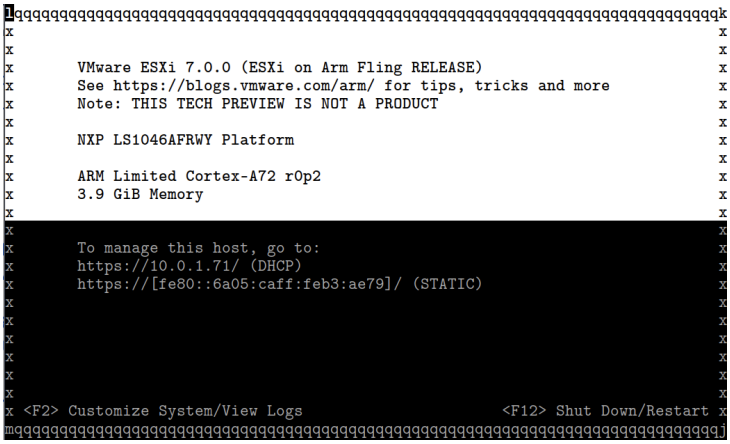
Fling on NXP LS1046A FRWY



1. Info

The NXP LS1046A Freeway board is compact evaluation platform, broadly positioned as a white-box platform for Industrial PC, Enterprise Router, Central-Office server, and SD-WAN aggregator use-cases supporting flexible software deployment.

The FRWY based on the NXP LayerScape LS1046A SoC with 4 x Cortex-A72 cores and supports up to 4GB ECC RAM. The SBC also has USB3, PCIe (m.2 Key E) and GbE connectivity.

The anticipated use case is "Far Edge": e.g. a virtualized IoT gateway.

The official support resources, including information on how to buy, are available at https://www.nxp.com/design/qoriq-developer-resources/ls1046a-freeway-board:FRWY-LS1046A

2. Required and supported hardware

Minimally, you need:

- An NXP FRWY.
- 1 x USB drive for installer ISO and actual ESXi installation
- 1 x USB NIC
- 1 x microUSB cable for serial console

The following hardware is supported:

- USB storage
- USB networking
- Serial console
- PCIe m.2 Key E
- Some PCIe NICs and other PCIe devices via adapter to m.2 Key E

As you will note, SD card and onboard GbE ports are not supported.

2.1. USB devices

IMPORTANT: USB device can consume significant power and thus put a stress on the FRWY's power circuits. Some USB devices could consume so much power (e.g. NVMe enclosure) that the system will simply not work, be unstable or have unstable USB behavior. For anything short of a basic USB key and NIC, use a powered USB3 hub.

2.2. PCIe m.2 Key E

There are two m.2 Key **E** slots on the board. If you have your FRWY in the official enclosure, you can access one of the m.2 slots via an access port on the bottom, held down by two screws.

2.2.1. Using regular PCIe or Mini PCIe devices.

Key **E** is not Key **M** - NVMe drives will not fit here. However, there are m.2 Key E to PCIe and Mini PCIe extenders.

You will have to file down the access port cover to allow the extension cable through.

Description	Product	Comments
M.2 (NGFF) Key A/E/A+E to Mini PCI-E Adapter	https://www.amazon.com/gp/product/B07JFYSNVL	Mini PCIe
ADT-LINK M.2 WiFi A.E Key A+E to PCI-e 4X x4 Riser Extender Adapter Card	https://www.amazon.com/gp/product/B07YDGJGBD	Solid construction
Coolerguys 100-240v AC to 12 & 5v DC 4pin Molex 2A Power Adapter	https://www.amazon.com/gp/product/B07GFSGQTG	Extra power for some cards
Kentek 6 Inch 6" 4 Pin Molex 5.25 Male to 4 Pin 3.5 Floppy	https://www.amazon.com/Kentek-Floppy-Internal-Computer-Adapter/dp/B07KS5NHTC	For above PSU

Do note, that non-trivial PCIe adapters may require more power than can be sourced directly from the FRWY via the PCIe extender. Practically every PCIe extender takes extra power via a 4-pin floppy power connector.

2.2.2. Supported PCIe devices

The PCIe extender allows the use of a PCIe NIC or even storage. Note, because ESXi-Arm does not support MSI/MSI-X interrupts on LS1046A-based platforms, some devices will not work, as their drivers only support MSI-X interrupts.

