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An Integrated Private Cloud Storage for Small and Medium Scale Business Industries

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Abstract: ***Cloud storages are becoming popular due to raising privacy concern regarding the available public cloud services. The main concern was to prevent data loss that occur due to various problems. Although it is challenging to embrace hybrid cloud solutions for personal use. People tend to use Network-Attached Storage (NAS) and hybrid cloud solutions which are available for enterprise usage. Currently, NAS is classified as two types, Storage NAS and Platform NAS. The research of this paper focuses on Storage NAS, which is connected to a network that allows storage and retrieval of data from a central location for authorised user and clients to effectively develop the system architecture for Small and Medium Enterprise (SME) businesses. This solution provides the users with expected privacy for content and features of remote file browsing, shareable link generation, robust synchronization among personal cloud devices, simple user management similar to cloud services and remote file uploading/downloading facilities. The results and evaluation of the paper demonstrate the real world and practical business cases under the NAS server, in which it significantly shows the contribution of the System architecture development and amortization of the affordable business costs, that leads to reasonable and flexible operational security for SME sectors in the commercial cities in developing countries such as India in Asia.***

Keywords: NAS (Network Attached Storage); database; IP (Internet Protocol); SMB (Samba Server); VPN (Virtual Private Network);

I. INTRODUCTION

Most of developing countries and cities like India in Asia are becoming business-oriented cities. With cloud computing also on the rise, cloud services have become a trending topic among the general public and private as storing and sharing of useful information which has become a routine task [3]. However, the communities who are concerned about their privacy of content are not willing to use publicly available services such as Dropbox, Google Drive and Microsoft One drive. Even though there is a chance of risk that the cloud service provider might be using the content for data mining purposes. This has given rise to the concept of private clouds. These solutions either use storage services that are locally installed, or private cloud spaces purchased and are secured through encryption schemes. Although the NAS devices solve the issue of confidentiality, features such as availability and flexibility of private cloud storage services are compromised by moving towards solutions such as NAS devices [3]. This is because most of the NAS devices do not provide remote access and synchronization of several NAS devices requires a significant internet bandwidth (uploading at one end and downloading at the other end). This increases the cost for the user when additional services are accessed over the Internet and users might even have to manually version and maintain copies of documents between NAS devices [2]. Furthermore, important features such as generation of shareable links for media enabling remote users to download content, browsing files over a web interface, file uploads and downloads and access management among multiple users are not readily available in most of the existing NAS devices. This paper presents a novel NAS solution named Next unit of Computing NAS (Mini-NAS) which provides all the features of a NAS device and extends its scope to provide better user experience by providing simple user management, remote access through web interfaces, a personal, version-tracking, distributed file system allowing transparent access to any data item from any device [1]. The user can retrieve, on the fly, files that are missing from his/her current device, provided one of his/her devices hosting them is within reach. Current centralized approaches require direct connectivity with the server where a user's files are stored. Mini-NAS targets a wide range of connectivity scenarios, allowing replication and synchronization to take advantage of any available network bandwidth (such as local Wi-Fi or point-to-point connectivity). For example, if a user wants to synchronize a large photo set to her tablet and there is a laptop in the local Wi-Fi network that has a copy of the photo set, Mini-NAS orchestrates the transfer between the two devices. Most existing cloud approaches require the synchronization to occur via the remote server which can be both costly and time-consuming and in cases of intermittent Internet connectivity, simply not possible [1]. The Mini-NAS was deployed on top of Intel NUC (BOXNUC5CPYH) development board running Ubuntu (18.04 LTS) in order to facilitate the novel features. Our philosophy is that users should exercise full control over their data, including where it is stored, who has access to it, how it is replicated and when it is deleted permanently.

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This paper presents the implementation of the Mini-NAS, the private cloud device and the results obtained after evaluation of the solution for performance and security. Section II outlines the related work in the field of private cloud computing, synchronization of such devices and related areas. Section III Outlines the existing system and its drawbacks. Section IV demonstrates the architecture of the implemented system. Section V presents the results obtained by experimental setup of the Mini-NAS. Finally, Section VII concludes the paper with the inferences obtained from the results, the limitations to which the evaluation was subjected to and future extensions.

