CSCI250 Raspberry Pi Project

Knowledge Box
Micro-SD Application and System Duplication Tower

I. Summary of the objectives

Build 2 full blown towers, using 8 existing Raspberry PI 3Bs (apx 12 hours)

The towers will be donated to The Knowledge Box. The Towers will be used as duplication station for the Knowledge Box content.

The Knowledge Box provides the best of the Internet in English and Spanish. It is great for remote places and does not require special setup or monthly access fees. It is great for universities, churches and orphanages. The Knowledge Box is a field technology project of Global Horizons Inc.

GHI recognizes cultural diversity and is passionate about mobilizing leaders who are engaging and selfless, pursuing reconciliation horizontally between people, God, and ideas. Through projects that provide interventions, development, and reconciliation, these leaders and projects seek to:

- Validate the honor and dignity of all creation
- Create environments and activities leading to reconciliation with chaos and dysfunction
- Empower marginalized people to become all that god would have them become

There will be two groups for this assignment. Each team will build a tower:

The teams are as follows:

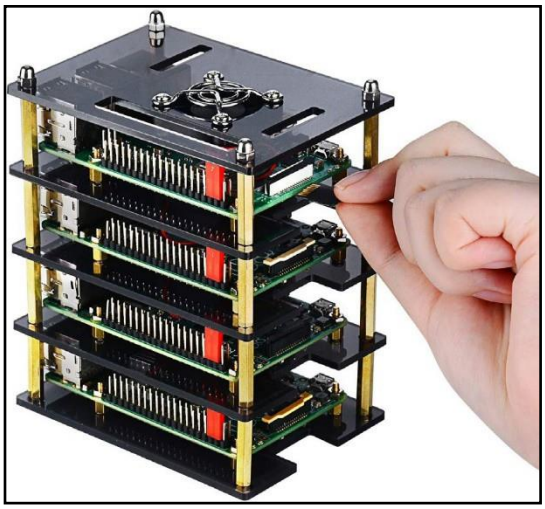
Team Member	Email	Team
		Team AMD
	REMOVED FOR PRIVACY	Team AMD
		Team AMD
	REMOVED FOR PRIVACY	Team Intel
David Vidic		Team Intel

II. Planning

1. Each team will have the following:
    a. Four Raspberry Pi's
    b. Twelve 16 GB micro-sd cards
    c. Four USB-Micro-sd adapters
    d. Six ethernet cables
    e. Zip ties
    f. Four AC power hub
    g. A 6 port ethernet switch
    h. Knowledge Box 'MAS Duplication' perl script
2. Each team will need a Windows PC or laptop with internet access
3. Some pre-work on the PC / laptop - install Raspberry PI Imager: From https://www.raspberrypi.org/software/, download and install Raspberry PI Imager loaded onto PC.
4. Close screen. You will install the OS later on the Raspberry Pi in the process.
5. The Knowledge Box MAS Duplication tower is built in five steps
    a. Tower -- build the physical tower
    b. Cabling -- connect the tower and switch and AC power hub
    c. OS -- build four 16 GB micro-sd cards with standard Raspbian OS
    d. Knowledge Box software -- install the custom Knowledge Box perl script
    e. Test -- use the MAS Duplication Tower to duplicate some micro-sds

III. Build Tower -- build the physical tower

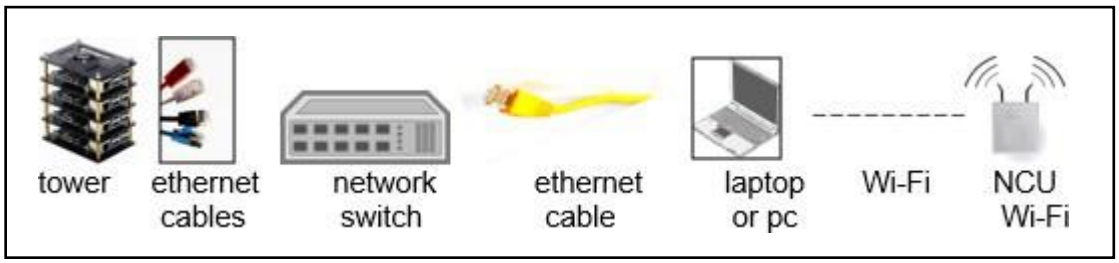
1. Follow instructions given by Geek-PI. Remove the protective plastic covering from each of the plexiglass panels. Apply heat sinks and connect the fan power leads to pin 1 and 2 of the Raspberry PI GPIO (see red pings in diagram below)



2. The hostnames for each of the PIs will be mas01, mas02, mas03 and mas04. For clarity, use a red label to mark the top Raspberry PI **‘mas01’** with the others assumed in order as mas02 - mas04