Intel e1000 NICs supported by the ne1000 driver are known to work.

3. Preparation

3.1. Serial console access

The serial console is provided via the microUSB connector in the front of the board. On the official enclosure it is labelled UART1.

This USB UART is a Silicon CP2102n, with no macOS drivers. Linux is fine.

Note: the USB UART device will not appear on your PC until the FRWY is powered.

Fire up your terminal emulation and connect to the device on your PC. The parameters used to open this port:

```
Baud Rate     115200
Data Bits     8
Parity        None
Stop Bits     1
Flow Control  None
```

3.1.1. 'screen' terminal emulator

Note: device names below may be different. Check your system.

On Linux:

```
$ screen /dev/ttyUSB0 115200
```

3.1.2. 'minicom' terminal emulator

Note: device names below may be different. Check your system.

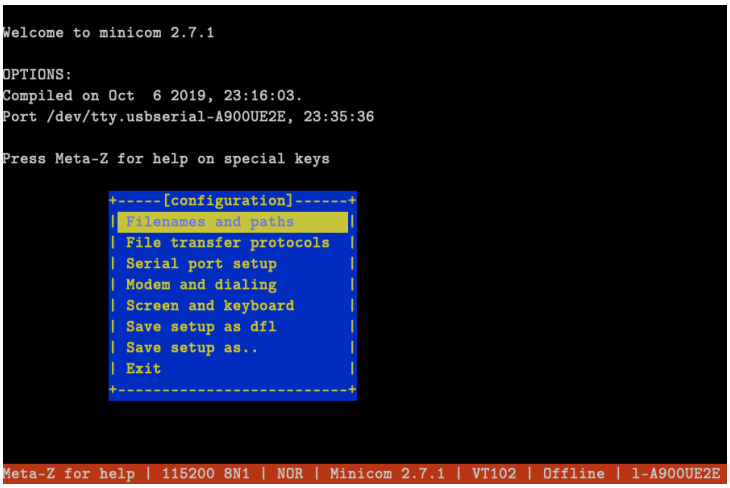
With **minicom**, you will have to configure settings the first time you use it.

On Linux:

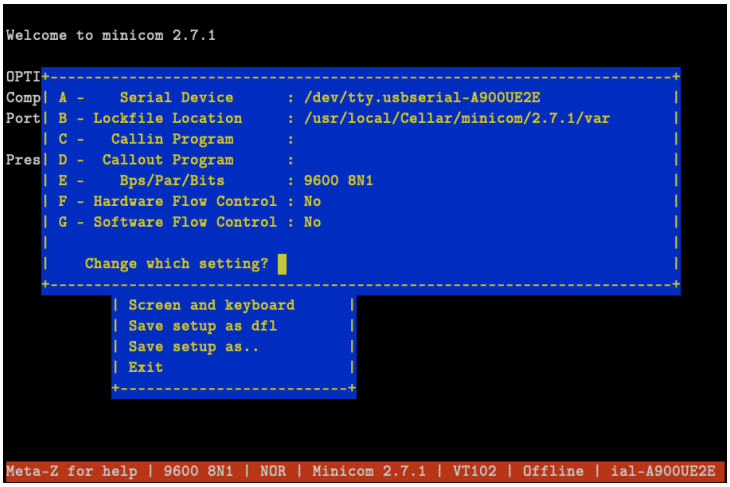
```
$ minicom -c on -D /dev/ttyUSB0
```

Now press **CTRL-Z**:

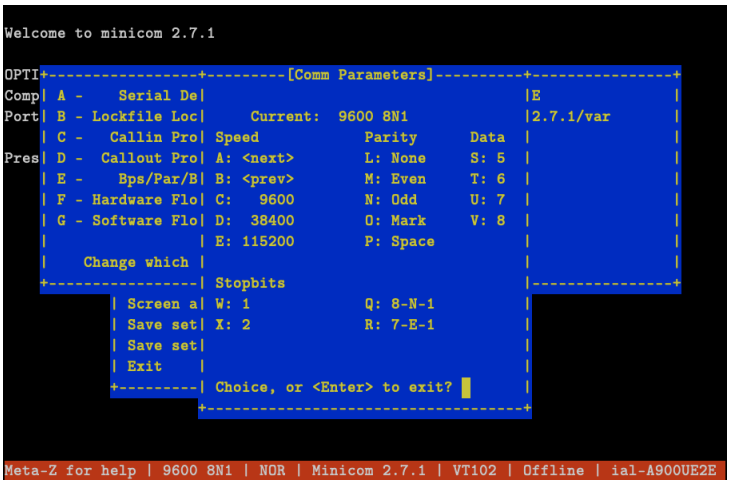
Now press **O**:



