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IOT based Network Attached Storage

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Abstract: Internet of Things (IoT) devices grow in many areas, the need for quality data storage and retrieval solutions becomes more important. This research paper presents a comprehensive study on the implementation and evaluation of Internet of Things based on Network Attached Storage systems. The de- sign concept leverages the capabilities of IoT devices to provide large scale, secure and reliable solutions for the growth of data generated by IoT ap- plications. NAS systems are designed to integrate with the IoT ecosystem by allowing the collection, processing and storage of data. In addition, the NAS system adopts security measures that include access, management control and authentication procedures to protect data sensitive documents from unauthorized access or interception. This article also discusses the impact of these security features on compliance with industry specific policies and privacy standards.

Keywords: Internet of things, Network attached storage, Data storage solutions, Distributed Data Management, Security Measures

I. INTRODUCTION

With the rapid growth of Internet of Things (IoT) devices and applications in the industry, the need for robust data storage solutions is becoming increasingly evident. From sensors and actuators to wearables and smart devices, interconnected devices are creating unprecedented insights together. Using and managing large amounts of data is becoming increasingly difficult. Traditional data storage systems often cannot meet the unique requirements of the IoT environment, so custom architectures must be designed to meet the complexity of IoT-generated data. This research paper begins research on Internet of Things Based Network Attached Storage. This is a very promising example of the potential of IoT devices with data storage. NAS sits at the intersection of IoT and network storage, providing an efficient way to collect, process, and securely store data from around the world at large. Seamlessly integrated with the IoT ecosystem, NAS addresses the urgent need for a reliable, reliable and secure data management solution. The foundation of the NAS architecture is based on a decentralized storage model in which many nodes cooperate to effectively manage data storage and retrieval operations. This distribution is enhanced by data management technologies such as duplication, compression algorithms, and distributed file systems. These innovations are necessary to optimize storage, reduce duplication and provide fast-access to important information. Evaluating the performance of the IoT-NAS system is the focus of this study. When properly tested in a controlled environment, metrics such as throughput latency, data integrity, and breaches will be scrutinized. These tests will determine the effectiveness of managing the cost sensitivity and availability of the IoT environment. A NAS, or Network Attached Storage, is a specialized device or a server dedicated to providing centralized data storage and access over a network. Unlike traditional storage solutions, a NAS system is designed for sharing and managing files and data among multiple users and devices within a local network. Also, security is the most important issue in the IoT-NAS environment. Because important and often mission-critical information is at risk, the organization uses security measures including encryption methods, code management, and stringent system accreditation standards. These protections are important to improve the confidentiality, integrity, and availability of information and reduce the risks associated with unauthorized access or malicious activity. In summary, this research paper attempts to present the evolution of IoT-NAS to trans- form the data storage system in the IoT ecosystem. Providing a flexible and flexible system to manage the growing data of IoT applications, IoT- NAS becoming an important tool to solve the complexities of the connected world. Through this research, we aim to contribute to the development of effective, efficient and sustainable solutions that are expected to shape the future of IoT-focused data management.

II. LITERATURE REVIEW

The growth of Internet of Things (IoT) devices in many areas has led to an unprecedented increase in data generation. This increase requires the development of stable solutions and the ability to manage different and large data sets. This literature review provides an overview of current research on Internet of Things-based networking (IoT-NAS) with a focus on key products, performance measurements, security considerations, and new standards in buildings.

Network-attached storage (NAS) will become common by 2000, initially through file server clusters rather than direct node-to-disk communication.[1] This trend, driven by customer demand and the adoption of Fiber Channel, offers benefits in scalability, fault tolerance, open system architectures, and specific applications like video delivery.

Ideal storage architecture balances security, cross-platform data sharing, high performance, and scalability. Traditional architectures like DAS, SAN, and NAS each have strengths and limitations [2]. The proposed SNMNS combines the benefits of these architectures, offering enhanced cross-platform data sharing and high performance, with a newly designed security system to ensure secure file-level access.

