Creating A Testbed for Flash Memory Research via LPC-H3131 and OpenNFM – Linux Version

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The Security and Privacy (SnP) Lab in Michigan Technological University has conducted extensive research on flash memory security [1-14], and most of our research relied on a flash memory testbed, which has been built using a cheap electronic development LPC-H3131 [15] and open-sourced flash controller OpenNFM [16]. A significant advantage of this testbed lies in its low cost, with less than \$100 in total cost. Previously, we have published a technical report [17] which provides a guideline to researchers, educators and practitioners to set up this flash memory testbed when the host computer uses Windows. In this new technical report, we will provide a step-by-step guideline on how to set up this testbed when the host computer uses Linux.

The report outlines a list of required hardware and software in Sec. I, the necessary system configuration and software installation in Sec, II, and the detailed steps on how to cross-compile the open-source flash controller and flash it to the electronic development board in Sec. III.

I. The Required Hardware and Software

a. Hardware:

- 1. LPC-H3131 USB HEADER DEVELOPMENT PROTOTYPE BOARD [link]
- 2. USB A to B cable
- 3. USB A to Mini Cable
- 4. A host computer equipped with USB ports

b. Software:

- 1. OpenNFM [link]: an open sourced flash memory controller
- 2. PuTTY [link]: a tool used to flash the flash memory controller (after compilation) to LPC-H3131. We used V4.105 in this technical report.
- 3. IAR Embedded workbench [link]: a cross compiler for OpenNFM. We used version 7.40.5.9739 in this technical report.
- 4. Microsoft Windows 10 operating system (for the host computer)
- 5. Virtual Machine Workstation 14 Pro[link]: version 14.1.8 build-14921873 is used to support Ubuntu operating system to run along with the host operating system and test the OpenNFM
- 6. Ubuntu ISO[<u>link</u>]: Ubuntu version 18.04.4-desktop-amd64 is used in VM to test the board.

II. System Configuration and Software Installation

a. Ubuntu

To install PuTTY in Ubuntu operating system, we are using Virtual Machine Workstation Pro and VM installation is carried using the instructions in this <u>link</u>. Once the installation of VM is complete, Ubuntu ISO desktop-amd64 version 18.4 is installed using below steps:

1. After successful installation Virtual Machine Workstation, open the VM workstation by clicking on the icon that looks as below.



2. Home page of VM looks as below and select "Create a New Virtual Machine" option.



3. Virtual Machine Wizard is now open and select "Typical(recommended)" for configuration and click on Next.

| New Virtual Machine Wizard | × |
|----------------------------|---|
| | Welcome to the New Virtual Machine Wizard |
| | What type of configuration do you want? |
| | Typical (recommended) Create a Workstation 14.x virtual machine in a few easy steps. |
| | O Custom (advanced) |
| | Create a virtual machine with advanced options, such as a SCSI controller type, virtual disk type and compatibility with older VMware products. |
| Help | < Back Next > Cancel |

4. On the next screen, select "Installer disc Image (ISO)" and navigate to the location of Ubuntu 18.04.4-desktop-amd64.iso file and select the file as shown below and click next

| New Virtual Machine Wizard | \times |
|---|----------|
| Guest Operating System Installation A virtual machine is like a physical computer; it needs an operating system. How will you install the guest operating system? | |
| Install from: | |
| ◯ Installer <u>d</u> isc: | |
| No drives available \sim | |
| | |
| Installer disc image file (iso): | |
| C:\Users\Deepthi\Downloads\ubuntu-18.04.4-desktop-; V | |
| Ubuntu 64-bit 18.04.4 detected. This operating system will use Easy Install. (What's this?) | |
| \bigcirc I will in <u>s</u> tall the operating system later. | |
| The virtual machine will be created with a blank hard disk. | |
| | |
| | |
| Help < <u>B</u> ack <u>N</u> ext > Cance | 4 |