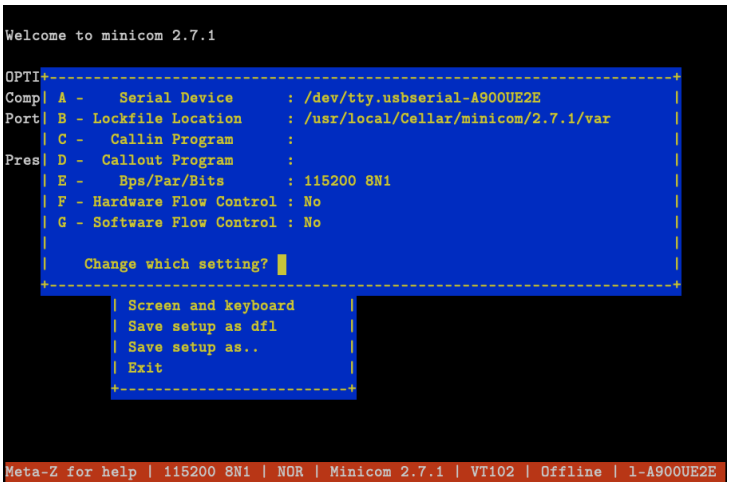
Use arrow key to navigate to **Serial port setup** and press the **ENTER**:



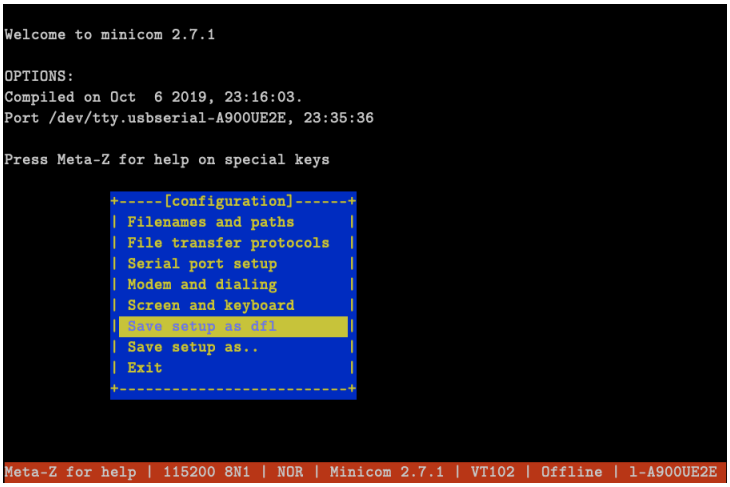
Now press **E**:



Press **E** again, then **ENTER**.



Make sure settings **F** and **G** both say **No** to any kind of flow control. Press **ENTER** when done, then navigate to **Save setup as dfl** and press **ENTER**.



Use **ESC** to exit out of the menus.

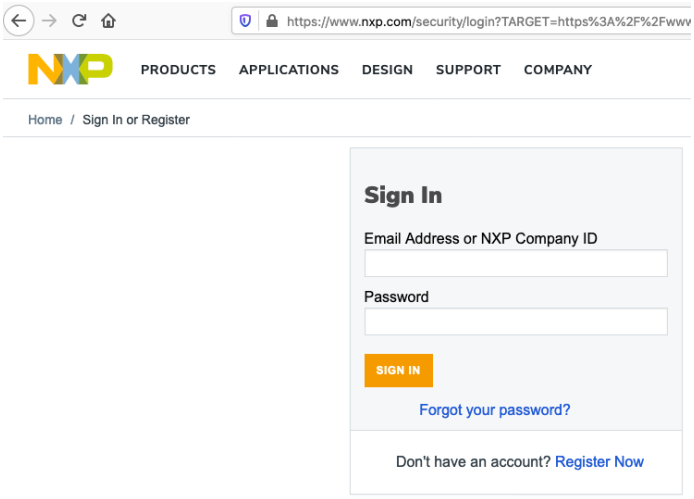
3.2. Flashing UEFI firmware

UEFI needs to be flashed to SPI flash. Most likely you'll have a device that comes with U-boot on SD card and nothing in SPI. Updating the firmware once you have UEFI is quite a bit easier.