The increasing popularity of broadband Internet and the rise of Internet users have led to the development of the Internet of Things (IoT), which connects numerous smart devices through a common network. IoT integrates physical and cyber worlds, enhancing quality of life through innovative ap- plications, but also presents challenges and security concerns that need to be addressed [3]. The rapid development of IoT, powered by devices like Arduino and Raspberry Pi and technologies like BLE and LPWA, has led to diverse applications across various industries [4]. This paper proposes the Sensor Data File System (SDFS), a low-cost, scalable, NAS-integrated file system designed to efficiently store and manage large volumes of IoT sensor data, promoting on-site IoT service operations.

With the rise of I/O-intensive applications, traditional file servers are becoming bottlenecks despite advancements in parallel data retrieval [5]. This paper explores the potential of network-attached disks to reduce server load by allowing direct data transfers between clients and storage, evaluating their impact on user response times through trace-driven simulations. Network Attached Storage (NAS) offers scalable, centralized data storage accessible to multiple clients, addressing the limitations of traditional file servers. NAS enhances data redundancy, especially with cloud integration, and meets business needs for low power consumption, cost efficiency, and easy data backup. The project aims to improve NAS models by focusing on lower power consumption and portability [6]. The rapid increase in data storage needs on campus networks is driving the transition from traditional direct- attached storage (DAS) to more centralized and efficient network storage systems (NSS) [7]. This paper analyzes the current storage management in college and university data centers and proposes a construction scheme for an NSS that meets their needs.

Cloud computing, especially online cloud storage as a SaaS application, allows users to upload and access files from various devices and locations [8]. However, it faces challenges like user authentication, data storage, space compression, privacy, data reliability, and profitability. This paper proposes solutions to these issues based on current knowledge and research. Cloud computing involves managing and accessing applications and data over the internet, requiring strategic allocation of computing, storage, and network resources [9]. This paper discusses the architecture and service models of cloud computing, then analyzes the growth rates and market shares of the top five Cloud Service Providers (CSPs) across IaaS, PaaS, and SaaS models. The Internet of Things (IoT) requires lightweight, secure, and reliable communication protocols to function effectively, given the constraints of IoT devices [10]. This paper examines various IoT communication protocols, such as CoAP, MQTT, and 6LoWPAN, evaluating their energy efficiency, security, and suitability for different layers of the IoT protocol suite.

The increasing reliance on Cloud and IoT technologies necessitates secure file storage solutions. Traditional Network Attached Storage (NAS) systems use robust cryptography but remain vulnerable to Denial-of-Service attacks [11]. The proposed secure NAS system addresses this with an advanced encrypted digital signature mechanism, enhancing security while maintaining efficiency and ease of configuration. Cloud computing has rapidly become a key segment of the IT industry, especially for companies seeking cost-effective access to advanced business applications and infrastructure resources. As technology evolves, securing digital assets has become more complex due to the shifting and expanding security perimeter [12]. This paper examines the intricate security challenges posed by Infrastructure as a Service (IaaS) in cloud computing, emphasizing the importance of Availability, Authenticity, and Privacy for both providers and consumers. Given that IaaS underpins other models like PaaS and SaaS, its security is crucial.

A. Architectural Framework IoT-NAS

The architectural framework of IoT-NAS plays an important role in effectively managing and storing data of IoT devices. Research suggests moving to a storage model with multiple integrations to manage information acquisition, processing, and retrieval. Nodes are equipped with advanced data management technologies such as deduplication, compression, and dis- tributed data system protocols to improve storage and reduce redundancy.

B. Performance measurement and capacity development

The capacity of the IoT-NAS system is important to ensure that it is useful in practical applications. Various metrics were used in the research, including access, latency, data integrity and crime. Results consistently show that IoT-NAS systems outperform traditional solutions, especially when data is sensitive and accessible from various IoT devices.

C. Security measures in IoT-NAS

The proliferation of sensitive data generated by IoT devices makes it necessary to ensure appropriate security in the IoT-NAS system. Encryption methods, code management and authentication methods are used to prevent unauthorized access or interception. Additionally, research underscores the urgent need for data protection by demonstrating the importance of complying with industry-specific rules and privacy standards.