5. Enter Full name, User name and password fields in this screen as shown below and click on next

| New Virtual M | × | |
|------------------------|---|--|
| Easy Instal This is | I Information used to install Ubuntu 64-bit. | |
| Personalize Linu | Х | |
| <u>F</u> ull name: | OpenNFM | |
| <u>U</u> ser name: | resesarch | |
| Password: | ••••• | |
| Confirm: | ••••• | |
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6. In the next screen, enter name and select the location for VM as shown below

New Virtual Machine Wizard

| Name the Virtual Machine |
|---|
| What name would you like to use for this virtual machine? |
| |

| ⊻irtual machine name: | | | |
|------------------------------------|---------------------|----------------|-----------------|
| Ubuntu 64-bit-Testbed | | | |
| ocation: | | | |
| sers\Documents\Virtual Machines\ | Ubuntu 64-bit-Tes | tbed | B <u>r</u> owse |
| The default location can be change | d at Edit > Prefere | ences. | |
| | | | |
| | | | |
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| | | | |
| | < <u>B</u> ack | <u>N</u> ext > | Cancel |

7. In the next screen, Maximum disc size, we select 20 GB and depending on the system capacity, users can change the capacity and select "Store virtual disc as single file" option and click on next as shown below

| New Virtual Machine Wizard | X |
|---|------|
| Specify Disk Capacity How large do you want this disk to be? | |
| The virtual machine's hard disk is stored as one or more files on the host compute physical disk. These file(s) start small and become larger as you add applications, files, and data to your virtual machine. Maximum disk <u>size</u> (GB): 20.0 Recommended size for Ubuntu 64-bit: 20 GB | r's |
| Store virtual disk as a single file Split virtual disk into multiple files Splitting the disk makes it easier to move the virtual machine to another comp but may reduce performance with very large disks. | uter |
| Help < Back Next > Cance | I |

8. In the next screen, select customize hardware option and change the memory of VM to 2 GM or 2048 MB and click on close as shown below

 \times

| Device | Summary | Memory |
|--|---|--|
| Memory Memory New CD/DVD (SATA) New CD/DVD (SATA) New CD/DVD (SATA) Second Card Printer Display | Summary 1 GB 1 NAT Present Auto detect Present Auto detect | Specify the amount of memory allocated to this virtual machine. The memory size must be a multiple of 4 MB. Memory for this virtual machine: 2048 MB 64 GB 12 GB 16 GB |

9. In the next screen, the summary is displayed, verify the details and click on Finish.

| New Virtual Machine | Wizard X | |
|--|---|---|
| Ready to Create Click Finish to and then VMw | Virtual Machine create the virtual machine and start installing Ubuntu 64-bit rare Tools. | |
| The virtual machine | will be created with the following settings: | |
| Name: | Ubuntu 64-bit-testbed | |
| Location: | C:\Users\Deepthi\Documents\Virtual Machines\Ubuntu 64 | |
| Version: | Workstation 14.x | |
| Operating System: | Ubuntu 64-bit | |
| Hard Disk: | 20 GB | |
| Memory: | 2048 MB | |
| Network Adapter: | NAT | |
| Other Devices: | CD/DVD, USB Controller, Printer, Sound Card | |
| | | |
| <u>C</u> ustomize Hardv | vare | |
| | | |
| <u>P</u> ower on this vir | tual machine after creation | |
| | | |
| | | |
| | | |
| | < Pack Finish Cancel | 1 |
| | <u>S</u> dck Finish Cancel | |