IV. Cabling -- Connect the tower and switch and AC power hub

1. The laptop should be connected to the NCU Wi-Fi as well as the network switch via an Ethernet cable



2. Use 2.4 Amp micro-USB AC adapters to connect each of the Raspberry PIs in the tower to the AC power supply. Leave at least one AC adapter open for the network switch by using one of the USB slots on the AC power supply to power one of the Raspberry PIs

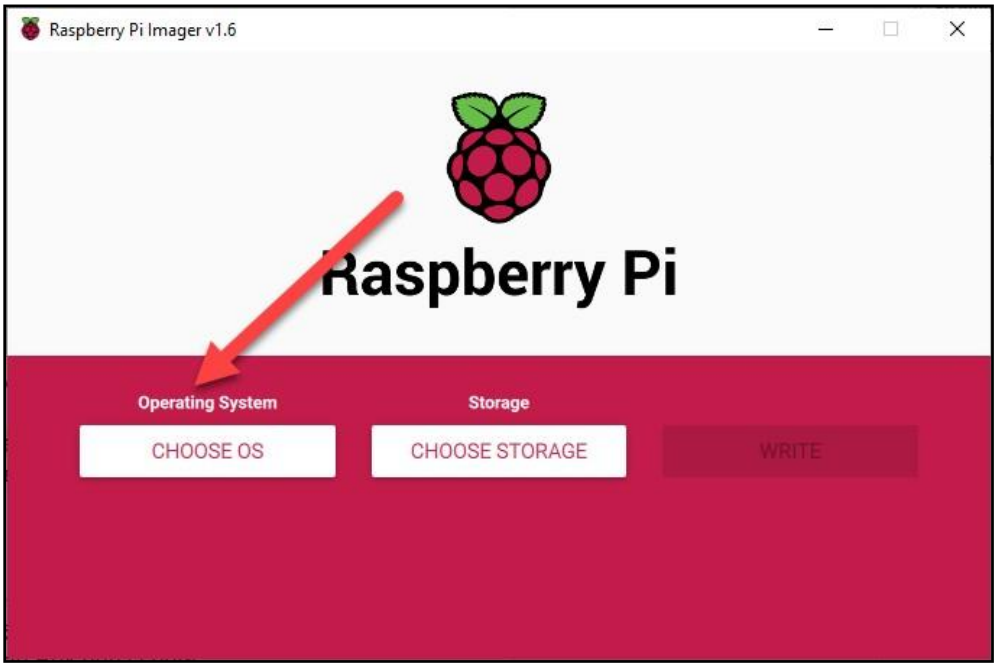
3. Install one USB to micro-sd adapter in each of the Raspberry PIs

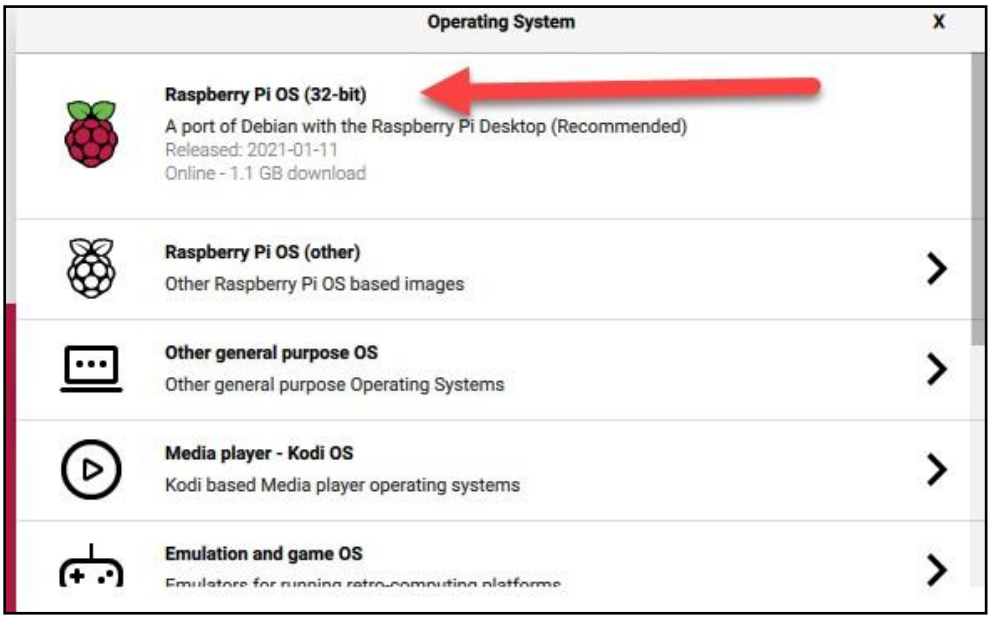
4. User zip ties to consolidate ethernet and power cables (note the final configuration will change after shipping to its final destination after transport in a backpack). A sample Knowledge Box MAS Duplication Tower is shown below