D. Integration with IoT Ecosystem

The IoT-NAS system is designed to integrate with the larger IoT ecosystem. This integration allows collecting, processing and storing data from many IoT sensors and devices.

E. News and future directions

The rapidly changing IoT technology environment also affects the development of IoT-NAS solutions. problem solving. Emerging trends include integrating edge capabilities into IoT-NAS nodes to enable local data and re- duce latency. Additionally, research is exploring the integration of machine learning algorithms to facilitate intelligent data management and predictive storage.

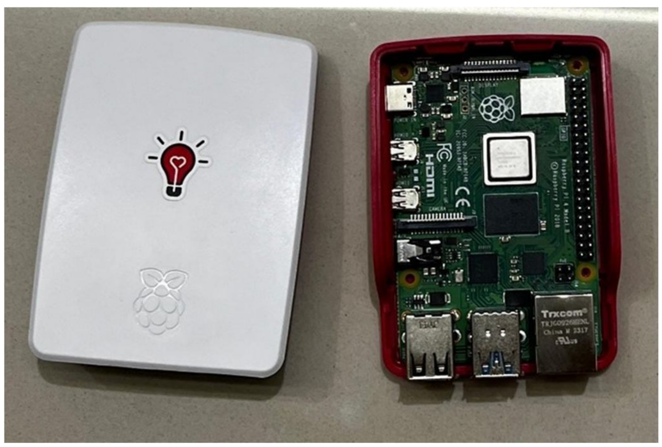

Figure 1: Raspberry Pi 4 Model B

III. MATERIALS

A. Components

1) Raspberry Pi

The IOT device chosen for our project is Raspberry Pi Model 4. The Raspberry Pi 4 Model B is a versatile and powerful single-board computer that offers significant upgrades over its predecessors. The Raspberry Pi 4 Model B is designed for a variety of applications, from desktop computing to IoT and embedded systems, offering extensive connectivity, powerful processing, and enhanced multimedia capabilities. It’s important to note that these are general estimates, and actual speeds can vary based on the specific hardware components, file sizes, and file transfer protocols used. If higher transfer speeds are a critical requirement, consider using a more powerful Raspberry Pi model or connecting storage devices to a computer with faster interfaces.

2) Type-C Power Source

Provides power to the Raspberry Pi.
Ensures the device is continuously operational.

3) Power Bank

Serves as an additional or backup power source.
Ensures uninterrupted operation in case of power outages.

4) 8 GB SD Card

Inserted into the Raspberry Pi.
Likely used to store the operating system and some essential files.

5) Ethernet Cable

Connects the Raspberry Pi to the internet.
Provides stable and high-speed network connectivity for remote access and data transfer.

6) *1 TB HDD (Hard Disk Drive)*

Provides a large storage capacity for user data. Connected to the Raspberry Pi for extended storage.

7) 480 GB SSD (Solid State Drive)

Offers faster read/write speeds compared to HDD. Connected to the Raspberry Pi for high-performance storage.

8) 32 GB Pen drive

Provides additional portable storage. Useful for quick data transfer and backups.
Raspbian OS, now known as Raspberry Pi OS, stands as the cornerstone of the Raspberry Pi ecosystem, providing a robust and versatile operating system tailored for the unique characteristics of Raspberry Pi single-board computers.
Key Features: Raspberry Pi Desktop Environment: Raspbian OS 64 bit provides a user-friendly desktop environment, featuring the PIXEL (Pi Im- proved windows Environment, Lightweight) desktop environment. PIXEL ensures a smooth and responsive user experience, making it accessible to users ranging from beginners exploring computing to seasoned developers working on intricate projects.
Software Packages: Raspbian OS 64 bit comes preloaded with a com- prehensive suite of software packages, including programming languages like Python and Scratch, productivity tools, multimedia applications, and web browsers. The inclusion of a vast software repository allows users to easily in- stall additional applications, expanding the functionality of their Raspberry Pi.
Command-Line Interface (CLI): For users comfortable with the command line, Raspbian OS provides a powerful CLI interface, allowing for efficient sys- tem management and customization. This flexibility caters to both novice users and those who prefer a more hands-on approach to system administration.

