Linux 5.10 Yocto SDK

User Manual

V 2.2

1 Introduction

Thank you for choosing a miriac Single Board Computer from MicroSys. This User Manual shows the steps needed to boot Linux, to run programs on the SBC, including your own benchmarks, and also details how to make modifications and updates to the U-Boot bootloader and/or the Linux kernel to meet your own requirements.

The Linux 5.10.35 Yocto Software Development Kit is valid for the following miriac Single Board Computers from MicroSys:

SBC-LS1043A
SBC-LS1046A
SBC-LS1088A
SBC-LS1046A-TSN
SBC-LX2160A
AIP-LX2160A

2 Prerequisites

2.1.1 Host Machine Requirements

To operate the board, you will need a host machine with the following capabilities:

- an Ethernet interface to connect to the SBC either directly or via your local network. In addition, to be able to build a Linux kernel you'll need an internet connection.
- a USB port running a terminal software program (e.g. TeraTerm, HyperTerminal, putty, ckermit...), or else a hardware serial console.

  Choose the following parameters:

  (a) **115200 Bd**

  (b) **8 Data bits**

  (c) **No parity**

  (d) **1 Stop Bit**

  If you want to build the Linux kernel, you'll need to have Linux running on your host. If the host is a Windows machine, then you'll need to run Linux in VirtualBox, VMware or a similar virtual machine.

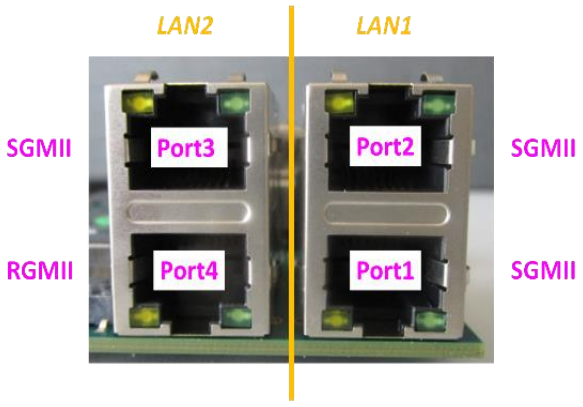
3 Board Preparation and Power-Up

3.1 CRX05

Make sure that switch SW1-1 is ON and SW1-2 is ON. This is the factory default and selects the SD card as the boot media.

- Insert the SD card provided into ST1
- The board comes pre-configured to boot correctly on arrival (by default from SD card)
- Connect the mini USB cable to ST5.
- Connect an Ethernet cable to an RJ45 connector (see table 3-1)
- Connect the power cable to the ST3 connector, while the power supply is still switched off.
- Open a terminal console on the host PC (set to 115200, 8, N, 1)
- Switch on the power.

The following picture shows the front view of the two dual RJ-45 connectors as placed on the CRX05 carrier.



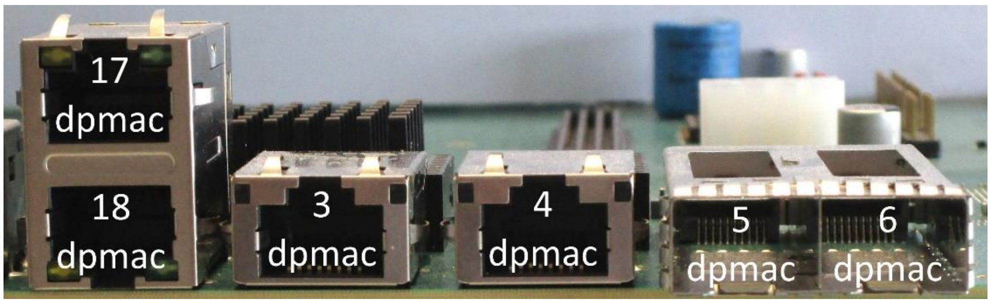
LAN port	LS1043A interface	LS1046A interface	LS1088A interface	PHY address
1	fm1-mac9	fm1-mac9	dpmac2	0000
2	n/c	fm1-mac6	dpmac3	0001
3	fm1-mac2	fm1-mac5	dpmac7	0010
4	fm1-mac3	fm1-mac3	dpmac4	0011

Table 3-1 Ethernet port to Linux interface assignment

3.2 CRX08

Make sure that switch SW5-1 is ON and SW5-2 is ON. This is the factory default and selects the SD card as the boot media.