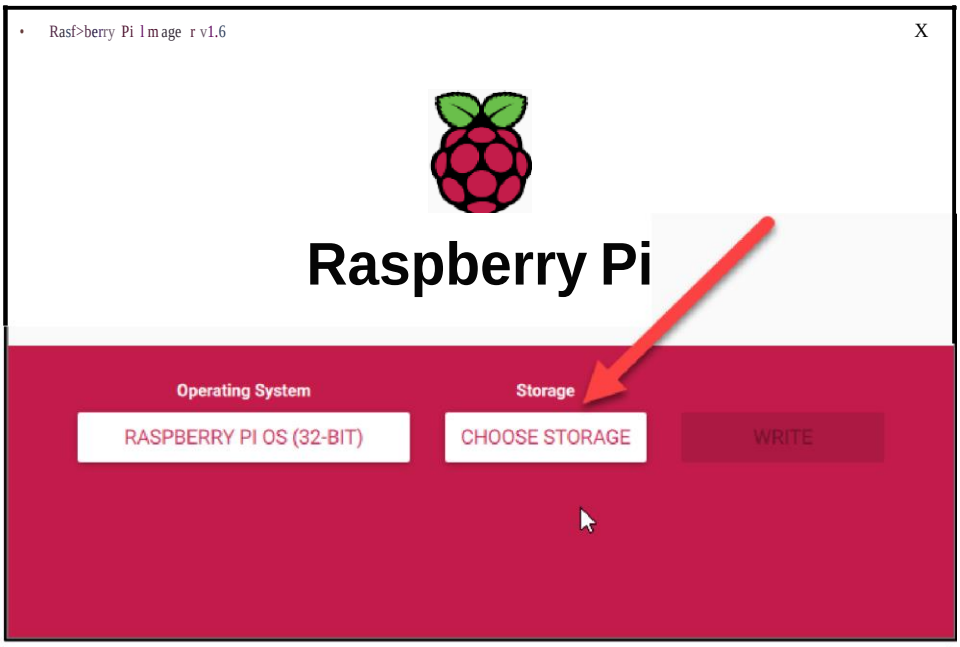
V. Build Raspbian OS -- build four 32 GB micro-sd cards with standard Raspbian OS

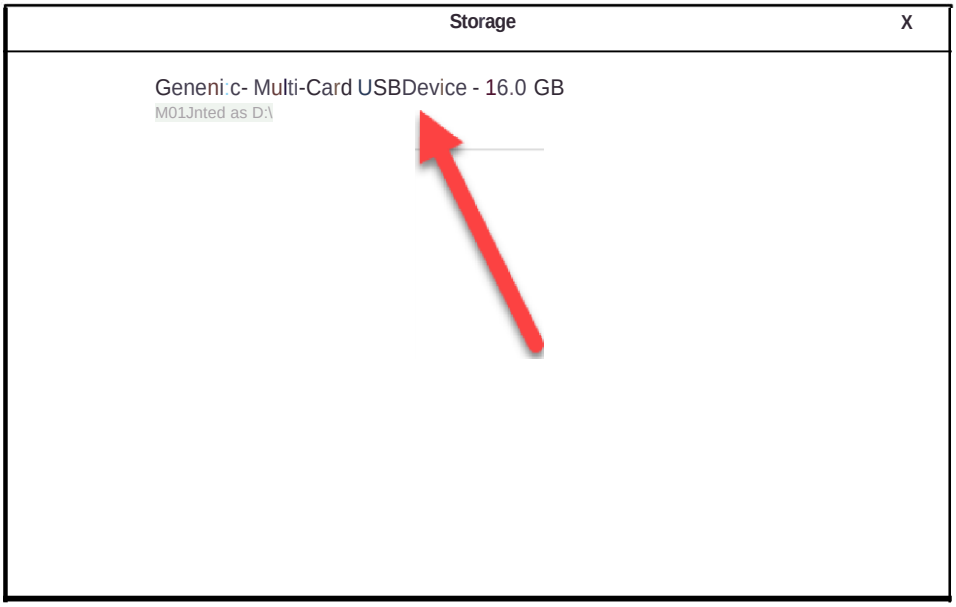
1. To setup the Raspbian OS on the four Raspberry PIs, we first need to determine the IP addresses to be used. The IP table for this project is as follows:
   - 192.168.4.101 mas01
   - 192.168.4.102 mas02
   - 192.168.4.103 mas03
   - 192.168.4.104 mas04
   - 192.168.4.105 your laptops ethernet port
2. As indicated in the IP table above and in the network diagram above, your laptop's ethernet will need a static IP address set to 192.168.4.105. To do this follow the steps here: https://portforward.com/networking/static-ip-windows-10.htm.