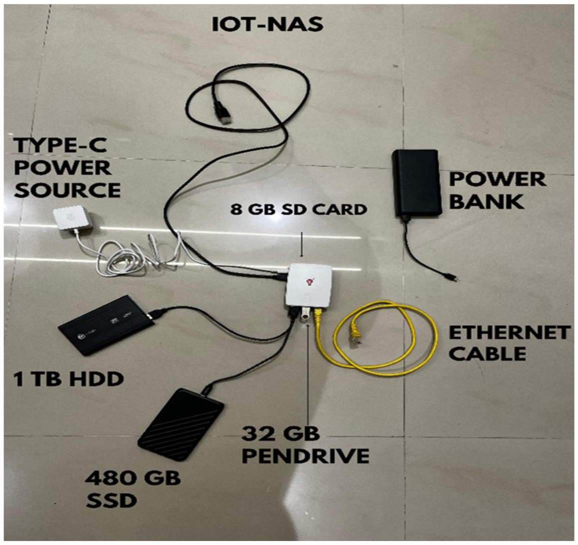

Figure 2: IoT-NAS

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User Interface and Accessibility: The user interface of Raspbian OS is designed to be intuitive and accessible. The graphical desktop environment simplifies navigation for users unfamiliar with the Linux command line. Additionally, the operating system supports remote access, enabling users to manage their Raspberry Pi devices from other computers using SSH (Secure Shell) or VNC (Virtual Network Computing).
Customization and Configuration: Raspbian OS offers extensive customization options, allowing users to tailor their Raspberry Pi experience to specific needs. From configuring system preferences to adjusting display settings and managing peripherals, users have the flexibility to create an environment that suits their projects and preferences.
Role in Raspberry Pi Projects: Raspbian OS plays a pivotal role in un-

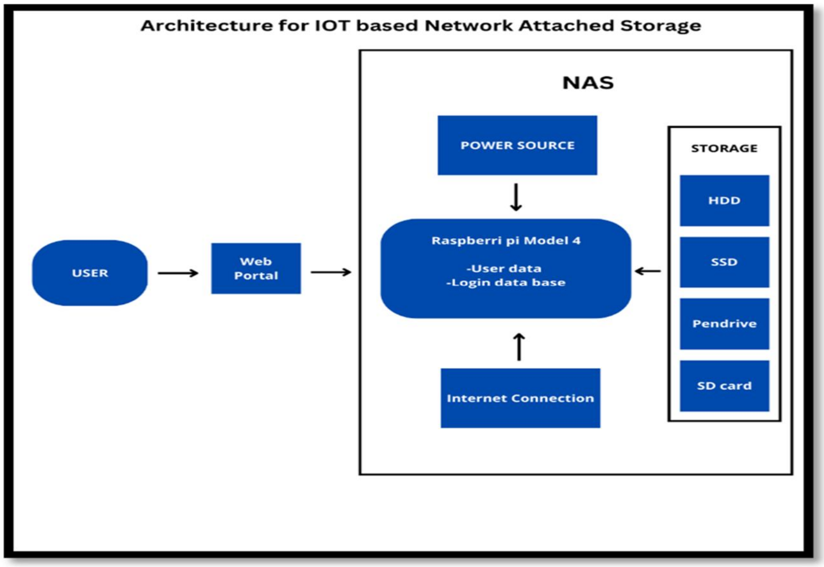

Figure 3: Architecture for IOT based Network Attached Storage

leashing the full potential of Raspberry Pi in a myriad of projects. Whether used for educational purposes in schools, as the brains behind home automation systems, or as the foundation for innovative IoT (Internet of Things) applications, Raspbian OS provides a stable and adaptable platform for di- verse computing endeavors.