- Insert the SD card provided into ST31
- The board comes pre-configured to boot correctly on arrival (by default from SD card)
- Connect the mini USB cable to ST29.
- Connect an Ethernet cable to an RJ45 connector (see table 3-1)
- Connect the ATX power cable (24 Pin Molex Mini-Fit) to the ST3 connector and 8 Pin Molex Mini-Fit to ST5, while the power supply is still switched off.
- Open a terminal console on the host PC (set to 115200, 8, N, 1)
- Switch on the ATX power supply and press the power up button.



LAN port	LX2160A interface	PHY address
1	dpmac17	0x0
2	dpmac18	0x1
3	dpmac3	0x10
4	dpmac4	0x11
5	dpmac5	SFP-25G
6	dpmac6	SFP-25G

4 Operation

ATTENTION

After Power-up, the green LED on the module should light up and any red LED should be off.

IF NOT, DISCONNECT THE UNIT FROM POWER AND CHECK FOR FAULTS!

4.1 Boot Procedure

When power is supplied the system will boot into U-Boot.
The factory default settings configure U-Boot to boot straight into Linux. So if you do not intervene, after a few seconds, you will see the Linux prompt:

```
MicroSys 3.3 mpxls10nn ttyS0

mpxls10xx login:
```

Enter ‘root’ and hit return. By default, no password is set for root.

```
mpxls10xx login: root
root@mpxls10xx:~#
```

You can now enter Linux commands and run programs. Continue in section 2.2

4.1.1 Only boot into U-Boot

If you want to view the U-Boot parameters, then you will need to prevent U-Boot from automatically booting into Linux by hitting any key during the autoboot timeout phase:

```
. . . . . . . .
PCIe0: pcie@3400000 disabled
PCIe1: pcie@3500000 Root Complex: no link
PCIe2: pcie@3600000 disabled
FM1@DTSEC3 [PRIME], FM1@DTSEC5, FM1@DTSEC6, FM1@DTSEC9
Hit any key to stop autoboot: 0
=>
```

When you see the U-Boot prompt, =>, you can enter U-Boot commands to change some parameters, for example your IP address, and view various settings.

```
=> version                    // show U-Boot version
=> help                       // show available commands
=> bdinfo                     // show board info
=> printenv                   // show environment variables
=> setenv ipaddr 192.168.1.22 // set environment variable
=> imi                        // print header information for
                        application image
=> reset                      // reboot the board
=> boot                       // boot OS (in our case: Linux)
```

Note that the U-Boot environment variables are stored in an I2C EEPROM on the SoM. This means that if you have updated your boot medium there might be a mis-match in the envvars which prevents Linux from booting. To update the envvars in EEPROM enter the following:

```
=> env default -f -a       // fetch defaults from boot medium
=> saveenv                    // save to EEPROM
```

If you want to return to U-Boot from Linux, then you need to reboot the board. This can be done either by power-cycling the board; or pressing the reset button; or, the most elegant and preferred method, by shutting down and rebooting Linux:

```
root@mpxls10xx:~# reboot

The system is going down for reboot NOW! (ttyS0) (Fri Aug 20
11:17:00 2021):
INIT: Sending processes the TERM signal
```

4.2 Running Linux Programs

Once you see the Linux prompt and have logged on, you can enter Linux commands. Here are some useful commands:

# uname -a	// shows Linux kernel version and other info
# ifconfig -a	// shows the Ethernet interfaces, including IP addresses
# df	// display filesystems
# cat /proc/mtd	// shows the partitions in NAND Flash
# reboot	// gracefully shutdown Linux and reboot
# shutdown now	// shutdown Linux immediately (no reboot)
# restool dpmac info dpmac.17	// show status of the Ethernet port in MC domain

4.2.1 Ethernet Connectivity

One of the first things you are likely to want to do is transfer programs from your host machine to the SBC target.

By default, the Linux is not configured to use DHCP, therefore no IP address will have been assigned.
To see the Ethernet interfaces, enter:

```
root@mpxls10xx:~# ifconfig -a
```

The SBC-LS1046A and SBC-LS1088A will show 4 Ethernet interfaces and the SBC-LS1043A will show 3 interfaces.

