Development of network attached storage using Raspberry Pi

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ABSTRACT –The advancement in computerized technology today has reached the level where technology is required in every aspect of life. Every day people use digital storage to store digital information. Digital storage could be the personal device or the storage inside the network. The personal device possesses a limitation of small storage size whereas dedicated storage device like Network Attach Storage (NAS) offers larger storage capacity. However, the commercial NAS device is expensive and not suitable for personal use or small business enterprise. Therefore, this paper aims to provide the development of a NAS device with less cost using a small microprocessor while maintaining common functions and capabilities of NAS. The Raspberry Pi is the main components used in the study respectively. The developed device works as per the requirements and provides an alternative solution in a digital storage device.

1. INTRODUCTION

Across the world the revolution in technology advancement relates to Industry Revolution 4.0 (IR4.0), a new phase in the industry that focuses heavily on interconnectivity, automation, machine learning, and real-time data. In supporting the IR4.0 advancement, current computerized system has shifted to the distributed computing which involves connected devices that communicates with each other inside the network. One part of the distributed computing relates to the Network Attached Storage (NAS) [1][2].

NAS is a dedicated file storage that enables multiple users and devices to retrieve data from centralized disk capacity within the same network. Resources can be shared with the non-storage device on the network. It solves the problem of limited storage in the user devices. Although, the necessity of network storage has become critical as daily data communication has increased, the price of dedicated NAS available in the market is still really expensive which can cost few thousands for few TB storage capacity. Normally, it is not affordable to small companies or home users, and the need of NAS device at a lower cost is really demanding.

The challenge is to prepare NAS device with less cost and affordable without effecting the function of NAS itself [3]. Microprocessor is the best solution to be use as the NAS controller and as management device. The microprocessor, for example Raspberry Pi [4] offers a size of a credit card with cheapest price, key computer functions, a motherboard, and operating system. The Raspberry Pi can also be integrated with hard disk drive to create an improved NAS device. Thus, the aim of this study is to develop a low-cost NAS that supports extended storage.

The rest of this paper is structured as follows: The following section describes a prototype design, whereas the subsequent section presents the result and discussion of the study. The paper ends with a conclusion.

2. METHODOLOGY

Figure 1 shows the architecture design of the proposed prototype. The prototype was developed using a microprocessor, Raspberry Pi 3 Model B+. The Raspberry Pi was chosen as the main processing unit based on its existing features such as low price, small size, and wireless and cable connections. In this design, the external hard disk drive was connected to the processing unit that act as the storage medium. The "Raspbian" open-source operating system was used. Four USB ports were used to support extended storage using USB connectors. The ethernet cable (RJ45), network device, such as router or switch were used to provide the communication medium between the devices. Figure 2 depicts the complete hardware set up for the prototype.

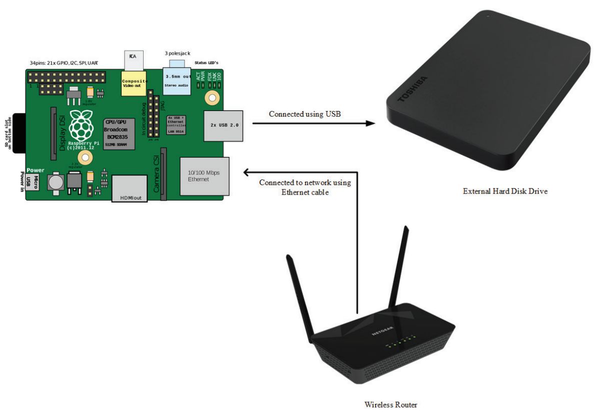


Figure 1 The architecture design of the NAS

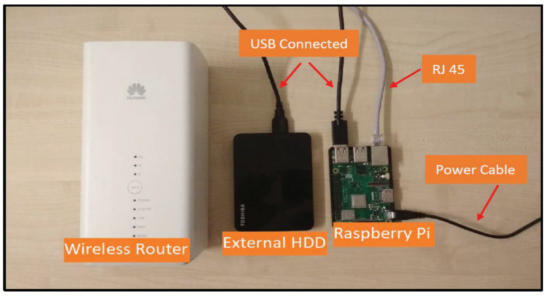
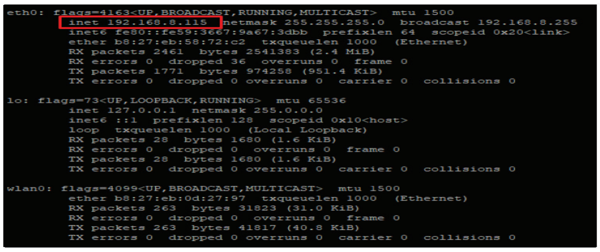


Figure 2 Complete hardware set up

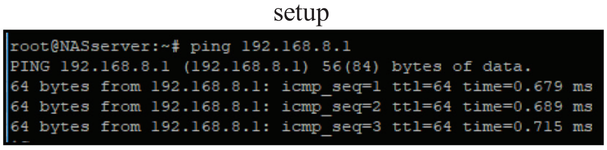
3. RESULT AND DISCUSSION

There were some tests conducted, for instance connectivity test among the Raspberry Pi, network device, and external hard disk drive, and the network connection test. All these tests were successfully executed and yields expected results. All devices accepted the inputs and processed the outputs and allowed two-way communication. In Figure 3 and 4, the "*ifconfig*" command, and "*ping*" commands were used to check the network connection of in and out data transmission of the Raspberry Pi. The external HDD was mounted automatically to the directory that already set in the boot initialization. Command "*df -h*" was used to verify and check if the hard drive mount properly. A directory inside the external drive was created to verify the external drive functions correctly. These are shown in Figure 5 and 6.