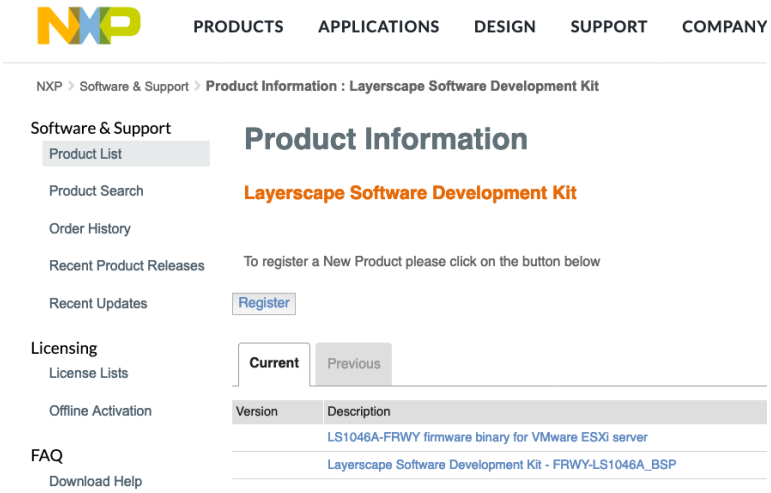
3.2.1. Downloading firmware

Go to https://www.nxp.com/webapp/swlicensing/sso/downloadSoftware.sp?catid=LAYERSCAPE-FRWYLS1046A-BSP

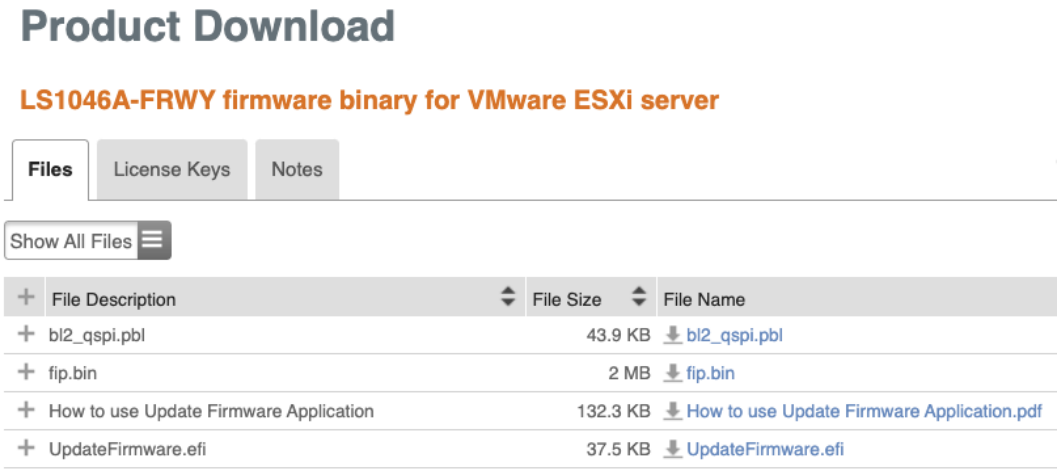
Log in with your NXP support account, or create one:



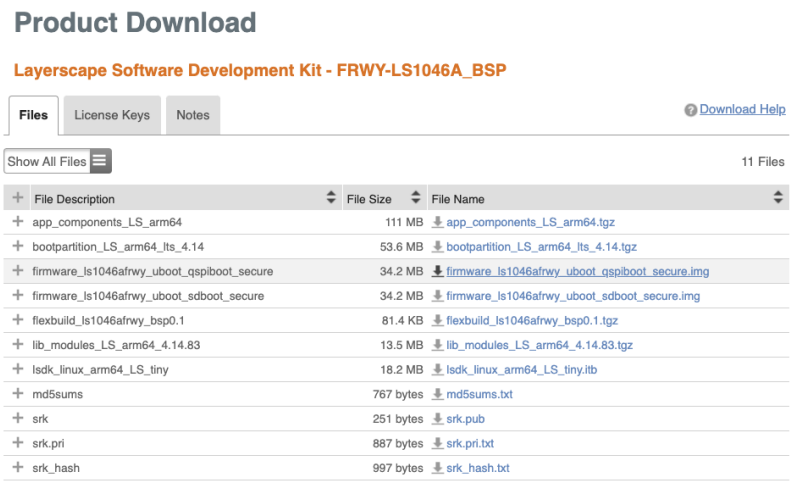
You should see two downloads:



You'll definitely need all the files under the **LS1046A-FRWY firmware binary for VMware ESXi server** label:



If you're flashing a brand new device (i.e. that boots U-boot from SD card), you also need to grab the **firmware_ls1046afrwy_uboot_qspiboot_secure.img** file under the **Layerscape Software Development Kit - FRWY-LS1046A_BSP** label:



Product Download

Layerscape Software Development Kit - FRWY-LS1046A_BSP

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File Description	File Size	File Name
app_components_LS_arm64	111 MB	app_components_LS_arm64.tgz
bootpartition_LS_arm64_lts_4.14	53.6 MB	bootpartition_LS_arm64_lts_4.14.tgz
firmware_ls1046afrwy_uboot_qspiboot_secure	34.2 MB	firmware_ls1046afrwy_uboot_qspiboot_secure.img
firmware_ls1046afrwy_uboot_sdboot_secure	34.2 MB	firmware_ls1046afrwy_uboot_sdboot_secure.img
flexbuild_ls1046afrwy_bsp0.1	81.4 KB	flexbuild_ls1046afrwy_bsp0.1.tgz
lib_modules_LS_arm64_4.14.83	13.5 MB	lib_modules_LS_arm64_4.14.83.tgz
lsdk_linux_arm64_LS_tiny	18.2 MB	lsdk_linux_arm64_LS_tiny.itb
md5sums	767 bytes	md5sums.txt
srk	251 bytes	srk.pub
srk.pri	887 bytes	srk.pri.txt
srk_hash	997 bytes	srk_hash.txt

3.2.2. From U-Boot

There's a switch (DIP) block on the board labeled SW1.

- Start with switch settings SW1[1:10]=0x0_0100_0000_0 (SD boot) and use the SD card that comes with the board. This has a working U-Boot.
- Put the files on a USB stick.

Once U-Boot gets to a command prompt, do the following to flash images to SPI:

```
=> usb start && usb dev 0
=> sf probe 0:0


// Flash the main recovery image
=> fatload usb 0:1 $load_addr firmware_ls1046afrwy_uboot_qspiboot_secure.img
=> sf erase 0x00 +$filesize
=> sf write $load_addr 0x00 $filesize

// Flash "bl2_qspi.pbl" to NOR Flash at address: 0x0
=> fatload usb 0:1 $load_addr bl2_qspi.pbl
=> sf erase 0x0 +$filesize
=> sf write $load_addr 0x0 $filesize

// Flash "fip.bin" to NOR Flash at address: 0x10000
=> fatload usb 0:1 $load_addr fip.bin
=> sf erase 0x100000 +$filesize
=> sf write $load_addr 0x100000 $filesize
```

Now flip SW1 from SW1[1:10]=0x0_0100_0000_0 (SD boot) to SW1[1:10]=0x0_0100_0100_0 (QSPI Boot).

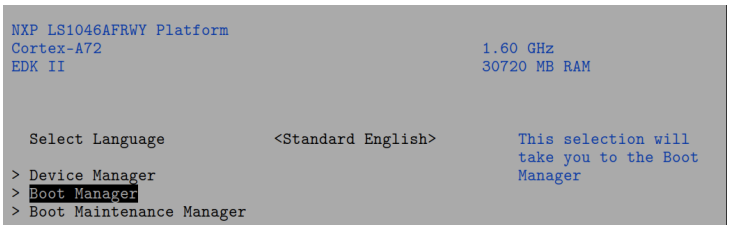
Power cycle the board.