To assign an IP address to an Ethernet interface, you can either configure the interface manually:

CRX05:

```
root@mpxls10xx:~# ifconfig fm1-mac3 192.168.0.111 up
```

CRX08:

```
root@mpxls10xx:~# ifconfig dpmac17 192.168.0.111 up
```

Or, to avoid having to enter this every time you boot Linux, you can edit the `/etc/network/interfaces` file and add configurations for all the interfaces you intend to use. For example, here fm1-mac3 is configured to use dhcp:

```
root@mpxls10xx:~# cat /etc/network/interfaces
# /etc/network/interfaces -- configuration file for ifup(8), if-
down(8)

# The loopback interface
auto lo
iface lo inet loopback

# The fm1-mac3 interface
auto fm1-mac3
iface fm1-mac3 inet dhcp
```

Once you can ping the SBC from your host, you can transfer a file to the SBC, for example a benchmark program. If your host machine is running Windows, we recommend using WinSCP to transfer files between host and target.

4.2.2 Ethernet Performance

The NXP Layerscape processors contain an Ethernet controller known as DPAA (Datapath Acceleration Architecture). The LS1043A and LS1046A contain a DPAA and the LS1088A and LX2160A contain the second generation DPAA2. Further documentation on the DPAA and DPAA2 can be found in NXP's Reference Manuals for the corresponding processor and the separate DPAA Reference Manual.

One of the hardware blocks within the DPAA is the Frame Manager (FMan) – a functional unit that combines the Ethernet network interfaces with packet distribution logic to provide intelligent distribution and queuing decisions for incoming traffic at line rate.

The Frame Manager Configuration Tool (FMC) is a command line tool used to configure the FMan to perform the desired parse-classify-distribute function for a given application. The FMC needs to be invoked to improve receive performance on the Ethernet interfaces.

```
root@mpxls10xx:~# cd /etc/fmc/config/private/mpxls1046
root@mpxls10xx:~# fmc -c mpxls1046_config.xml -p policy_ipv4.xml -a
```

4.2.3 Compiling Programs On The Target

If you booted from the SD card, then the default root filesystem already contains a gcc toolchain (GCC 10.2.0) allowing you to compile natively on the target.

```
root@mpxls10xx:~# cc helloWorld.c -o hello
```

This creates an executable with the name `hello`. To run it:

```
root@mpxls10xx:~# ./hello
```

4.2.4 Cross-compilation On The Linux Host

To cross-compile for an ARMv8 target you first need to build the cross-toolchain on your Linux host. Please refer to section 6.4 Build Toolchain for Cross-compilation.

After you have soured the environment file you can verify the setup and build your application

```
$ echo $CC

aarch64-fsl-linux-gcc --sysroot=/home/user/yocto-
sdk/build_mpxls1046/tmp/work/aarch64-fsl-linux/meta-ide-sup-
port/1.0-r3/recipe-sysroot

$ $CC helloWorld.c -o hello
```

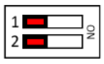
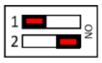
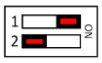
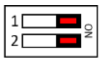
Now you can transfer the executable file `hello` over to your target and run it there.

5 Restoring The Default Images

5.1 Boot Media

5.1.1.1.1 CRX05

Per default the board will boot into Linux from the SD card (assuming you have inserted it correctly). The alternative boot media are provided so that you can experiment. In addition, they serve as a means of recovery should you accidentally corrupt or delete any of the boot images. The following table shows how to select between the three boot media. Note that booting from NAND Flash is only supported on the MPX-LS1043A.

Setting	SW 1-1	SW 1-2	Boot device	Features	Boot location
	OFF	OFF	QSPI Flash		module
	OFF	ON	NAND Flash		module
	ON	OFF	SD/MMC		carrier board
	ON	ON	SD/MMC		carrier board

The accompanying SD card contains a complete U-Boot, Linux kernel and root filesystem whereas only U-Boot is programmed in the SPI Flash (and also in NAND on the MPX-LS1043A).

The default images for each boot media are provided on the USB stick delivered with the Evaluation Kit. The following sections describe how to deploy these images to the respective boot media.

Copy the build images to your nfsserver directory on a Linux host. If you are running on a Windows host, then use the directory shared between Windows and your Linux VM (VirtualBox or VMware). Also for Windows hosts you will need to have a TFTP server running.