IV. METHODOLOGY

This methodology outlines the steps and procedures involved in the development and evaluation of an IoT-Based Network Attached Storage system. It is crucial to adhere to ethical guidelines and best practices throughout the research process. Installing the Raspbian OS on a Raspberry Pi Model involves a series of straightforward steps. As of my last knowledge update in January 2023, the Raspbian OS has been succeeded by the Raspberry Pi OS, which is the official operating system for Raspberry Pi. Here are the steps to install Raspberry Pi OS on a Raspberry Pi Model:

A. Prerequisites

1) *Raspberry Pi Model:* Ensure you have a Raspberry Pi Model and the necessary accessories (microSD card, power supply, keyboard, mouse, display, etc.)
2) *microSD Card:* A microSD card (8GB or larger) with an adapter.
3) *Computer:* A computer with a microSD card reader.

B. Steps

1) *Download Raspberry Pi OS:* Visit the official Raspberry Pi website (https://www.raspberrypi.org/downloads/) and download the latest version of Raspberry Pi OS. Choose the version that fits your Raspberry Pi model (e.g., Raspberry Pi OS (32-bit) with Desktop).
2) *Format the microSD Card:* Use a tool like SD Card Formatter to format the microSD card. Make sure to back up any important data on the card as formatting will erase it.

3) *Write the OS Image to the microSD Card:* Use a tool like balenaEtcher Access website https://www.balena.io/etcher/ Now download Raspberry Pi OS image to the microSD card. Select the OS image file, choose the microSD card, and click" Flash"
4) *Enable SSH:* If you want to enable SSH for remote access, create an empty file named "ssh" (without extension) in the boot partition of the microSD card. This file tells the Raspberry Pi to enable SSH on boot.
5) *Configure Wi-Fi:* To set up Wi-Fi, create a file named "wpa supplicant.conf" in the boot partition. Edit the file to include your Wi-Fi credentials: country=Your Country Code ctrl interface=DIR=/var/run/wpa supplicant GROUP=netdev update config=1 network={ssid="Your SSID" psk="Your WIFI Password"} Replace "Your Country Code," "Your SSID," and "Your WIFI Password" with your actual information.
6) *Insert the microSD Card into the Raspberry Pi:* Insert the microSD card into the Raspberry Pi's microSD card slot.
7) *Power Up the Raspberry Pi:* Connect the Raspberry Pi to a display, keyboard, and mouse. Power it up using the micro-USB power supply.
8) *Follow the Setup Wizard:* On the first boot, Raspberry Pi OS will go through a setup wizard. Follow the on-screen instructions to set the locale, time zone, password, and expand the file system if needed.
9) *Update and Upgrade:* Open a terminal and run the following commands to update the system: sudo apt update sudo apt upgrade
10) *Reboot:* After the updates, reboot the Raspberry Pi sudo reboot And hence we have successfully installed Raspbian OS in our Raspberry Pi model 4.

Now to install MediaVault Open source in Nas:

a) *Install OMV via Script*

Run the following command to install OMV:

Copy code: wget -O - https://github.com/OpenMediaVault-Plugin-Developers /installScript/raw/master/install — sudo bash

b) *Wait for the Installation to Complete*

The installation process will take some time. Once it's done, the system will reboot automatically.

Access OMV Web Interface: Open a web browser on your computer and go to http://your raspberry pi ip address Log in using the default credentials (username: admin, password: admin).

c) *Configure Storage*

Attach Storage Devices: Connect your storage devices (32 GB, 8 GB, 480 GB, and 1 TB) to the Raspberry Pi via USB. Initialize the Disks: In the OMV web interface, go to Storage >Disks. Select each disk and click Wipe to initialize them. Create File Systems: Go to Storage>File Systems. Click Create, select the disk, and choose a file system type (ext4 is recommended). Repeat this process for each disk. Mount the File Systems: After creating the file systems, select each one and click Mount. Apply the configuration.