II. RELATED WORKS

In this domain of private cloud devices synchronization and remote access plays an important role in provision of content availability and better user experience. *A. Synchronization.* File synchronization is a key requirement in private clouds, Pedra Casas *et al.* [4] presents a quality of experience (QOE) of private cloud devices. The QOE has evaluates the user experience of Dropbox, One drive and Google Drive. The results suggest that the QOE of file sharing and storage operations held a key role in the evaluation process. Furthermore, in an early study by Marshall *et al.* [5] it has been discovered that the user experience of a cloud service is directly affected by the ability to share and synchronize content. Research conducted on data synchronization by Choi *et al.* [6] presents the avenues of synchronization using Bluetooth, ZigBee and Wi-Fi. The solution uses adhoc networking facilities for synchronization. However, this requires storages to be in connectable distances which is not a common use case of private cloud devices. Therefore, it is clearly evident that a novel synchronization mechanism is required beyond conventional means to maintain the synchronicity of private cloud devices. *B. Remote Access and Cloud Services* Two of the most commonly used cloud storage providers are Google and Dropbox. These services provide free cloud storage and synchronization facilities to their users. The services include file synchronization, storage backup and public file sharing using sharable links. They also provide privacy and confidentiality of data which is not guaranteed since Google performs analytics on consumer data. Dropbox in fact uses personal information such as physical addresses to improve quality of service for users. Furthermore, the content that resides in the cloud is encrypted, yet certain data is retained unencrypted in order to adhere with certain security regulations [8] and May subject to disclosure under certain legal demands. Two of such popular personal cloud devices are Seagate NAS and Western Digital My Cloud. Both the devices can be mounted to the computer while the users are in the same network and request content over the Internet through the provider's website. Also, the vendors provide applications to synchronize content and setup the device in the first run. Although the basic features required by a NAS are readily available, some of the key features expected from a cloud service such as link sharing are not found. Here, we take advantage of the ease of usage of NAS servers and add a few tweaks to make data storage and accessibility both user friendly as well as preventing loss of data. The Intel NUC kit serves as the host to the external storage devices. We have also enabled RAID backup of data present in the external storage device to prevent loss of data. Implementing the idea of protecting data by using a secondary storage device ensures the maintaining of the confidentiality and integrity of the data stored on the external drive which is mounted to the NUC kit. But this setup works for all devices in a particular LAN only. We use Port Forwarding in this case, to make the data remotely accessible across any network. Apart from the remote access given, crucial data can be provided with sufficient security using the virtual private network created [6]. Furthermore, web-based file browsing capabilities are only limited to uploading, downloading and sharing. In contrast, sophisticated features such as file compression followed by sharing and browsing content without uploading to a public cloud are much appreciated as it reduces the cost and redundant usage of space.

III. EXISTING SYSTEM

Typically NAS architecture provides consolidation, rapid deployment and central management, more convenient backup and high availability [10]. The existing system was built around as Platform NAS. Additionally, it provides fascinating features SME such as web hosting, file sharing, cloud services, email server, certificated security and surveillance controls, and multimedia technologies [9]. It has been found that the total cost of the NAS architecture used in this study for basic and typical SMEs is strived to a very minimal of HKD $1,600 and is approximately USD $250 which is not affordable to most SME in developing countries and cities like India. Sometimes the hardware's are not available and difficult to find in countries like India.

A. Drawbacks

1) The Existing system was aimed for home user, where the usage was mostly as a home media server.
2) Raspberry Pi a single board computer was used as NAS server in the existing system.
3) Micro Secure Digital High Capacity (MicroSDHC) is the only storage slot available which supports cards with capacities up to 32 GB.

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4) The Existing system uses only 1GB of RAM which is sufficient, but may not in the future.
5) The Existing system can't be used for business industries because of lowered RAM and memory support.

IV. SYSTEM ARCHITECTURE

The Intel Mini-NAS consists of three key architectural components. They are software architecture, hardware architecture. The architecture of the system is organized in a layered manner which enables the easy deployment of the implemented software on specific hardware architecture.*A. Software Architecture*The Intel Mini-NAS consists of a layered software stack. Fig. 1 demonstrates the software stack implemented on Intel Mini- NAS. The layers of the software are almost similar to Linux Operating System (OS), this is because of Ubuntu is a Gnome based OS which provides rich user experience and interface. The file system adopted for this scenario is Unix File System.