5.1.2 CRX08

Per default the board will boot into Linux from the SD card (assuming you have inserted it correctly). The alternative boot media are provided so that you can experiment. In addition, they serve as a means of recovery should you accidentally corrupt or delete any of the boot images. The following table shows how to select between the boot media.

	SEL3	SEL2	SEL1	SEL0	Boot Source	Description
0xF	*1*	*1*	*1*	*1*	Flex-SPI Serial-NOR A	default
0xD 0x9 0x5 0x1	*X*	*X*	*0*	*1*	SD Card	
0x7	*0*	*1*	*1*	*1*	Flex-SPI Serial-NOR B	Second NOR Flash (Available only when the PLL is configured accordingly)

5.2 Memory Map

This version of the MicroSys Yocto SDK contains major changes to the boot flow compared to the previous release for the 5.10.35 kernel. This version uses TF-A instead of PPA as used in the previous release.
For a detailed explanation of the changes, it is recommended to read NXP's LSDK 21.08 documentation:

https://www.nxp.com/docs/en/user-guide/LSDKUG_Rev21.08.pdf

The various hardware accelerator blocks in the QorIQ processors, for example DPAA in the LS1043A and LS1046A or DPAA2 in the LS1088A and LX2160A, require microcode to be loaded. The memory map is uniform across all the modules supported by this SDK, but not all the firmware needs to be loaded for a given module.

Definition	Max Size	QSPI/NAND Flash Offset	SD Card Start Block (hex)	SD Card Start Block (dec)
bl2.pbl	1MB	0x0000.0000	0x00008	8
fip_uboot.bin	2MB	0x0010.0000	0x00800	2048
DPAA FMan ucode	256KB	0x0001.0000	0x04800	18432
QE Firmware	256KB	0x0094.0000	0x04A00	18944
DPAA2 MC Firmware	3MB	0x00A0.0000	0x05000	20480
DPAA2 DPL	1MB	0x00D0.0000	0x06800	26624
DPAA2 DPC	1MB	0x00E0.0000	0x07000	28672

Table 5-2 Memory Map for Flash and SD Card

5.3 SD Card

It is advisable to deploy the default images to a second, new microSD card so that you have a back-up. MicroSys recommends using a microSD card with a capacity of at least 4GB. The SBC will accept SDHC cards up to 32GB and an SDXC card of 64GB has also been successfully tested.

The first step involves partitioning your virgin SD card. The second step involves copying the root filesystem and Image Tree Binary over and the third step is to copy U-Boot and the various firmware to the SD card.

Step 1) Create a new partition on the SD card.
Insert an SD card in your Linux host and use the dmesg command to determine the name it has been assigned.

```
$ dmesg | tail

[118013.491177] sd 4:0:0:2: [sdd] 3921920 512-byte logical blocks:
(2.00 GB/1.87 GiB)

[118013.495020] sd 4:0:0:2: [sdd] Write Protect is off

[118013.495023] sd 4:0:0:2: [sdd] Mode Sense: 43 00 00 08

[118013.499008] sd 4:0:0:2: [sdd] No Caching mode page found

[118013.499011] sd 4:0:0:2: [sdd] Assuming drive cache: write
through
```

From the above log, we can see that the SD card is /dev/sdd.

Use the df command to see if it has been mounted and, if yes, please unmount it using the umount command.

Use the fdisk command to create a new partition. (In most cases you can use the default value with the exception of the first sector which should be at least 131072 blocks since you need to leave space for all the firmware).

```
# fdisk /dev/sdd
Command (m for help): p

Disk /dev/sdd: 2008 MB, 2008023040 bytes, 3921920 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x00000000

   Device Boot      Start         End      Blocks   Id  System
/dev/sdd1            4096     3921919     1958912   83  Linux

Command (m for help): d
Selected partition 1
Partition 1 is deleted
```

```
Command (m for help): n
Partition type:
   p   primary (0 primary, 0 extended, 4 free)
   e   extended
Select (default p): p
Partition number (1-4, default 1):
First sector (2048-3921919, default 2048): 131072
Last sector, +sectors or +size{K,M,G} (131072-3921919, default
3921919):
Using default value 3921919
Partition 1 of type Linux and of size 1.9 GiB is set


Command (m for help): w
The partition table has been altered!


Calling ioctl() to re-read partition table.
Syncing disks.
```

