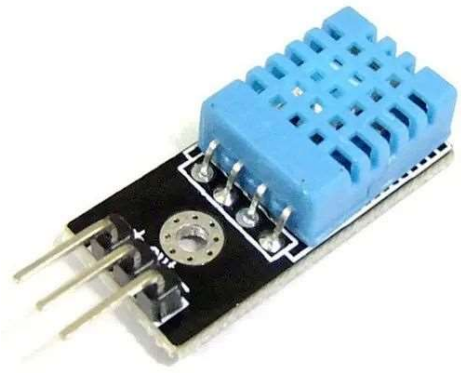
Overall, though, Raspberry Pi-based NAS systems are not so powerful as higher-end appliances. That makes them very suitable for home models and small offices, even as those with huge data needs may require even more powerful systems. A number of studies suggested considering more heavyweight devices for better performance. The flexibility or customization options given by Raspberry Pi-based NAS systems are undeniable but require further study for enhancement in security and reliability.

4.Hardware Components and Circuit diagram

1. Raspberry Pi 4 Model B
   - ❖ Power Supply: The Raspberry Pi 4 is powered by a 5V/3A USBC power adapter. Ensure a stable power source to avoid disruptions.
   - ❖ GPIO Pins: Various sensors and peripherals are connected to the General-purpose Input/Output (GPIO) pins of the Raspberry Pi.

2. **FAN**
   - ❖ Power Connection: The fan is connected to the 5V and GND pins on the GPIO header of the Raspberry Pi. This ensures the fan operates when the Raspberry Pi is powered on.
   - ❖ Control Circuit: Optionally, a transistor and a GPIO pin can be used to control the fan's operation based on temperature readings.

3.**Temperature Sensor**
   - ❖ Sensor Type: A DS18B20 temperature sensor is commonly used. It has three pins: VCC, GND, and Data.
   - ❖ Connections:
     - ✓ VCC: Connect to a 3.3V pin on the Raspberry Pi.
     - ✓ GND: Connect to a GND pin on the Raspberry Pi.
     - ✓ Data: Connect to a GPIO pin (e.g., GPIO4) and pull up the line using a 4.7kΩ resistor between the VCC and Data pins.



4.Methodology

This methodology describes the steps and processes of instituting NetworkAttached Storage using a Raspberry Pi. Among them, good hardware setup, software installation, and configuration, performance testing, steps securing, and maintenance. A set of procedures that would like to provide a trustworthy and faultfree solution for a personal or small business scenario.

2. **Hardware Selection and Setup**

2.1 **Select Raspberry Pi Model**.

Chosen Model: The Raspberry Pi 4 Model B, with maximal processing capacity and an 8 GB integrated RAM, is convenient for large data operations, intense volumes, and storage.

Other required hardware includes power source of a Raspberry Pi, accessible free source of power, microSD card of a sufficient size—preferably over 32 gigabytes for the operating system—big external hard drives or slower SSD drives for the storage of data, network cable, and a fitting box, which is compatible with accommodation of a Raspberry Pi and storage.

1.2. **Hardware Connection**

Implementation: I assemble the Raspberry Pi and insert it into the enclosure once I have removed the microSD card, and I plug in the below external storage devices to USB ports. Ensure that a stable network connection is set between the wired Ethernet and the router.

2. **Software Installation and Configuration**

2.1 **Operating System Installation**

Operating System: Download the Raspberry Pi OS Lite and flash it to the microSD card. We can do this using either Raspberry Pi Imager or balenaEtcher. The only reason I used the Lite version was to keep the resources free for as many NAS features as possible.

2.2 **Raspberry Pi configuration**

First setup Boot the Raspberry Pi and follow the first boot configuration option. Its options have to set is to set the filesystem to be expanded, set up locale, and time zone. Also update all packages `sudo apt update && sudo apt upgrade``

Network Configuration: To give a static IP address to the Raspberry Pi to have constant network accessibility.

2.3 **NAS Software Installation**

Software Selection: OpenMediaVault is one of the most used NAS software due to its userfriendly user interface; omnipresent on Raspberry Pi; this would give all the NAS services using a comprehensive web interface.