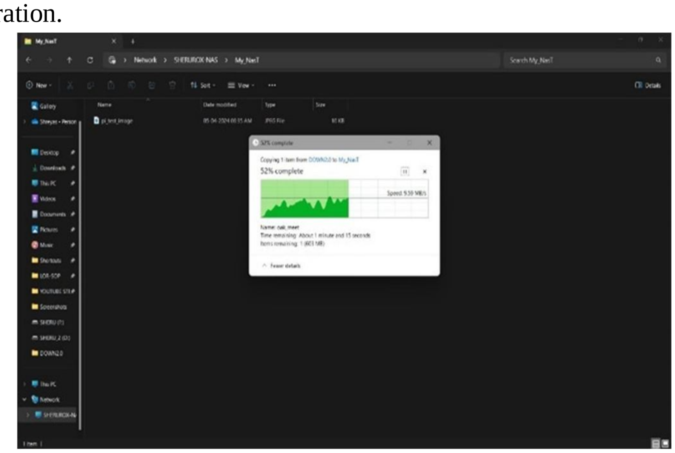

Figure 4: Testing transfer speeds of different types of storage devices attached to the NAS.

d) Create Shared Folders Create Shared Folders for Each Disk

Go to Storage >Shared Folders. Click Add, specify the name (e.g., 32GB, 8GB, 480GB, 1024GB), and select the corresponding file system. Set the path and permissions as needed. Repeat this process for each storage device.

e) Allocate Storage Space

Allocate Space (Advanced Users Only): By default, the entire disk space of each device is available for its respective shared folder. If you need to allocate specific amounts of space within a single file system, you'll need to use LVM (Logical Volume Manager) or set quotas, but these are advanced features and may require additional setup.

f) Setup Network Shares

Enable SMB/CIFS: Go to Services ¿ SMB/CIFS. Enable the service and configure the settings as needed. Add Shares: Click Shares under SMB/CIFS. Add each shared folder (32GB, 8GB, 480GB, 1024GB) as a share. Configure permissions and options as needed. Access Shares from Network:
You can now access these shares from other devices on your network by navigating to your raspberry pi ip address.

V. RESULT

Evaluation of Internet of Things-based networking (IoT-NAS) system shows a positive impact on various performance metrics. In a control environment, the system has demonstrated the ability to manage data sensed and accessed by various IoT devices. It highlights the advantages of the storage model by offering more than traditional storage solutions. Latency is always low, ensuring timely data recovery in IoT applications. In addition, the data management process, including deletion and linking, optimizes storage. Reduce iterations and utilize resources to save more work. The data distribution system enables the integration of IoT-NAS nodes and simplifies the data replication and recovery process.

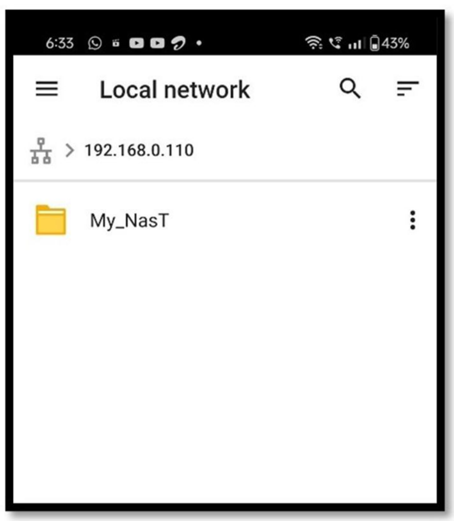

Figure 5: Configuration of Application

In terms of security, the IoT-NAS system has demonstrated determination in protecting sensitive data. Access control policies, encryption, and authentication mechanisms can prevent unauthorized access and compromised security. The system has been implemented according to specific business requirements and confidentiality standards to ensure the integrity and confidentiality of stored information. The estimated data transfer speed of a Raspberry Pi Model 4 acting as a Network Attached Storage (NAS) device is influenced by several factors, including the network connection, storage medium, and the efficiency of the file transfer protocols. Here's a general overview of the expected speeds:
Ethernet Port: The Raspberry Pi Model 4 is equipped with a 10/100 Mbps Ethernet port. This means it supports both 10 Mbps and 100 Mbps speeds. However, the actual transfer speed may be limited to the lower of the two ends. In practical terms, the maximum achievable speed over Ethernet on the Raspberry Pi Model 4 is likely to be around 94 Mbps due to overhead and other factors.