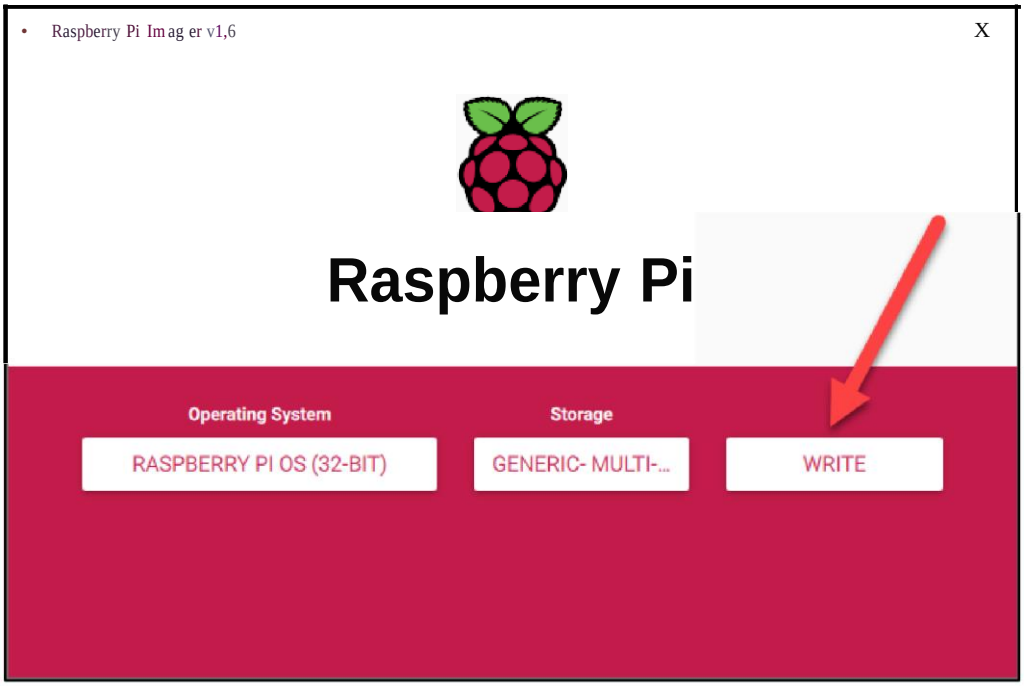
3. Build mas01 Raspberry PI server: From https://www.raspberrypi.org/software/, download and install Raspberry PI Imager loaded onto PC.
    a. **As you are prepping to build the Raspbian OS, ensure that your PC has an ethernet port as well as Wi-Fi (The Wi-Fi will connect to the school network the Ethernet will connect to the switch). If your PC does not have an Ethernet port please let Professor Miller know.**
    b. Insert a blank 32 GB micro-sd into the PC.
    c. Launch the Raspberry PI Imager and **choose 'Raspberry PI OS** (32-Bit)' and the blank 32 GB micro-sd card and click on 'Write' to create a Raspbian OS micro-sd card. See screen-prints below for step by step instruction.