Installation Steps:Download installation script of OMV from the website.

The execution is done, and then one should follow the instructions, which are to be applied; then, it is ready to reboot the system.

2.4 **NAS Services Configuration**

Web Interface Access: Use the static IP provided to log into the OMV web interface.

Configure Storage: Assign, Start, and Mount up external storage drives, make file system creation, and shared folder configuration.

User Management: Create user accounts and grant permissions for shared data access and security.

Network Services: Set access rights for the existing and predefined network services including SMB/CIFS for Windows shares, NFS for Unix/ Linux shares and FTP .three. performance trying out and assessment

3. **Benchmarking overall performance**

gear and Metrics: the subsequent gear may be used for benchmarking performance, hdparm, dd and iperf if you want to get study and write speeds with respect to storage devices and community throughput

Conditions for Testing: Testing should be done under diversified conditions like single and multiuser access, control on different loads, and variation in the loads at the desired levels.

Stress Testing: Stress tests must be conducted for data transferred in large amounts, and the NAS should be accessed with a number of devices running at the same time. The system should be kept under observation to see its stability regarding the performance bottlenecks or related issues.

Backup and Recovery: The backup programs included in OMV shall be validated and tested with their approach for backup and recovery. The backup, upon recovery shall be done conscientiously and shall have no hardware failover or data corruption.e.

4. **Security Mechanisms**

4.1 **Security Policies**

User Authentication: Setup userauthentication systems and ensure proper policy deployment on strong passwords.

Encryption: This point suggests enabling encryption for sensitive data in transit and at rest. Tools that can be used for encrypted backups are rsync and SSH—these two for secure remote connections.

Firewall and Updates: With regard to access by unauthorized persons, a good firewall is used for the system. This can be done by the proper working of all frequencies of required systems in an updated manner and updating of all packages so that vulnerability by the system can be avoided..

4.2 **Monitoring and Maintaining**

Monitoring Tools: For checking the performance of the system, we can generally prefer Munin or NetData—it also the configurations set of some Warnings on crucial issues.

Routine Maintenance: There should have routine maintenance, system upgrading, and the start of backups and examination of the safety of storage.

5. **Documentation and User Training**

5.1 **Documentation Preparation**

This would involve documenting the procedure from the hardware setup, software installation up to configuration steps. Where necessary, include examples in terms of screenshots and commands.

5.2 **User Guides**

Procedures to start using the NAS will complete the entire process in terms of file management. Include some early troubleshooting mechanisms.

Training Sessions and Workshops The users should be taken through workshops to have them acquainted with working on the NAS, its features, and means of storage. They must be informed on approaches of having access to shared folders, user permissions, and given an average appreciation of what primary NAS renovation involves..

6. Real World Applications

1. **Personal Data Storage and Backup**

1.1. **Automating Backups**

PC and Mobile Device Backups: Technology that enables personal computers and mobile device backups to be done automatically. Components of the data are stored regularly to render recovery simpler, for example, when a system malfunctions.

Photo and Video Backup: How to: Back up all your photos and videos from your Smartphone. Protect your data by freeing up your storage space and clearing your phone of unnecessary documents.

2. **Small Business Data Management**

2.1 **File Sharing and Collaboration**

Shared Workspaces: A virtual team project folder should be set up for the more coherent collaboration process of employees, which they can share as a team.

Remote Access: Employees should get access to the HDD outside the office, for example, by cutting VPNs and secure web interfaces.

2.2 **Document Management and Archiving**

Centralized Repository: The basic principle of business documents should be organized by different categories in a common repository to eliminate chances of access, enforce controlled versioning, and data policy adherence.

Archiving: This is a process that safeguards both the storage of essential business documents, the housing of historical documentation among others, and the fulfillment of authority obligations.