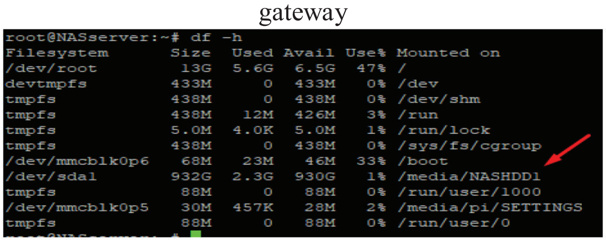
```
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.8.115  netmask 255.255.255.0  broadcast 192.168.8.255
        inet6 fe80::fe59:3667:9a67:3dbb  prefixlen 64  scopeid 0x20<link>
        ether b8:27:eb:58:72:c2  txqueuelen 1000  (Ethernet)
        RX packets 2461  bytes 2541383 (2.4 MiB)
        RX errors 0  dropped 36  overruns 0  frame 0
        TX packets 1771  bytes 974258 (951.4 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 28  bytes 1680 (1.6 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 28  bytes 1680 (1.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlan0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether b8:27:eb:0d:27:97  txqueuelen 1000  (Ethernet)
        RX packets 263  bytes 31823 (31.0 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 263  bytes 41817 (40.8 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Figure 3 Check the IP Address for network setup



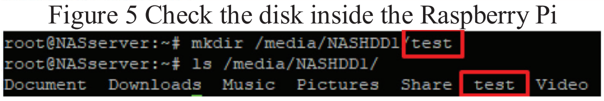
```
root@NASserver:~# ping 192.168.8.1
PING 192.168.8.1 (192.168.8.1) 56(84) bytes of data.
64 bytes from 192.168.8.1: icmp_seq=1 ttl=64 time=0.679 ms
64 bytes from 192.168.8.1: icmp_seq=2 ttl=64 time=0.689 ms
64 bytes from 192.168.8.1: icmp_seq=3 ttl=64 time=0.715 ms
```

Figure 4 Verify the connection to the router gateway



```
root@NASserver:~# df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/root        13G  5.6G  6.5G  47% /
devtmpfs        433M     0  433M   0% /dev
tmpfs           438M     0  438M   0% /dev/shm
tmpfs           438M   12M  426M   3% /run
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           438M     0  438M   0% /sys/fs/cgroup
/dev/mmcblk0p6   68M   23M   46M  33% /boot
/dev/sda1       932G  2.3G  930G   1% /media/NASHDD1
tmpfs            88M     0   88M   0% /run/user/1000
/dev/mmcblk0p5   30M  457K   28M   2% /media/pi/SETTINGS
tmpfs            88M     0   88M   0% /run/user/0
```

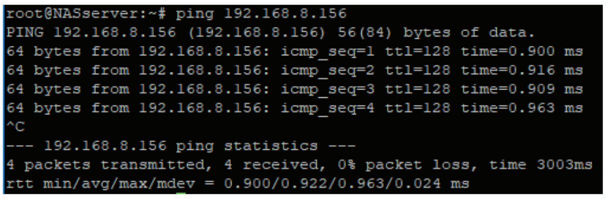
Figure 5 Check the disk inside the Raspberry Pi



```
root@NASserver:~# mkdir /media/NASHDD1/test
root@NASserver:~# ls /media/NASHDD1/
Document  Downloads  Music  Pictures  Share  test  Video
```

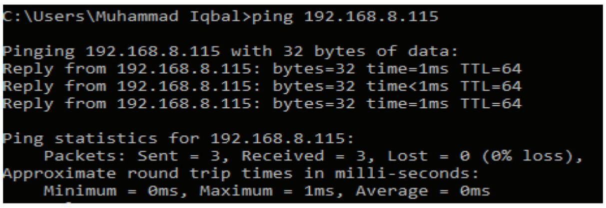
Figure 6 Create new folder and view the folder

Figure 7-8 shows the results of the network test. "*ping*" commands were used to verify the available connection within the network between Raspberry Pi and other device. The results show the prototype able to communicate with other devices as intended.



```
root@NASserver:~# ping 192.168.8.156
PING 192.168.8.156 (192.168.8.156) 56(84) bytes of data.
64 bytes from 192.168.8.156: icmp_seq=1 ttl=128 time=0.900 ms
64 bytes from 192.168.8.156: icmp_seq=2 ttl=128 time=0.916 ms
64 bytes from 192.168.8.156: icmp_seq=3 ttl=128 time=0.909 ms
64 bytes from 192.168.8.156: icmp_seq=4 ttl=128 time=0.963 ms
^C
--- 192.168.8.156 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/mdev = 0.900/0.922/0.963/0.024 ms
```

Figure 7 Raspberry Pi ping to another device



```
C:\Users\Muhammad Iqbal>ping 192.168.8.115

Pinging 192.168.8.115 with 32 bytes of data:
Reply from 192.168.8.115: bytes=32 time=1ms TTL=64
Reply from 192.168.8.115: bytes=32 time<1ms TTL=64
Reply from 192.168.8.115: bytes=32 time=1ms TTL=64

Ping statistics for 192.168.8.115:
    Packets: Sent = 3, Received = 3, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Figure 8 Windows desktop ping to Raspberry Pi

4. CONCLUSION

As conclusion, this study has shown that low price NAS are able to develop without eliminating key functionalities likes files transfer within the same network, allows users to collaborate and share information more effectively, and provides backup and recovery functions. However, the work can be improved by adding web or mobile applications to manage the NAS device. This study opens new opportunity for future advancement in network storage technology.

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