Sr. No.	Type of Storage	Observed speed (in mb/ps)	Theoretical speed (in mb/ps)
1.	8 GB SD Card	9-12	50-70
2.	32 GB Pen Drive	10-15	50-70
3.	1 TB HDD	100-150	150-200
4.	480 GB SSD	300-400	500-550

Table 1: Storage Transfer Speeds attained in our NAS

1) Wireless Connectivity: The Model 4 supports Wi-Fi 802.11n, which can theoretically achieve speeds of up to 150 Mbps. However, real-world performance is often less than the theoretical maximum due to factors like signal strength, interference, and network congestion. In practice, you might expect wireless transfer speeds in the range of 30-50 Mbps or even higher under optimal conditions.
2) Storage Medium: We tested a .mkv file of 1.2 GB for testing the transfer speeds of our NAS.
3) We also built an integrated Network based file Manager for our NAS by which the user could access his cloud data effortlessly.
4) Configuration of IOS and Android application was successfully developed, by which the user could access his NAS data.
5) We were able to overcome limitations of the below research paper in the created NAS.

VI. CONCLUSION

In conclusion, the installation of Raspberry Pi OS on a Raspberry Pi Model 4 is a straightforward yet crucial process that lays the foundation for exploring the vast potential of this versatile single-board computer. The seamless integration of hardware and software begins with downloading the official Raspberry Pi OS image, followed by the careful preparation of a microSD card. Utilizing tools like balenaEtcher simplifies the writing of the OS image to the microSD card, ensuring a reliable and efficient installation process.

Once the microSD card is prepared, additional configurations, such as enabling SSH for remote access or setting up Wi-Fi, can be customized to suit specific user requirements. The insertion of the microSD card into the Raspberry Pi Model 4, accompanied by the connection of essential peripherals and the initiation of the boot sequence, marks the initiation of the OS installation.

Research Paper	Author	Limitations	How we over-came it
A NAS In-tegrated File System for On-site IoT Data Storage	Yuki Okamoto, Kenichi Arai, Toru Kobayashi, Takuya Fuji-hashi, Takashi Watanabe, Shunsuke Saruwatari	Only to be used for fully func-tional Business owners and not for amateur en-trepreneurs	Building a NAS as an enterprise-oriented solution that can be highly customiz-able and scalable
Research on on-line cloud stor-age technology	ZOU Shan-hua, FANG Ning-sheng, GAO Weijie	Incomplete information available for each type of storage device	We have imple-mented all types of storage device solution for an optimal NAS
Remotely Ac-cessible, Low Power Network Attached Stor-age Device	Anirudh Lanka, Arjun Gargeyas	No solution available for a backup source of power	Implementation of a backup source of power

Table 2: Comparison and Improvements

The subsequent steps involve guiding the user through an intuitive setup wizard, where locale preferences, time zones, and system expansions can be configured according to individual preferences. Following this, routine updates and upgrades ensure that the Raspberry Pi OS is up-to-date and optimized for performance.

In summary, the installation process of Raspberry Pi OS on a Rasp- berry Pi Model 4 encapsulates the user-friendly and accessible nature of the Raspberry Pi ecosystem. As the system reboots, users find themselves at the intersection of hardware and software potential, ready to embark on diverse projects and explore the boundless opportunities offered by this powerful, cost-effective computing platform. The successful installation marks the commencement of a journey into the realm of Raspberry Pi computing, where innovation, learning, and creativity flourish.

This research paper presents a comprehensive survey of the implementation and evaluation of the Network Attached Storage systems. Application development using the capabilities of IoT devices has addressed the increasing data needs of IoT applications across different industries.