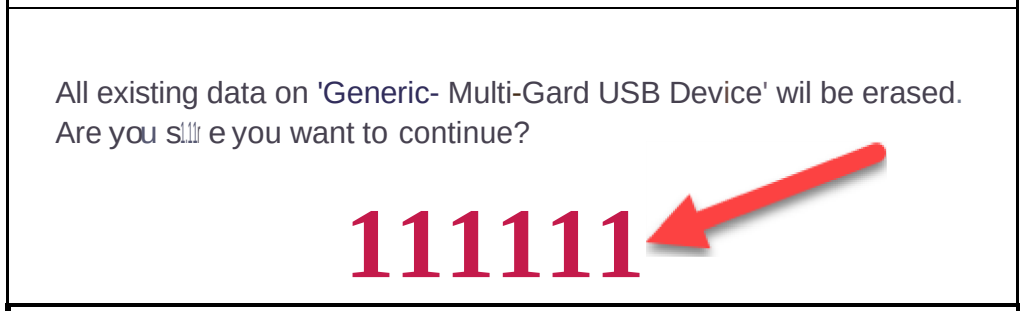


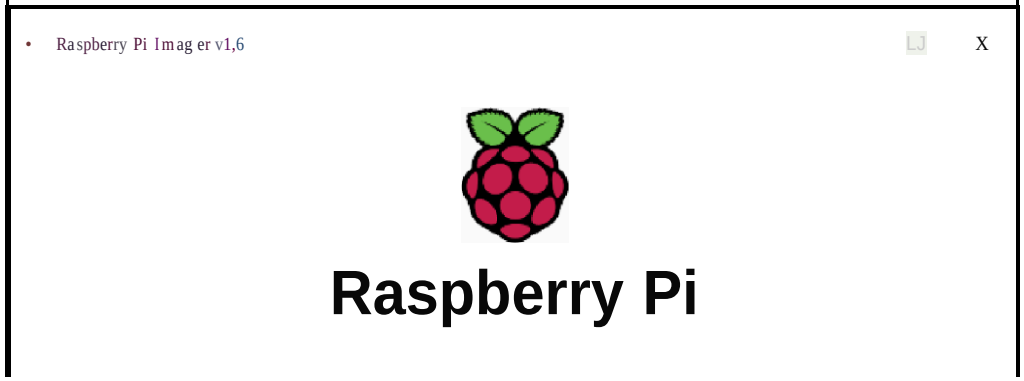


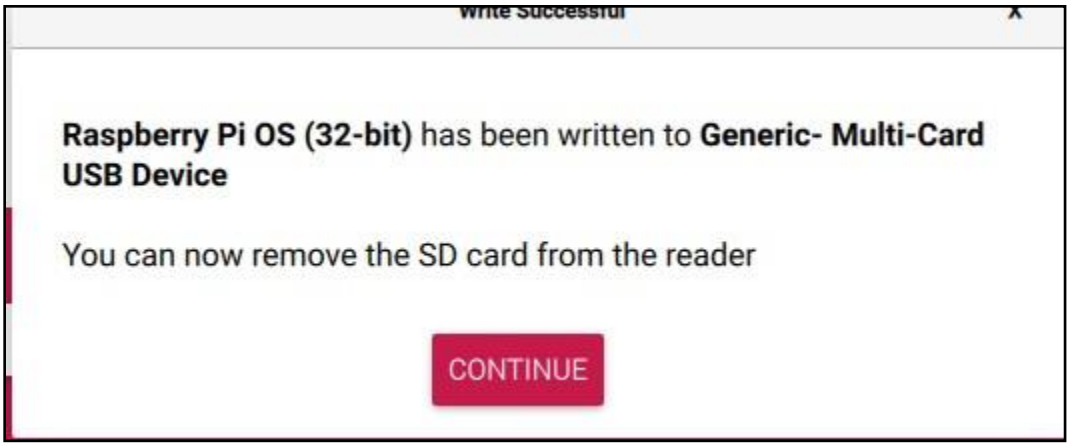

Rasf>berry Pi l mage r v1.6
X
Raspberry Pi
Operating System
RASPBERRY PI OS (32-BIT)
Storage
CHOOSE STORAGE
WRITE