10. Home screen of VM is displayed as below and click on power on the virtual machine.

| 🔂 Home 🛛 🗇 Ubuntu (| 64-bit-testbed × | |
|--|------------------------|---|
| Ubuntu 64-bit | -testbed | |
| Power on this virtual m | nachine | |
| Edit virtual machine se | ttings | |
| Devices | | |
| I Memory | 2 GB | |
| Processors | 1 | |
| Hard Disk (SCSI) | 20 GB | |
| 🐑 CD/DVD 2 (SATA) | Using file C:\Use | |
| 🐑 CD/DVD (SATA) | Using file autoin | |
| 🚍 Floppy | Using file autoin | |
| 🗓 Network Adapter | NAT | |
| 🚭 USB Controller | Present | |
| 🌒 Sound Card | Auto detect | |
| 🖶 Printer | Present | |
| Display | Auto detect | |
| Description | | |
| Type here to enter a descr machine. | iption of this virtual | ▼ Virtual Machine Details |
| | | State: Powerd off Configuration file: (CUREN)Deepth\Documents\Virtual Machines\Ubuntu 64-bit-testbed\Ubuntu 64-bit-testbed\vmx Hardware compatibility: Workstation 14.x virtual machine Primary IP address: Network information is not available |

11. Once the installation is completed, login screen is displayed as below

| Sun 17:32 | 🔂 🕶 🛔 🕪 🛈 🗸 |
|------------------|-------------|
| | |
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| | |
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| | |
| OpenNFM | |
| Password: | |
| ••••• | |
| | |
| Cancel 🌣 Sign In | |
| | |
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| | |
| uduntu | |
| | |

12. On successful login, home screen of Ubuntu is displayed. Now right click on home screen to open the terminal as shown below



13. In the terminal use the command "**sudo apt-get update**" to check for updates and if any OS updates are present, system will be updating on executing this command above.



14.Ubuntu is now successfully installed.

b. PuTTY

PuTTY is the application we are using for serial console and network file transfer. Below are the sets for setting up PuTTY on the Ubuntu VM installed in the above section II a.

- 1. Firstly, connect the LPC board to the Desktop or the system you are using to create the testbed.
- 2. Open the terminal by right clicking and selecting Open Terminal option.
- 3. To install PuTTY, we need to run the terminal as Admin i.e. Root user. Use the command "**sudo apt-get install -y putty**" and run the command as shown below



4. Once the PuTTY is successfully installed, open a new terminal and enter the command "putty" as shown in the below image. Putty configuration window should be now open.

| Activiti | ies 🛃 | PuTTY SSH Client 🔻 | Sun 20:34 | よ 🕪 🛈 🗕 |
|------------|-------------|--------------------------------|--|------------------------|
| | | | research@ubuntu: ~ | |
| | File Ec | | | |
| | resear | ch@ubuntu:~\$ putt | У | |
| | (putty | :3379): Gtk-CRITI | CAL **: 20:34:24.686: gtk_box_gadg | et_distribute: asserti |
| | on 'si ∏ | ze >= 0' failed i | n GtkScrollbar | |
| | | | PuTTY Configuration | |
| | | Category: | Basic options for your PuTTY ses | sion |
| | | ▼ Session | Specify the destination you want to connect | to |
| | | Logging | Host <u>N</u> ame (or IP address) | Port |
| | | ▼ Terminal | | 22 |
| == | | Keyboard | Connection type: | |
| | | Bell | ○ Ra <u>w</u> ○ <u>T</u> elnet ○ Rlog <u>i</u> n ○ <u>S</u> SH | ○ Se <u>r</u> ial |
| -8- | | Features | Load, save or delete a stored session | |
| A | | ▼ Window | Sav <u>e</u> d Sessions | |
| | | Appearance | | |
| \bigcirc | | Translation | Default Settings | Load |
| | | Selection | | Cauc |
| _ | | Colours | | save |
| <u>}_</u> | | Fonts | | Delete |
| | | Connection | | |
| ::: | | Data | | |
| ••• | | Ргоху | Close window on exit: | |

5. Enter Host Name as "/dev/ttyUSBO", select connection type as "serial", change speed to "115200" and select "Default Settings" under saved sessions and click on save as shown in the below image. Saving the settings saves us time in future since we don't have to set these configurations every time, we connect putty.