Use the mkfs.ext2 command to format the filesystem (this command will take 4 or 5 secs to complete; user input is not required).

```
# mkfs.ext2 /dev/sdd1
mke2fs 1.42.9 (28-Dec-2013)
Filesystem label=
OS type: Linux
Block size=4096 (log=2)
Fragment size=4096 (log=2)
Stride=0 blocks, Stripe width=0 blocks
122640 inodes, 489728 blocks
24486 blocks (5.00%) reserved for the super user
First data block=0
Maximum filesystem blocks=503316480
15 block groups
32768 blocks per group, 32768 fragments per group
8176 inodes per group
Superblock backups stored on blocks:
   32768, 98304, 163840, 229376, 294912


Allocating group tables: done
Writing inode tables: done
Writing superblocks and filesystem accounting information: done
```

Step 2) Now mount this partition and copy the rootfs and Image Tree Binary over.

```
# mkdir /media/SD

# mount /dev/sdd1 /media/SD

# sudo tar xf microsys-image-networking-mpxls10xx-date.rootfs.tar.gz
-C /media/SD

# cp fitImage.itb /media/SD/boot
```

Step 3) You still need to copy U-Boot and various microcodes to the SD card. There are 2 methods to do this. The easiest is to use Linux while you still have your SD card mounted on your Linux host.

For the LS1043A and LS1046A processors, the procedure is as follows:

```
# dd if=bl2_sd.pbl of=/dev/sdd bs=512 seek=8

# dd if=fip_uboot.bin of=/dev/sdd bs=512 seek=2048

# dd if=fsl_fman_ucode_ls1043_r1.1_106_4_18.bin of=/dev/sdd bs=512
seek=18432

# dd if=iram_Type_A_LS1021a_r1.0.bin of=/dev/sdd bs=512 seek=18944
```

For the LS1088A processor, use:

```
# dd if=bl2_sd.pbl of=/dev/sdd bs=512 seek=8

# dd if=fip_uboot.bin of=/dev/sdd bs=512 seek=2048

# dd if=ddr-phy/fip_ddr_all.bin of=/dev/sdd bs=512 seek=16384

# dd if=mc_app/mc.itb of=/dev/sdd bs=512 seek=20480

# dd if=dpl-eth.19.dtb of=/dev/sdd bs=512 seek=26624

# dd if=dpc-usxgmii.crx08.dtb of=/dev/sdd bs=512 seek=28672
```

Alternatively, you can insert the SD card into the SBC-LS10xxA and having booted into U-Boot from QSPI, enter the following commands:

```
=> setenv loadaddr a0000000
=> tftp bl2.pbl
=> mmc write $loadaddr 8 $filesize
=> tftp fip_uboot.bin
=> mmc write $loadaddr 800 $filesize
=> tftp fman_ucode_ls1046_r1.0_108_4_9.bin
=> mmc write $loadaddr 4800 $filesize
```

Note that the U-Boot mmc command requires the block number as a hexadecimal (0x4800 = 18432)

5.4 QSPI Flash

When programming the QSPI Flash, the RCW needs to be programmed separately and, for the MPXLS1043A and MPXLS1046A, you must use the swapped version.

The RCW file is to be found in a sub-directory from where the other images are. For example:

```
$ cd
$BLD/tmp/deploy/images/mpxls10xxcrxxx/qspi_firmware_mpxls1043.img/
```

At the U-Boot prompt, edit the serverip address to suit your network and make sure you are able to ping the server:

```
=> ping $serverip
=> setenv loadaddr a0000000 // should already be set
=> tftp qspi_firmware.img // download from server
=> sf probe
=> sf erase 0 +$filesize
=> sf write $loadaddr 0 $filesize

=> reset
```

5.5 NAND Flash

If NAND Flash has been completely deleted or corrupted, meaning there is no U-Boot output when you power on the board, then you will need to boot into U-Boot from one of the other boot media in order to restore the contents of NAND Flash.

For an MPX-LS1043A, at the U-Boot prompt, enter the following commands:

```
=> setenv loadaddr a0000000
=> tftp nand_firmware.img
=> nand erase 0 +$filesize
=> nand write $loadaddr 0 $filesize

=> reset
```

5.6 XSPI Flash

If Flex-SPI Nor Flash has been completely deleted or corrupted, meaning there is no U-Boot output when you power on the board, then you will need to boot into U-Boot from one of the other boot media in order to restore the contents of SPI Nor Flash.