Storage
X
Geneni c- Multi-Card USBDevice - 16.0 GB
M01Jnted as D:\

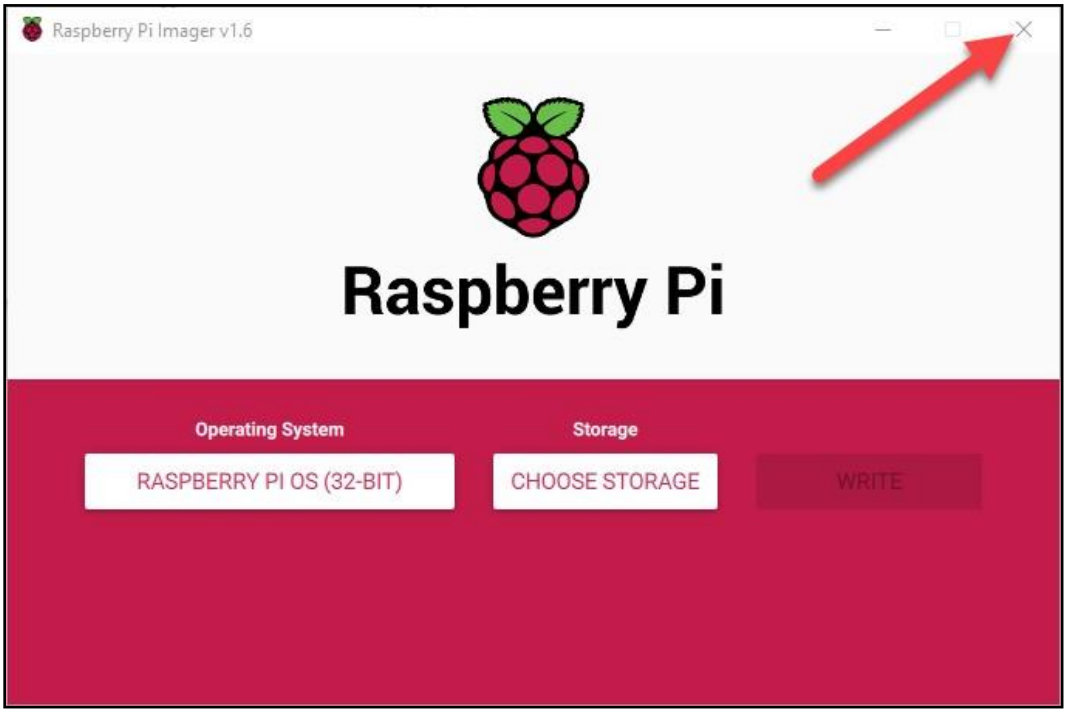

Raspberry Pi Imager v1,6
X
Raspberry Pi
Operating System
Storage
RASPBERRY PI OS (32-BIT)
GENERIC- MULTI-...
WRITE


All existing data on 'Generic- Multi-Gard USB Device' wil be erased.
Are you sure you want to continue?
111111

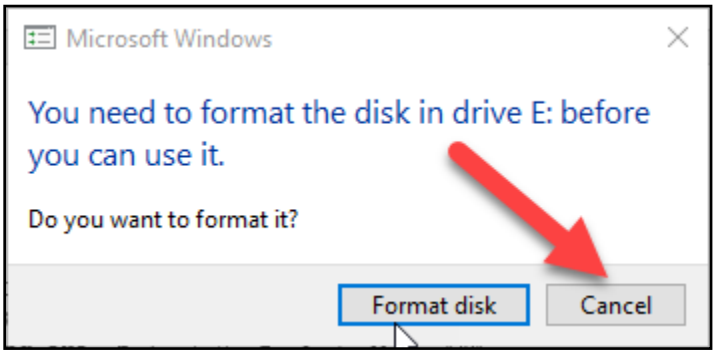

Raspberry Pi Imager v1,6
X
Raspberry Pi
Operating System
Storage
Writing... 0%
CANCEL WRITE



d. Close installer



e. When the Raspberry PI Imager is completed, eject the micro-sd card from the PC and then re-insert it into the PC.



f. Open a DOS Command prompt on the PC and navigate to the primary drive on the micro-sd (eg: d:). Should d: or e:

Note: If you cannot navigate to the primary drive on the micro-sd drive, then you will need to install the EXT2FSD driver. Follow instructions on (http://www.ext2fsd.com/?page_id=16 and reboot your PC.

```
C:\Users\csmiller>D:
```

g. Verify that you are on the right drive. Type **dir cmdline.txt.** See screen-print.

```
D:\>dir cmdline.txt
 Volume in drive D is boot
 Volume Serial Number is F4F1-BC2C

 Directory of D:\

01/11/2021  01:15 PM               208 cmdline.txt
               1 File(s)            208 bytes
               0 Dir(s)     216,905,728 bytes free
```

h. To enable the SSH service on the Raspbian type the following '**echo > ssh**' and hit return. Once done, close the DOS Command prompt and use File Manager to eject the Micro-SD card

i. Verify that the ssh file is created by typing the following: **D:\>dir ssh**

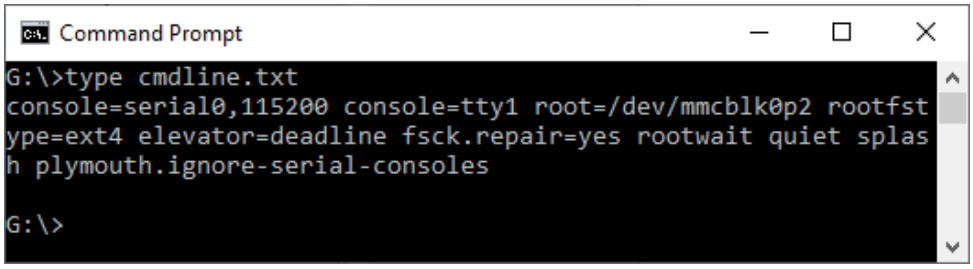
```
D:\>dir ssh
 Volume in drive D is boot
 Volume Serial Number is F4F1-BC2C

 Directory of D:\

03/17/2021  04:34 PM                13 ssh
               1 File(s)             13 bytes
               0 Dir(s)     216,905,216 bytes free
```

j. In this next step we will set the IP address for this server by editing cmdline.txt.