3. **Home Automation and IoT Integration**

3.1 **Smart Home Hub**

Home Automation Data: Save and process information about multiple domestic smart home appliances like a security camera, smart thermostat, and motion sensor right in one monolithic device, making home automation systems significantly simpler in operation. (S0E)

Home Assistant Integration: Running the NAS in conjunction with interfaces such as Home Assistant for automation and diversification of intelligent home appliances under the control of the user. (I0E)

3.2 **IoT Data Logging**

Sensor Data Storage: Obtaining and keeping statistics from various types of IoT devices including ones related to the environment and weather as well as energy monitors. (I0I)

Data Analysis: Automatic data capturing and analysis to understand not only the overall home functions or commercial processes, but also to take thoughtful decisions in a time frame. (IE)

4. **Enhanced Data Security and Privacy**

4.1 **Private Cloud Storage**

Personal Cloud: Offers personal cloud storage that works just like public cloud options but with less privacy issues because public clouds are hosted by commercial providers. (I0I)Data Encryption: At relaxation and In Transit: Create facts safety for records at relaxation encryption and switch safety protocols to make certain handiest depended on resources have access to touchy records. (I0I)

4.2 **Secure Data Sharing**

Confidential Data: The sharing of confidential records with the assist of trustworthy companions is done in a information concepting machine that is strong and properlycovered with all of the safety functions at the proper region. (S0I)

Access Control: Establish strong access control strategies for permission management, and therefore certain data can only be reached by such authorized users. (S0I)

CONCLUSION

Storage systems are becoming the dominant investment in corporate data centers and a crucial asset in ecommerce, making the rate of growth of storage a strategic business problem and a major business opportunity for storage vendors.in order to fulfill consumer desires, storage structures should consolidate resources, deploy speedy, be centrally managed, be distinctly to be had, and permit facts sharing. It should additionally be feasible to distribute them over international distances, make them comfortable in opposition to external and inner abuse, and scale their performance with ability. Putting storage in specialized systems and accessing it from clients across a network provides significant advantages for users. Moreover, the most apparent difference between the NAS and SAN versions of network storage use of Ethernet in NAS and Fibre Channel in SAN is not a core difference and may soon not even be a recognizable difference.as an alternative, we may also have NAS servers that seem like disks, disks that connect to and operate on Ethernet, arrays of disk bricks that, as far as the person is worried, function as one massive disk, and arrays of clever disks that verify every command against the rights of person users.

REFERENCES

[1] 1. Benner, A. Fibre Channel: Gigabit Communications and I/O for Computer Networks. McGraw Hill, New York, 1996.

[2] Callaghan, B. NFS Illustrated. Addison Wesley Publishing Co., Reading, Mass., 2000.

[3] Gibson, G., et al. A costeffective, highbandwidth storage architecture. In Proceedings of the ACM 8th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS) (San Jose, Calif., Oct). ACM Press, New York, 1998, 92 103

[4] Hartman, J. and Ousterhout, J. The Zebra striped network file system. In Proceedings of ACM Symposium on Operating Systems Principles (SOSP) (Ashville, N.C., Dec.). ACM Press, New York, 1993, 29 43.

[5] Hitz, D., Lau, J., and Malcolm, M. File systems design for an NFS file server appliance. In USENIX Winter 1994 Technical Conference Proceedings (San Francisco, Jan. 1994).

[6] Kronenberg, N., et al. VAXclusters: A closely coupled distributed system. ACM Transact. Comput. Syst. (TOCS) 4, 2 (May 1986), 130 146.

[7] Lee, E. and Thekkath, C. Petal: Distributed virtual disks. In Proceedings of the ACM 7th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS) (Cambridge, Mass., Oct). ACM Press, New York, 1996, 84 92.

[8] McKusick, M., et al. A fast file system for Unix. ACM Transact. Comput. Syst. (TOCS) 2, 3 (Aug. 1984).

[9] Network Appliance, Inc. DAFS: Direct Access File System Protocol, Version 0.53 (July 31, 2000);

[10] Sachs, M., Leff, A., and Sevigny, D. LAN and I/O convergence: A survey of the issues. IEEE Comput. 27, 12 (Dec. 1994), 24 32

[11] Van Meter, R., Finn, G., and Hotz, S. VISA: Netstation's virtual Internet SCSI adapter. In Proceedings of the ACM 8th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS) (San Jose, Calif., Oct.). ACM Press, New York, 1998, 71 80;