3.2.3. From UEFI

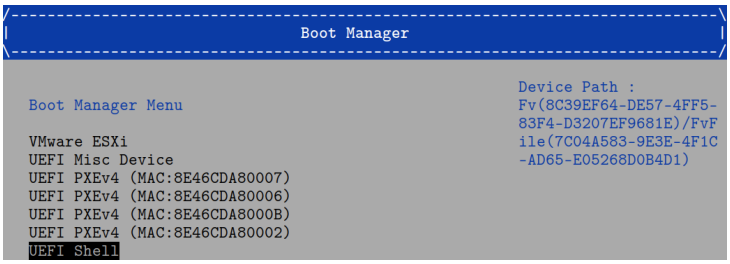
This assumes **UpdateFirmware.efi**, **bl2_qspi.pbl** and **fip.bin** are copied to SD card or USB drive.

Turn the system on by plugging in the power supply.

Enter UEFI configuration by mashing the **ESC** key. Then, use the arrow keys to navigate to **Boot Manager**:

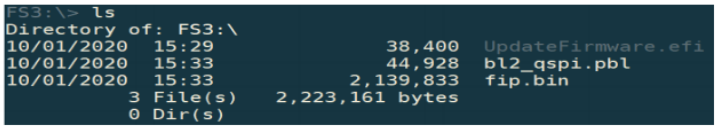


Press **ENTER**, then navigate UEFI Shell:



Press **ENTER**. Shell will start.

Find the right fsX that contains the firmware update application and files. It may be called something else, like **fs0** or **fs1**:



Program the firmware and reset the board.

```
fs3:\> UpdateFirmware.efi -f bl2_qspi.pbl -d 1 -of 0x0
fs3:\> UpdateFirmware.efi  -f fip.bin -d 1 -of 0x100000
fs3:\> reset
```

4. Install ESXi-Arm

Follow the generic installation steps, with a few caveats.

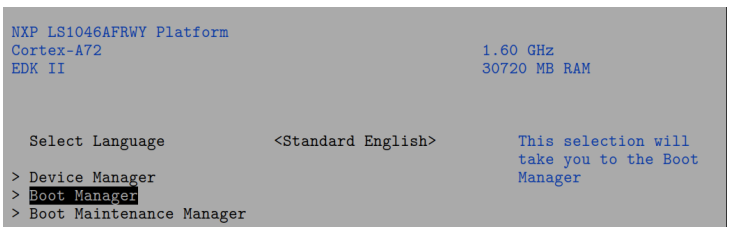
- Because the FRWY only has two USB ports, and one the ports has to be occupied by a USB NIC, you will have to flash the ISO to the same drive you intend to use for ESXi-Arm.
- Because only the serial console is available, you will not be able to pass any advanced options to installer (e.g. **autoPartitionOSDataSize** via **Shift-O** in the ESXi bootloader)

4.1. Automated installation.

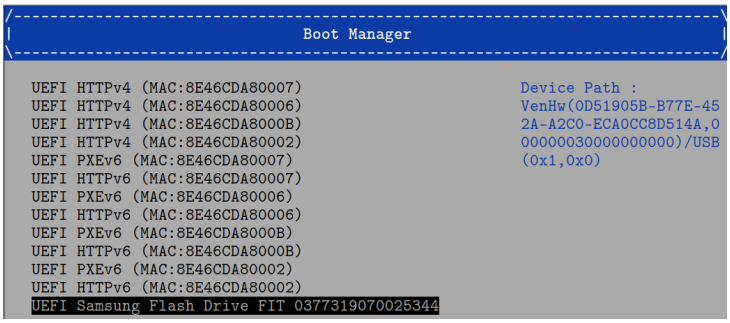
If using a kickstart script, the NIC name for a USB NIC is **vusb0**. The NIC name for a PCIe NIC is **vmnic0**.

4.2. Booting the installer

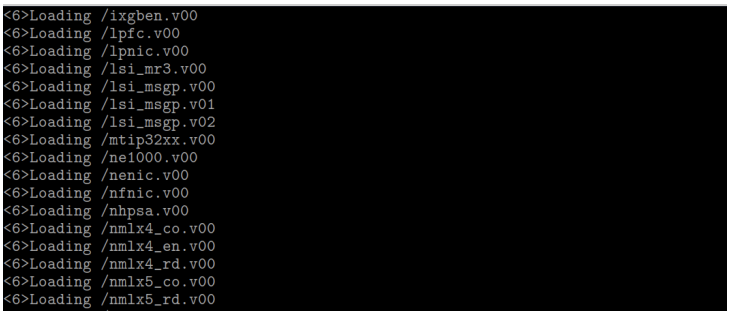
Plug in the USB NIC and USB key with installer into the FRWY and turn the system on by plugging in the power supply. Enter UEFI configuration by mashing the **ESC** key. Then, use the arrow keys to navigate to **Boot Manager**:



Press **ENTER**, then navigate to the USB drive with the installer.