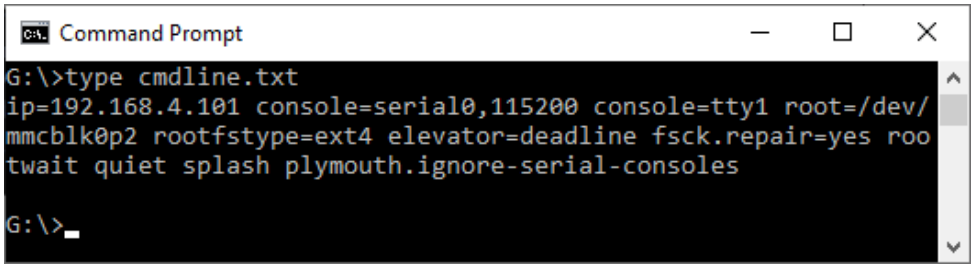
   i. To see how cmdline.txt is currently set, execute the following: **type cmdline.txt. (Note in your case the directory will either be D: or E:)**



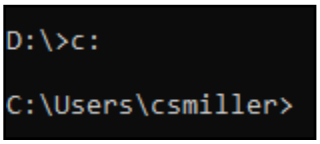
   ii. Edit this file by typing: **notepad cmdline.txt**

   iii. Add the following to the beginning of this file: ip=192.168.4.101. For example, the new cmdline will be:
   ip=192.168.4.101 dwc_otg.lpm_enable=0 console=serial0,115200 console=tty1 root=/dev/mmcblk0p7 rootfstype=ext4 elevator=deadline fsck.repair=yes rootwait splash plymouth.ignore-serial-consoles quiet

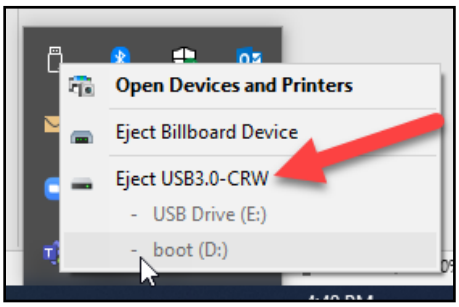
iv. Save and exit the notepad session. To ensure the change was made correctly, execute: type **cmdline.txt. (Note in your case the directory will either be D: or E:)**



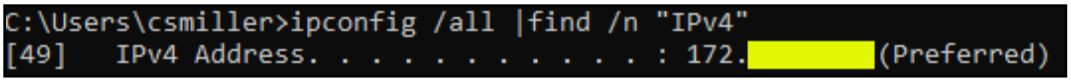
k. In Command Prompt change directory to C: See screen-print.



l. From the PC's File Explorer, eject the micro-sd card and after that is done, physically remove the micro-sd card from the PC (note: it is important to use logically eject the disk before physically ejecting the disk to ensure the ssh file is written to the micro-sd card)



4. pingAll.cmd and arp: Before powering up the raspberry pi, on your PC run a couple commands to find existing machines on your network
   a. To find the proper IP address to enter into pingAll.cmd, run the following from the DOS Command prompt: **ipconfig /all |find /n "IPv4"**. The output will look something like this:



   b. Create a simple batch file to ping existing machines on your network by typing: ***notepad pingAll.cmd*** Copy and paste the following into this file. Save and exit notepad:

```
@Echo off
Set "SubNet=192.168.4"
Set "PiMac=b8-27-eb"
Set "Ping=ping.exe -n 1 -l 0 -f -i 2 -w 1 -4"
For /L %%A in (1,1,254) do Start /HIGH /B %Ping% %SubNet%.%%A >nul 2>&1
```

   c. Save the batch command above and then from a command line prompt on your PC, do the following:
      i. Execute **pingAll.cmd**
      ii. Run '**arp -a**' to make note of all existing IP addresses in use

2. Boot PI: Insert the micro-sd card into the raspberry pi and connect the raspberry pi to the network via an ethernet cable and then power it up (watch the red light and green light to ensure they are blinking as the device boots up). If the green light does not blink at all, then the micro-sd card does not have properly configured operating system and carefully repeat the previous steps, possibly with a different micro-sd card.

3. pingAll.cmd: Wait a couple of minutes and then re-run 'pingAll.cmd' and the 'arp -a' command on your PC to find the new IP address your router as assigned to the Raspberry PI server (again, making sure the server has an ethernet cable connecting it to the local network your PC is using). Note: the MAC address of Raspberry PIs often begin with 'dc-a6', so that may make finding the new IP address easier in the arp -a output (MAC addresses ie '*Media Access Control Addresses*' appear in the 'Physical Address' column). **You should see the new IP Address: 192.168.4.101**.

4. SSH: From the PC, ssh -l pi <IP>, answer 'yes' to ECDSA key fingerprint question and supply the password 'raspberry'. Become root by typing 'sudo su - ' and hitting enter.

5. Root password: Set the root password to something easy to remember - ie: masDupe by typing 'passwd ' and hitting enter and then correctly type the new root password twice.