| | PuTTY Configuration | - 0 8 |
|---|--|------------------------|
| Category: ▼ Session | Basic options for your PuTTY ses Specify the destination you want to connect | to |
| Logging ▼ Terminal Keyboard Bell | /dev/ttyUSB0 Connection type: Raw Telnet | 115200 Serial |
| Features Vindow Appearance Behaviour Translation Selection Colours Fonts Connection Data | Load, save or delete a stored session Sav <u>e</u> d Sessions Default Settings | Load Save Delete |
| Proxy Telnet Rlogin | Close window on e <u>x</u> it: • Always O Never O Only on cle | ean exit |
| About | | <u>C</u> ancel |

15. On successful connection, a new terminal will open and you can press the refresh button present on the LPC to check if the board is ready for Binary file transfer. A message "LPC21XX Ready for Plain Image" is displayed as shown below.

| | | | | /de | v/ttyU | SB0 - P | uTTY | | |
|---------|-------|-----|-------|--------|--------|---------|------|--|--|
| LPC31×× | READY | FOR | PLAIN | IMAGE> | | | | | |
| LPC31xx | READY | FOR | PLAIN | IMAGE> | | | | | |
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c. IAR Workbench

IAR workbench is used for executing the OpenNFM Code and generating the Binary file required for getting the LPC board started.

- 1. Free Version of IAR workbench is downloaded from this [link] and normal installation steps as directed by the installation is followed.
- 2. OpenNFM source code is added to the IAR Workbench and executed to generate "Binary File" that is used for setting up the test bed.

III. Compiling OpenNFM and Flashing The Binary to LPC-H3131 a. Cross-compiling OpenNFM

OpenNFM code base contains all the code required for creating our test-bed for NAND flash research. To compile OpenNFM, the project must be opened in IAR Workbench. Since we already have installed the IAR workbench, below are the steps for compiling and generating binary file required for our test bed.

1. Open IAR Workbench by clicking on the application icon which looks like this.



2. Once the application is open, go to menu bar and click the file option to find "open" and select "Workspace" option.





4. Now the OpenNFM is imported into IAR Workbench. And the all the workbench structure is displayed under Debug panel of IAR workbench as below.

💥 onfm - IAR Embedded Workbench IDE

Options for node "onfm"

| File Edit View Pr | roject | RDI | Tools | Window | Help |
|-------------------|--------|--------|--------|--------|------|
| 🗅 🛩 🖬 🕼 🏼 | 8 | Þa (| a 10 | CH | |
| Workspace | | × | | | |
| Debug | | \sim | | | |
| Files | ٣. | e: | | | |
| 🗉 🗇 onfm - Deb. | 🗸 | | | | |
| 📗 🛏 🗀 core | | . * | | | |
| 📗 🛏 🗀 lpc313x | | * | | | |
| 🛛 🖵 🗀 Öutput | | | | | |
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5. We need to set the linker settings for this project. Go to Project option on the menu bar and click on linker option and under override default option, add the address location of "LPC313x_iRAM.icf" file present in the OpenNFM code folder Opennfm>>trunk>>sys>>lpc313x>>config>> LPC313x_iRAM.icf and click ok.

 \times

| Category: | Factory Settings |
|--|---|
| General Options Static Analysis Runtime Checking C/C++ Compiler Assembler Output Converter Custom Build Build Actions Linker | Config Library Input Optimizations Advanced Output List |
| Debugger Simulator Angel CMSIS DAP | Edit Configuration file symbol definitions: (one per line) |
| GDB Server IAR ROM-monitor I-jet/JTAGjet J-Link/J-Trace TI Stellaris | ^ |
| PE micro RDI ST-LINK | × |
| Third-Party Driver TI XDS | OK Cancel |

6. To make sure, all the files are present, you need to check if the code compiles by right clicking on the project present under the "Debug" panel and select "Rebuild All" option.