Press **ENTER**, and the installer will boot:



4.3. NTP

The FRWY does have a battery RTC. The time may not have been set correctly. It is highly recommended that you configure NTP, especially if adding the FRWY to a vCenter (ideally, matching the NTP servers used by vCenter to avoid time skew issues).

5. Known issues

5.1. Hardware

5.1.1. PCIe device not enumerating

If you used am m.2 to PCIe adapter, and your device is not enumerating in UEFI Shell or ESXi, then your device may need more power than provided by the extender. Practically all extenders have take a 4-pin floppy power connector (5V and 12V rails), so be sure to provide extra power if needed.

5.1.2. Flaky USB in UEFI or ESXi

I/O errors, device not enumerating or disappearing (works in UEFI, not ESXi).

5.1.2.1. This is largely due to power issues.

Workaround: Use a powered hub, especially if using power hungry USB-SATA or USB-NVMe enclosures, or USB NICs with embedded USB hubs.

5.1.2.2. Plugging devices while system is on.

The USB3 implementation on the FRWY is a bit sensitive. Could also be due to power fluctuations.

Workaround: Avoid hot plugging devices directly into the FRWY if you can.

5.2. ESXi-Arm

5.2.1. My PCIe NIC doesn't work

MSI/MSI-X interrupts are not supported on the LS1046A today, and this may preclude some PCIe devices from working correctly (e.g. **igbn** driver for some Intel NICs). Use a different PCIe NIC (e.g an **ne1000** driver one for Intel NICs) or a USB NIC.

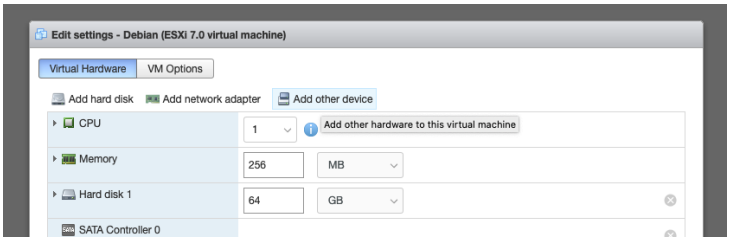
5.2.2. PCIe device cannot be toggled for pass-through

Update firmware. The first version published by NXP accidentally omitted the firmware configuration for SMMU (IOMMU).

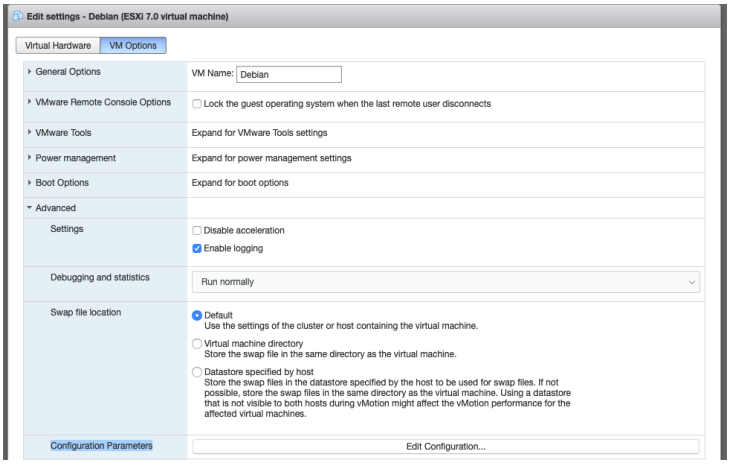
5.2.3. Passed-through PCIe device: VM powers off

Most PCIe devices use MSIs. MSI/MSI-X interrupts are not supported on the LS1046A today, and MSIs cannot be virtualized if a passed-through device is using legacy interrupts, but a workaround is possible.