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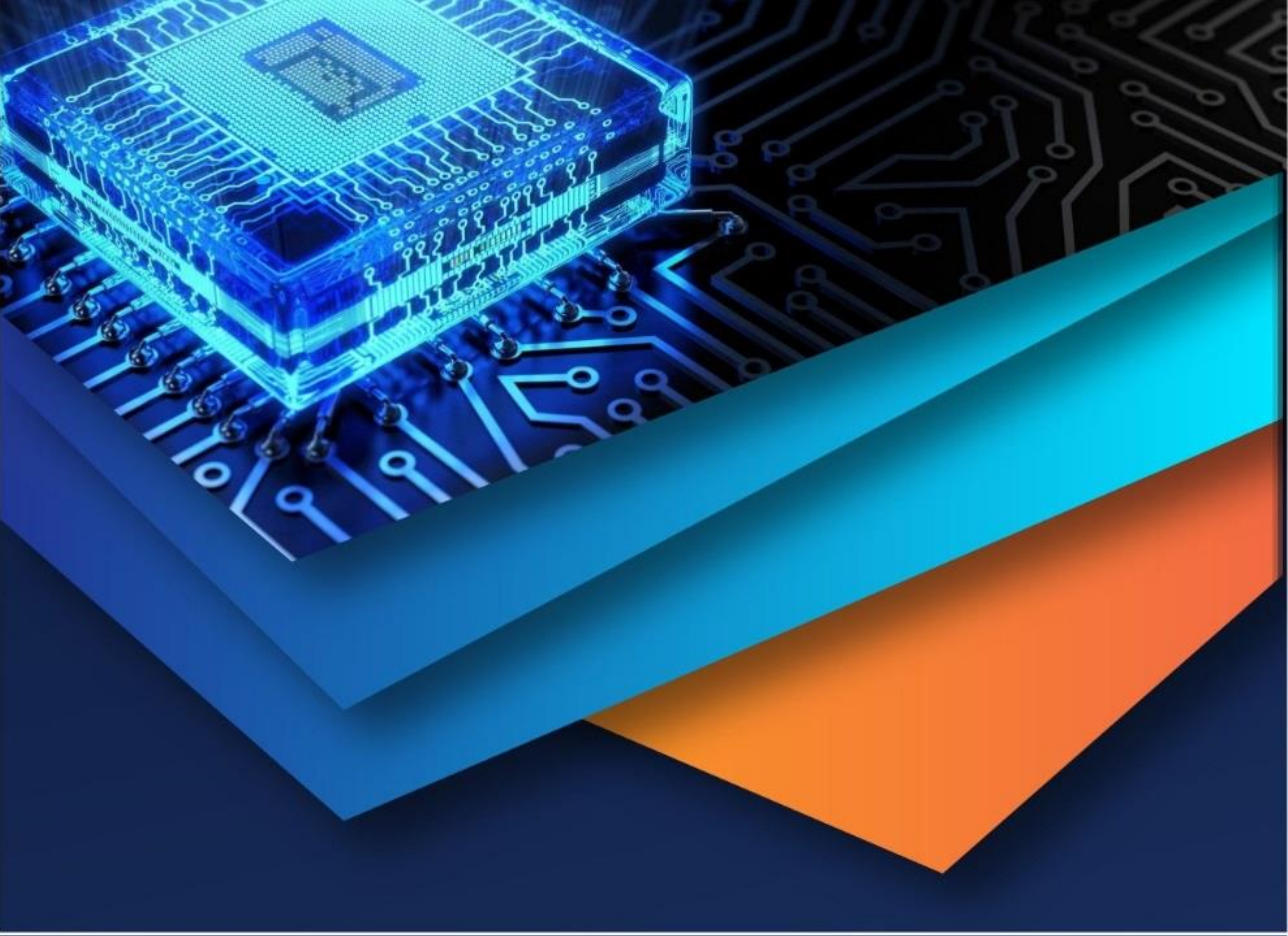

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