| 💘 onfm - IAR Emk | oedded Workbench IDE |
|------------------------|---|
| <u>File Edit V</u> iew | <u>P</u> roject <u>R</u> DI <u>T</u> ools <u>W</u> indow <u>H</u> elp |
| 🗅 🚔 🔒 🞒 | |
| Workspace | x |
| Debug | ~ |
| Files | 2. B |
| □ □ onfm - De | Options |
| Ipc: L⊕ Cut | Make |
| | Compile Rebuild All |
| | |
| | Clean |
| | C-STAT Static Analysis > |
| | Stop Build |
| | Add > |
| | Remove |
| | Rename |
| | Version Control System > |

- 7. If all the files are intact, the project should compile successfully without errors.
- 8. If any errors are present, the details of the error are displayed under the build panel of the IAR workbench.
- To clear the error messages under the build panel and to rebuild the entire project, right click on the project and click on "clean" option
 NSAC HIFL IAR Embedded Workbench IDE



10. On successful compilation of the OpenNFM code, binary file with the name "onfm" will be generated in the Exe folder present in the below location

- 11. Opnfm>>prj>>iar>>Debug>>Exe
- 12. To verify whether the binary file is latest or not, check the Date modified property of the opennfm (OUT File type). The time should match the time when OpenNFM project was rebuild from IAR Workbench.

| | log.txt | 25-06-2020 13:25 | Text Document | 3 KB |
|-----|----------------|------------------|---------------|--------|
| 4 | 🦪 onfm | 13-07-2020 20:23 | OUT File | 420 KB |
| 13. | onfm_fresh.bin | 13-07-2020 20:23 | BIN File | 23 KB |

14. Whenever any changes are made to the files in the project folder, the entire code should be re-compiled and then newly generated "onfm" binary file should be uploaded in the Tera Term to see the updated changes in action on the OpenNFM test bed simulation.

b. Flashing The Binary of OpenNFM to LPC-H3131

For Ubuntu operating system, we are using PuTTY application for serial console and network file transfer. Below are the steps:

- 1. We will need below mentioned .sh files for starting the process
 - a) download.sh:

sudo ./bin-xfer.sh -i NSAC_DEBUG.bin -o /dev/ttyUSB0

b) bin-xfer.sh:

#!/bin/sh INFILE=/dev/null OUTFILE=/dev/null

| exists() { |
|---------------------------------|
| command -v \$1 >/dev/null 2>&1 |
| } |
| while [\$# -gt 0]; do |
| case "\$1" in |
| -i) |
| shift |
| INFILE="\$1" |
| ;; |
| -0) |
| shift |
| OUTFILE="\$1" |
| ;; |
| -h help) |
| echo "\$0 -i infile -o outfile" |
| ;; |
| *) |
| INFILE="\$1" |

| esac |
|--|
| shift |
| done |
| cat << EOF |
| binary-xfer utility for minicom |
| Sending file \${INFILE} to \${OUTFILE} |
| EOF |
| if (exists pv); then |
| pvforce -i 0.25 -B 128 \${INFILE} 2>&1 > \${OUTFILE} |
| else |
| cat \${INFILE} > \${OUTFILE} |
| fi |
| cat << EOF |
| File transfer complete |
| EOF |
| sleep 1 |

- 2. Onfm_fresh.bin file is taken from the location **Opnfm>>prj>>iar>>Debug>>Exe** folder after successfully rebuilding the workspace.
- 3. Copy all the three folders into Ubuntu VM currently running from Sec II (a)
- 4. If PuTTY is not currently running or disconnect, follow the steps in Sec II (b) to start the connection.
- 5. All the above 3 files are copied on to Ubuntu Desktop for convenience. User can choose any location/folder to copy these files accordingly.
- 6. Right click on bin-xfer.sh and go to properties and check "Execute: Allow executing file as program" and Access to "Read and Write" and repeat the same process for download.sh file as shown below.