For an MPX-LX2160A, at the U-Boot prompt, enter the following commands:

```
=> ping $serverip
=> setenv loadaddr a0000000 // should already be set
=> tftp xspi_firmware.img // download from server
=> sf probe
=> sf erase 0 +$filesize
=> sf write $loadaddr 0 $filesize
```

6 Rebuilding U-Boot and Linux

MicroSys uses a Yocto-based Software Development Kit (SDK) for the miriac Single Board Computers.

The current release of MicroSys' Linux 5.10 Yocto SDK uses "Yocto Project Core – Hardknott 3.3". If you are new to Yocto, then documentation to get you started can be found at https://docs.yoctoproject.org/3.3.4/

The Yocto SDK is maintained by the SoC manufacturer NXP (previously Freescale). MicroSys has added patches to cater for the changes made to the MicroSys hardware. The MicroSys patches are available on the USB stick which was provided with the miriac SBC.

MicroSys's Linux 5.10.35 Yocto SDK is based on NXP's Layerscape SDK v21.08 and it is advisable to refer to some of the LSDK 21.08 documentation from NXP for detailed explanations of various features.

Please go to: https://www.nxp.com/lsdk

You will need to download the Yocto SDK if you want to make changes to U-Boot or the Linux kernel, which will be the case if you want to modify U-Boot and Linux for your own carrier board. To be able to rebuild the Linux kernel you will need to have a Linux host machine. If your preferred host machine is running Windows, then you will need to use VirtualBox or VMware, or something similar, to run Linux. All popular Linux distributions should work (CentOS, Debian, Fedora, openSUSE, Ubuntu). A list of supported versions can be found here:

https://docs.yoctoproject.org/3.3.4/ref-manual/system-requirements.html

6.1 Prerequesits

In order to run the build of SDK following packages are required:

chrpath curl diffstat gawk git g++ make python3 python3-distutils software-properties-common

Git needs to be configured with user name and email address in global settings.

6.2 Installing the Yocto SDK

The Yocto SDK can be found on GitHub at this URL:

https://source.codeaurora.org/external/qoriq/qoriq-components/yocto-sdk

Install the repo utility:

```
$: mkdir ~/bin
$: curl http://commondatastorage.googleapis.com/git-repo-
downloads/repo > ~/bin/repo
$: chmod a+x ~/bin/repo
$: export PATH=${PATH}:~/bin
```

Download the metadata:

```
$: mkdir yocto-sdk
$: cd yocto-sdk
$: repo init -u
https://source.codeaurora.org/external/qoriq/qoriq-
components/yocto-sdk -b hardknott

$: repo sync --no-clone-bundle
```

Install MicroSys' Layer for MPX-Modules:

```
$ cd /home/$USER/tmp

$ tar -xjf meta-microsys-layerscape-MICROSYS_LSDK_21.08-
4.0.2.tar.bz2

$ cd meta-microsys-layerscape-MICROSYS_LSDK_21.08-4.0.2

$ ./install

Where is the yocto-sdk installed? (/home/$USER/yocto-sdk)

/home/$USER/yocto-sdk

Installing...

Configuring...


Installation complete

[user@localhost MicroSys_Yocto_21.08-3.3]$

$ cd /home/$USER/yocto-sdk
```

That completes the installation process.

6.3 Building the BSP

To be able to build everything you will need to have internet access from your host machine since the scripts need to fetch packages from the git repositaries.

Make sure you are in the directory where you installed the SDK. Typically,

```
 /home/$USER/yocto-sdk
```

The following command will create the build directory for your chosen target. If the command is invoked with the -h option (help) it lists all the possible target machines, which are mainly NXP Reference Design Boards. The final targets in the list should be the MicroSys Single Board Computers. Now invoke the command with the -m option (machine) and choose the mpxls1043 as your target machine.

```
$ . ./setup-env -m mpxls1043ac1600msatacrx05

For lx2160a machine

$ . ./setup-env -m mpxlx2160acrx08

For lx2160a machine with Hailo features

$ . ./setup-env -m mpxlx2160acrx08ai
```

This will create the build directory and setup the required environment (after you have scrolled through a long license and accepted the EULA).

```
$ bitbake microsys-image-networking
```

The above command will build everything (U-Boot, kernel, root filesystem) and may take several tens of minutes depending how powerful your host machine is (for the very first build, this can take several hours). Note that your Linux machine needs an internet connection for the above command.