6. Test out VI skills: Vi is the primary editing tool in the Unix environment and it is fairly easy to use with a few basic commands. Here are all the details you need:

vi <filename> (example: q!)	
<esc>	when in doubt, type <esc> and you'll be in command mode
<esc> :q!	exit, no save
<esc> :wq	exit, save first
i	insert (you exit command mode and enter edit mode)
<shift> a	append at the end of the file (existing command mode to edit)
:<number>	move you to line number
<shift> g	move you to the end of the file
dd	delete line
x	delete character
cw	change word
. (period)	repeat command
yy	copy
10yy	copy 10 lines
p	paste
u	undo
/<words>	find words in the doc

   A simple test of vi: type 'vi /tmp/vitest' and try adding a line or two, editing a line and deleting a line. Finally quit editing and save the changes. To make sure your vi test worked, type 'cat /tmp/vitest' to see your handiwork

7. sshd_config: Once comfortable with simple edits using vi, update /etc/ssh/sshd_config to permit root login: To do this backup /etc/ssh/sshd_config by typing 'cp -p /etc/ssh/sshd_config /etc/ssh/sshd_config.bak' and hitting enter

a. Now type ‘vi /etc/ssh/sshd_config’ and hit enter to edit the sshd config file and uncomment the line ‘#PermitRootLogin prohibit-password’ and change the setting to ‘yes’: ie the line should be: PermitRootLogin yes
b. Save the changes to the file (<esc> and then :wq). To confirm the change worked, type ‘grep PermitRoot /etc/ssh/sshd_config’ and hit enter to see that line in the config file has changed as expected:

```
PermitRootLogin     yes
```

8. hostname: From the Raspbian command prompt type ‘raspi-config’ and select #1 (System Options) and then arrow down to #S4 to change the hostname to ‘mas01’. To commit the change, choose ‘finish’ from the menu and ‘yes’ to the request to reboot

9. login as root to mas01: Back at the PC DOS Command prompt, test this hostname and root password change by typing: ‘ssh -l root mas01’ to login as root

10. SSH root trust:
    a. Use vi to add a new entry to /etc/hosts: <IP> mas01. When completed, the file will look like this:

```
127.0.0.1       localhost
::1             localhost ip6-localhost ip6-loopback
ff02::1         ip6-allnodes
ff02::2         ip6-allrouters
127.0.1.1       mas01
192.168.4.101   mas01
```

    b. RSA key: Create a RSA SSH key by executing the ssh-keygen command. Accept the default location /root/.ssh/id_rsa when prompted and leave the passphrase blank by hitting ‘enter’ when prompted
    c. Use ssh-copy-id to copy this newly generated key to the root .ssh public key file: ‘ssh-copy-id root@mas01’ and then press enter, supplying the root password set above to complete the copy
    d. To test the ssh connection execute the following: ssh root@mas01 and see you are not prompted for a password (note this is a trivial test given you are already logged in as root on mas01, but still useful to see working)

11. Build mas02 - mas04: Repeat the above 10 steps with Raspberry PI Imager, hostname and ssh configuration for the three other disks in the tower (mas02, mas03 and mas04).
    a. Note, use the correct IP addresses from the project IP table.
    b. Note, when step 10c is executed, it will update the file /root/.ssh/id_rsa.pub on mas01

12. Copy id_ras.pub: Ssh to mas01 as root (ssh -l root mas01). Execute the following command to secure copy ssh keys to mas02: scp /root/.ssh/id_rsa.pub root@mas02/root/.ssh/id_rsa.pub Supply the root password when prompted. Repeat this process for mas03 and mas04

13. Test ssh trust: Try using ssh to connect from mas01 to mas02, mas03 and mas04 as root. You should not be prompted for the password if the trust is set up correctly

VI. Software Config - Knowledge Box software -- install the custom Knowledge Box perl script

1. Get tar file: Instructor will email a unix tar ‘mas.tar’ to each team. Download this tar file onto the PC (eg: the downloads directory)

2. SCP tar file: From the PC DOS prompt navigate to where the tar file resides and use ‘dir’ to confirm the file is there. Then use secure copy (scp) to copy it to mas01: scp mas.tar root@mas01:/root/mas.tar

3. Untar the tar file: Use ssh to connect to the mas01 server (ssh -l root mas01). Confirm the tar file is present (ls -l /root/mas.tar). Navigate to the top directory on the Unix filesystem (cd /). From the top directory, execute the following: untar /root/mas.tar

4. Test masDuplication: The above untar command will create /scripts and within /scripts the Knowledge Box Micro-SD and Application Duplication program: masDuplication.pl. To confirm this execute it to see syntax details: /scripts/masDuplication.pl