| | bin-xfer.sh Propertie | s 😣 |
|-------------------|-------------------------|-----------|
| Basic | Permissions | Open With |
| Owner: | Me | |
| Access: | Read and write | • |
| Group: | research 🔻 | |
| Access: | None | • |
| Others | | |
| Access: | None | • |
| Execute: | Allow executing file as | program |
| Security context: | unknown | |
| | | |
| | | |

- 7. Open a new terminal and navigate to the location where the above files are placed. In this case, I am navigating to desktop using cd Desktop command in the new terminal. Always run the terminal as root user.
- 8. Now type the command "./download.sh" from the desktop location as shown below. Update the bin folder name in the download.sh file if there are any

changes to the file name.



9. If the command is successfully executed, successfully mounted message is displayed on the putty console terminal as shown below



10. Removable Drive is detected under the disks folder as shown in the below image



11. Now the disk needs to be formatted before it is used by clicking on the settings

| Activities Disks ▼ Mon 21:15 S08 MB Drive /dev/sdb /dev/sdb Image: Composition of the state of the s | | | | n | button |
|---|---------|--------------------------------|--|---|------------|
| Source /dev/sab 21 GB Hard Disk Model Woware, VMware Virtual S Size 508 MB (507,770,880 bytes) Source Source Source Journal | ∔ ๗ ଓ ◄ | | Mon 21:15 | s 🔯 Disks 🔻 | Activities |
| Image: Willware Virtual S Image: Willware Virtual SATA CDRW Drive Image: VMWare Virtual SATA CDRW Drive Image: V | | ك 🔺 | 508 MB Drive /dev/sdb | | |
| Witware Virtual SATA CDRW Drive Serial Number ABCD123456789 Volumes SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive SoB MB Drive </th <th></th> <th>Mgr <mark>(0.1)</mark> tes)</th> <th>Model Crane544 Open NANDF M Size 508 MB (507,770,880 byte</th> <th>21 GB Hard Disk VMware, VMware Virtual S</th> <th></th> | | Mgr <mark>(0.1)</mark> tes) | Model Crane544 Open NANDF M Size 508 MB (507,770,880 byte | 21 GB Hard Disk VMware, VMware Virtual S | |
| S08 MB Drive CraneS44 Open NANDF Mgr Volumes S08 MB Unknown Size 508 MB (507,770,880 bytes) Device /dev/sdb Contents Unknown | | | Serial Number ABCD123456789 | VMware Virtual SATA CDRW Drive | |
| SOB MB Unknown Size SO8 MB (507,770,880 bytes) Device /dev/sdb Contents Unknown | | | Volumes | 508 MB Drive Crane544 Open NANDF Mgr | |
| Size 508 MB (507,770,880 bytes) Device /dev/sdb Contents Unknown | | wn | 508 MB Unknow | | |
| Device /dev/sdb Contents Unknown | | | Size 500 MD (507 770 000 buter) | | |
| Contents Unknown | | | Device /dev/sdb | | |
| | | | Contents Unknown | | |
| | | | | | |

12. You will be prompted to enter Volume name of the disk as shown below and click on next and then click Format

| Cancel | Format Volume | Next |
|-------------|--|------|
| Volume Name | E For example: "Angela's Files" or "Backup". | |
| Erase | OVERWRITES EXISTING DATA, but takes longer. | |
| Туре | Internal disk for use with Linux systems only (Ext4) Password protect volume (LUKS) For use with Windows (NTFS) For use with all systems and devices (FAT) Other | |