Assuming the build is successful, you should see some text similar to the output below:

```
 .  .  .  .  .  .  .  .

meta-openstack-swift-deploy

meta-cloud-services =
"HEAD:d8bc0d92d0f741e2ea1e6d3d9bc6b7a091d03cfb"

meta-security     = "HEAD:f9367e71f923fc7d2fb600208e2b97535ea41777"

meta-microsys     = "<unknown>:<unknown>"


NOTE: Preparing RunQueue

NOTE: Checking sstate mirror object availability (for 11 objects)

NOTE: Executing SetScene Tasks

NOTE: Executing RunQueue Tasks

NOTE: Tasks Summary: Attempted 3054 tasks of which 2957 didn't need
to be rerun and all succeeded.

[user@localhost build_mpxls1043]$
```

NOTE

The exact output may vary, depending on the version of Yocto in use.

Since your build was successful, you will see the resulting images if you change to the following directory:

```
[user@localhost mpxls10xx]$ cd ~/yocto-
sdk/build_mpxls10xx/tmp/deploy/images/mpxls10xx
```

The Image Tree Binary file will have a name similar to:

```
fitImage.itb
```

The kernel and root filesystem are the same for all MPX modules supported by this SDK; only U-Boot and the Device Trees are different between the modules.

Yocto will also generate a complete SD card image which can be copied directly onto an SD card inserted in the Linux host with the following command:

```
$ sudo dd if=microsys-image-networking-machine-
date.rootfs.sdcard of=/dev/$SDX bs=2048 && sync
```

Where $SDX is the SD card device on your host and can be determined by invoking the following command after inserting the SD card:

```
$ dmesg | tail
```

To rebuild U-Boot on its own the process is similar.

```
$ bitbake u-boot
```

If, for example, you have modified the device tree (mpxls1043.dts), the commands to rebuild this are:

```
$ bitbake -f -c compile linux-qoriq
```

```
$ bitbake microsys-image-networking
```

6.3.1 Using Devtools to modify recipes.

6.3.1.1 Create Your Own Layer

Before you start modifying recipes it is best to create your own layer which will contain your changes.

1. If not already done go to the build directory of the machine and call:

   ```
   $. SOURCE_THIS
   ```

   This configures and starts bitbake.

2. Go to the sources/ directory and create your layer there:

   ```
   $ bitbake-layers create-layer --priority 20 meta-mylayer
   ```

Note 1: because the priority of meta-microsys-layerscape is 10, it is recommended to choose a higher number as priority for your own layer (but less than 99).

Note 2: it is a good practice to prefix the layer name with "meta-".

Note 3: this is an optional step. You can remove the directory recipes-example in the directory meta-mylayer/.

3. Go to the build directory of the machine and add your new layer with:

   ```
   $ bitbake-layers add-layer ../sources/meta-mylayer
   ```

6.3.1.2 Modifying Linux Kernel

You can modify the sources of Linux kernel using the Yocto tool devtool. This task assumes that you have created your own layer as described in the section above.

Note that this works for other recipes, too. For example, if you plan to modify the RCW or U-Boot

use linux-qoriq as recipe name.

1. If not already done go to the build directory of the machine and call:

   ```
   $ . SOURCE_THIS
   ```

   This configures and starts bitbake.

2. Call devtool with the recipe for Linux as argument:

   ```
   $ devtool modify linux-qoriq
   ```

This creates a layer called "workspace" which contains the Linux

sources as a GIT repository. The sources can be found in the directory

workspace/sources/linux-qoriq.

Note: if you have done this step before, for example from a previous

modification, then you have to call:

```
$ devtool modify --no-extract linux-qoriq
```

with the additional option '--no-extract'. In this case devtool expects that

the source tree already exists.

3. Modify the sources with your favourite editor.

6.3.1.3 Build your Linux with devtool

```
$ devtool build linux-qoriq
```

You can find the results in workspace/sources/linux-qoriq/oe-workdir/image/boot.

The resulting linux images are:

- fitImage-5.10.35-3.0+<commit>.itb and device tree binaries.

If you now want to test your new Linux you can create a new boot image with:

```
$ devtool build-image microsys-image-layerscape
```

You can find the output files in tmp/deploy/images/<machinename>.