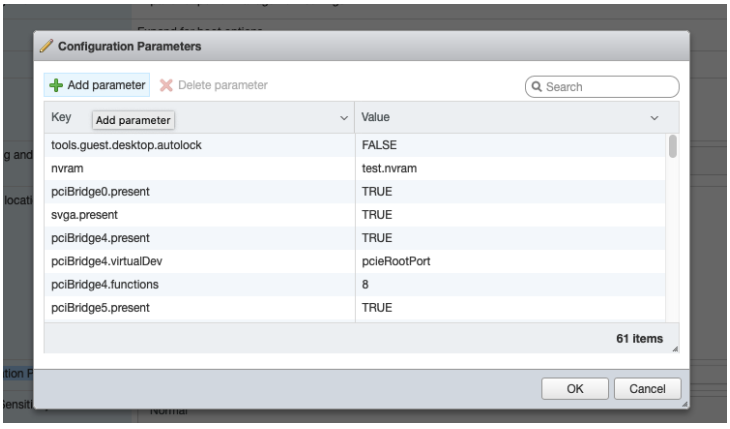
Open the VM configuration:



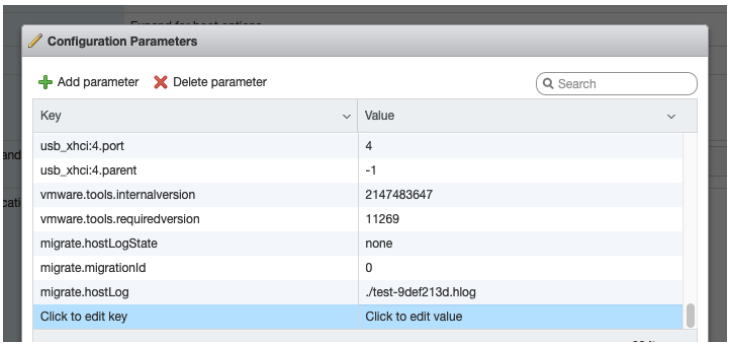
Click on **VM Options**, and expand the **Advanced** group of settings:



Click on **Edit Configuration.**

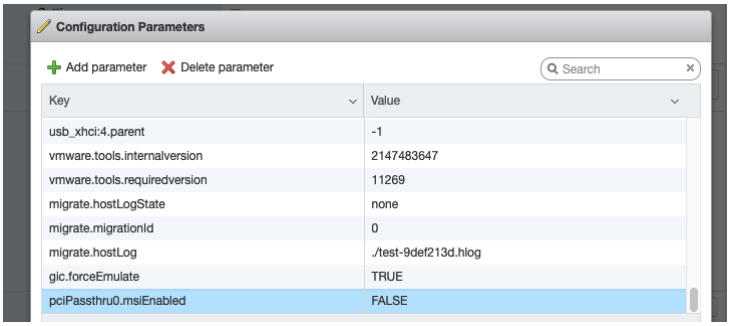


Click **Add parameter**:

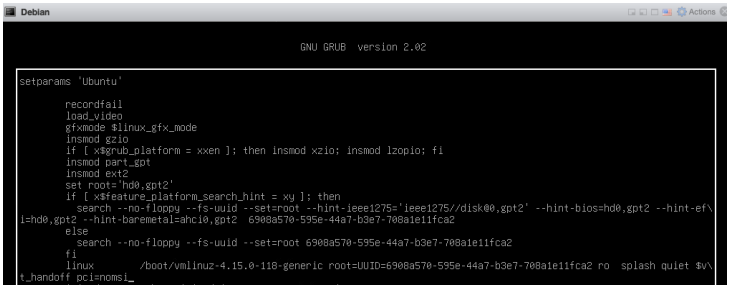


Edit the row that says **Click to edit key**, setting **Key** to **gic.forceEmulate** and **Value** to **TRUE**.

Now add another parameter, setting **Key** to **pciPassthru0.msiEnabled** and **Value** to **FALSE**.



Add **pci=nomsi** Linux kernel boot option inside the VM:



5.2.4. Passed-through PCIe device: VM powers off with SMMU error

The VM crashes, and VMKernel **dmesg** says something about SMMU errors caused by the passed-through device. This has been seen with passing through the Qualcomm Atheros QCA6174 802.11ac Wireless Network Adapter that some FRWY systems ship with, into VMs with less than 512MiB RAM.

Give the VM 512 MiB RAM.