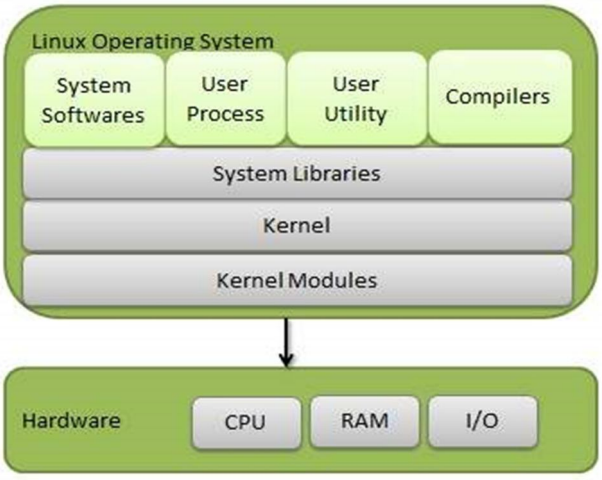


Fig. 1 Software Stack

The System Software component communicates with the File System while handling file change events for synchronization, performing file writes, changing file permissions, generation of symbolic links for shared file, etc. The User Process is the instance of a computer program that is being executed by one or many threads. It contains the program code and its activity. Depending on the (OS), a process may be made up of multiple threads of execution that execute instructions concurrently. *System libraries* are special functions or programs using which application programs or *system* utilities accesses Kernel's features. These *libraries* implement most of the functionalities of the *(OS)* and do not requires kernel module's code access rights. The kernel facilitates interactions between hardware and software components. On most systems, it is one of the first programs loaded on start-up.Ubuntu provides Extended Security Maintenance (ESM) extends official support for the operating system, guaranteeing the continued security of ITstrategen's servers and saving its clients from costly application updates. Ubuntu also provides support for administration and customization. It also supports plug-in system approach. Plug-in enables third party developers to code directly inside Ubuntu based tools.*B. Device Architecture and Operating Environment*The device consists of 3 major components as Motherboard, Storage HDD and RAM. The motherboard consists of a Intel BOXNUC5CPYH (NUC kit) device. The picture of NUC kit is displayed in Fig, 2. The storage is provided using a SATA 1TB hard disk drive. The motherboard consists of an extendable memory of 8GB which is used to store the operating kernel. However, all the data are stored in a separate partition in the hard disk in order to separate the interacting memory from the kernel memory. The system is powered using a 12-19V DC. The network access is granted by a gigabit Ethernet connectivity. However, after initial connectivity through the Ethernet connection. The detailed configuration of Intel NUC kit is displayed in Table 1.

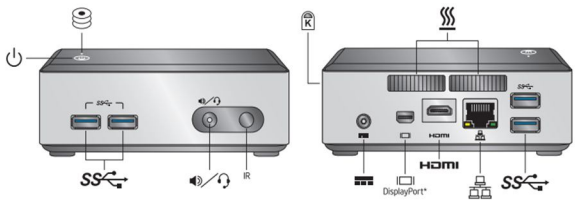


Fig. 2, Intel NUC kit

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Attribute	Specification
Sockets Supported	FCBGA1170
SOC	Intel Celeron N3050
CPU	Dual-core CPU, 2.16 GHz
Max CPU Configuration	1
Memory	Single DDR3L memory slot, max. memory 8 GB
Storage	Support for a single 2.5″ SATA drive
Supported Operating Systems	All Linux Versions and IOT operating systems.
Lithography	14 nm
TDP	6 W
DC Input Voltage Supported	12-19 DC

Table. 1 Configuration of Intel NUC Kit

A. Web File Explorer

Web file explorer provides the users with remote access without having to store the content in a public cloud storage. The Mini-NAS has to be connected to the DHCP Server and the content can be accessed by remote login through the website. Once the login is successful, the content is directly taken and rendered via a Chrome peer-to-peer connection. The interface provides most of the missing features of existing web-based file browsing facilitators. The users are provided with facilities similar to Google Drive such as file browsing, sharing, uploading/downloading, compressing and previewing while they are on the move away from the local network of the Mini-NAS device. The interface is an Angular 4 application which maintains a WebSocket connection with the central server. JSON messages are passed to the Mini-NAS through the central server in order to brows the files within the Mini-NAS.

B. Client Application

Client application is shipped along with the Mini-NAS device. The application enables the users to discover the device within the same network using the Simple Service Discovery Protocol (SSDP) [13]. Also, the client application enables addition/removal of users, mounting the device directly using Server Message Block (SMB) [14] protocol and managing the synchronization process of the device.