13. Now the disk needs to be started by clicking on the play button available on the disk as shown below

| Activities | 🛛 🕅 Disks 🔻 | Mon 21:21 👗 🐠 🖒 | - |
|------------|---|--|---|
| | | 508 MB Drive /dev/sdb | 8 |
| | 21 GB Hard Disk VMware, VMware Virtual S CD/DVD Drive | Model Crane544 Open NANDF Mgr (0.1) Size 508 MB (507,770,880 bytes) | |
| | 508 MB Drive Crane544 Open NANDF Mgr | Serial Number ABCD123456789 Volumes | |
| | | Е 508 МВ FAT | |
| - | | | |
| | | | |
| | | Size 508 MB (507,770,880 bytes) | |
| | | Device /dev/sdb | |
| | | UUID 28E5-2D0C | |
| | | Contents FAT (16-bit version) — Not Mounted | |
| ••• | | | |

14. Once the disk is started successfully, the status of the drive looks as below



15. Disk with the volume name given while formatting on the desktop as shown below



16. Open the E disk and the disk is ready to write files and used as any other USB Flash device for reading and writing as shown below

| Activiti | es i | 🖥 Files 🔻 | Mon 21:28 | Å | ●) () - |
|----------|------|-----------------|------------------------------|----------|----------|
| | | > ∢ ■ E → | ٩ | :: = | |
| | Ø | Recent | Name 🔺 | Size M | Aodified |
| • 🔍 | 企 | Home | PNG 3.PNG | 39.0 kB | Wed |
| | | Desktop | PNG 4 PNG | 38.7 kB | Wed |
| ► | D | Documents | | | |
| | ∻ | Downloads | PNG 5.PNG | 11.7 kB | Wed |
| • 🛃 | 93 | Music | PNG 6.PNG | 66.1 kB | Wed |
| | ø | Pictures | | | |
| • 🔚 | • | Videos | PNG 7.PNG | 12.2 kB | Wed |
| | | Trash | SelicPragmatics.pdf | 152.8 kB | 29 Jun |
| | | E 🗅 | tn2959_bbm_in_nand_flash.pdf | 325.4 kB | 29 Jun |
| | | Other Locations | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | She | ow Applications | | | |

17. To remove the drive, click on the disconnect usb and the PuTTY connection is automatically closed.

<u>Note</u>: The OpenNFM testbed setup is done for Windows 10 operating system for compiling code and generating Binary file and the generated Binary file is used in Ubuntu VM installed in the same windows machine

IV. **Equipment:** a. Desktop: View basic information about your computer Windows edition Windows 10 Home Single Language Windows 10 © 2019 Microsoft Corporation. All rights reserved. System Processor: Intel(R) Core(TM) i5-6200U CPU @ 2.30GHz 2.40 GHz DELL Installed memory (RAM): 8.00 GB (7.86 GB usable) System type: 64-bit Operating System, x64-based processor Pen and Touch: Touch Support with 10 Touch Points System type: and the second ______ Information Computer name, domain, and workgroup settings Computer name: DESKTOP-JD8VI03 Full computer name: DESKTOP-JD8VI03 Change settings Computer description: WORKGROUP Workgroup:

b. USB A to B & A to Mini cables:



c. LPC-H3131 Prototype Board:



References

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Appendix

bin-xfer.sh

```
#!/bin/sh
INFILE=/dev/null
OUTFILE=/dev/null
exists() {
```

```
command -v $1 >/dev/null 2>&1
```

}

```
while [ $# -gt 0 ]; do
 case "$1" in
 -i)
 shift
 INFILE="$1"
 ;;
 -0)
 shift
 OUTFILE="$1"
 ;;
 -h|--help)
 echo "$0 -i infile -o outfile"
 ;;
 *)
 INFILE="$1"
 esac
 shift
done
cat << EOF
binary-xfer utility for minicom
Sending file ${INFILE} to ${OUTFILE}
E0F
if (exists pv); then
  pv --- force -i 0.25 -B 128 ${INFILE} 2>&1 > ${OUTFILE}
else
  cat ${INFILE} > ${OUTFILE}
fi
cat << EOF
File transfer complete
E0F
sleep 1
download.sh
```

sudo ./bin-xfer.sh -i onfm_fresh.bin -o /dev/ttyUSB0