V. CONCLUSION

From what has been discussed, existing methodologies for NAS involve the measurement of parameters essential for a considerable amount of power consumption and centralized storage. A majority of these approaches are based on providing security, support and building NAS on a Single Board Computer (SBC) etc. and use the data stored as home media server. The approach proposed in this paper differs from the rest when it focuses on small scale business industries. In the event of creating from an Intel NUC kit and if any deviation the NAS provides a RAID backup for industrial expertise. A user-friendly interface for the mobile application, web and IOS puts the user in full control of the process. Hence it can be concluded that the proposed approach is well versed when it comes to protecting data and minimizing the cost in building a NAS.

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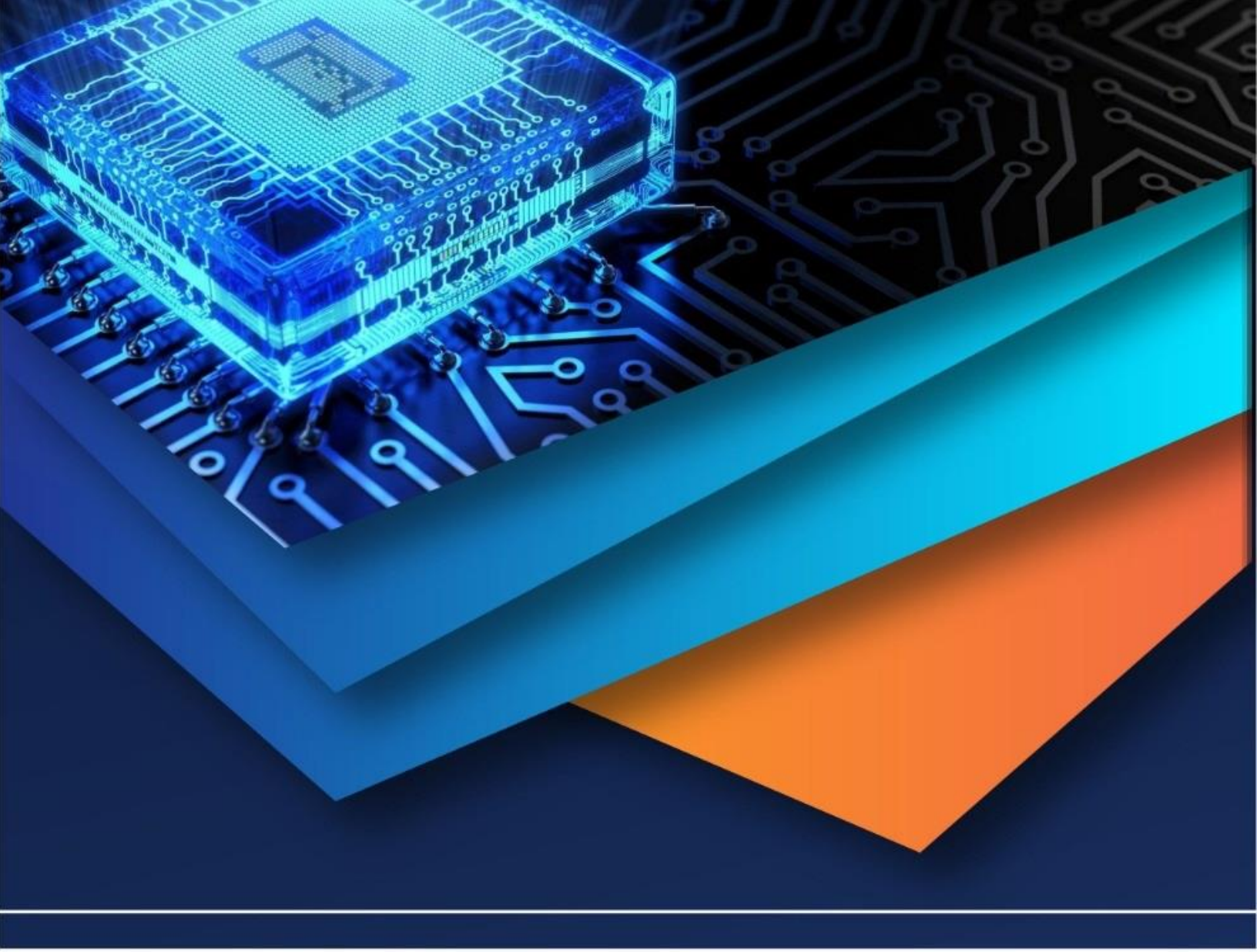
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