4. Once you're done with your changes finish your work

- Go to workspace/sources/linux-qoriq and commit your changes using 'git'
- Update the recipe with:

```
$ devtool finish linux-qoriq meta-mylayer
```

  This copies and saves your changes into meta-mylayer.

If you plan to make more modifications to Linux it's better not to delete the source tree from the 'workspace' directory. Keep it.

Note: If you think that you are done with all of your changes then you can remove the recipe from the workspace layer with:

```
$ devtool reset linux-qoriq
```

This will **erase all** of your changes from workspace.

5. Now you can rebuild your image including your changes with:

```
$ bitbake microsys-image-layerscape
```

Note: if you want to modify the Linux kernel configuration you can call:

```
$ bitbake -c menuconfig linux-qoriq
```

6.4 Build Toolchain for Cross-compilation

If you want to cross-compile for an ARMv8 target you first need to build the cross-toolchain on your Linux host. This requires that the Yocto SDK be installed so that you can execute the appropriate bitbake command. Please refer to section 6.2 Installing the Yocto SDK and setup the environment as described in start of 6.3 Building the BSP.

To build the toolchain, enter:

```
$ bitbake meta-ide-support
```

After you have built the toolchain, you'll see a script in the tmp directory which needs to be sourced from each terminal where you want to invoke the cross-compiler.

```
$ cd tmp

$ source environment-setup-aarch64-fsl-linux

$ unset LDFLAGS
```

6.5 Hailo Benchmarking:

Please follow the installation procedure for installing the network data to perform benchmarking.

By default we have included yolov5m network data for benchmarking which can be run as follows:

```
# hailortcli run /home/root/yolov5m/files/yolov5m.hef
Running inference (/home/root/yolov5m/files/yolov5m.hef):
  Mode: streaming
  Transform data: true
    Data is quantized: true
    Format type: auto
  Time to run: 00:00:05
Inference... 100% | 956 | FPS: 191.11 | ETA: 00:00:00
Inference result:
  Duration: 00:00:05
  FPS: 191.10
  Send Rate: 1878.58 Mbit/s
  Recv Rate: 3305.87 Mbit/s
```

For scanning the available Hailo devices please use:

```
# hailortcli scan
Hailo PCIe Devices:
[-] Device BDF: 0000:01:00.0
[-] Device BDF: 0001:01:00.0
#
```

7 Appendix

7.1 Offer to Provide Software Source Code

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82054 Sauerlach
Germany

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7.2 Alternative Operating Systems

MicroSys Electronics GmbH offers Linux and Microware's OS-9 RTOS support for modules containing NXP's QorIQ processors.

Other Operating Systems are available on request only.

7.3 Further Reading

Documentation on NXP's QorIQ processors and the Layerscape SDK can be found here:
www.nxp.com/qoriq-arm
www.nxp.com/lsdk
Click on the Documentation tab to download PDFs. Registration is usually required.

7.4 Glossary

Here are some acronyms and abbreviations which you will encounter when dealing with the SDK and NXP's Layerscape processors.

ATF	Arm Trusted Firmware. Now more accurately known as TF-A (Trusted Firmware-A). See https://developer.arm.com/
DPAA	Data Path Acceleration Architecture (first generation) used in LS1043A and LS1046A
DPAA2	Data Path Acceleration Architecture (second generation) used in LS1088A and LX2160A
DPC	Data Path Configuration file. Needed for DPAA2
DPL	Data Path Layout. Needed for DPAA2
DTB	Device Tree Blob. The binary representation of device trees.
FMan	Frame Manager. A DPAA hardware block.
FSL	Freescale (were acquired by NXP Semiconductors in Dec 2015)
ITB	Image Tree Binary. A file containing kernel(s) and device tree(s)
MC	Management Complex. A DPAA2 hardware block.
PBL	Pre-Boot Loader. Can be optionally loaded after RCW.
PPA	Primary Protected Application. A secure monitor running in TrustZone which provides boot and runtime software services such as PSCI and Arm’s SMC calling convention.
PSCI	Power State Coordination Interface. An Arm standard interface.
RCW	Reset Configuration Word. The first data the processor loads to configure various interfaces and internal frequencies.

7.5 Document History

Date	Version	Change Description
2018-08-22	**0.1**	Initial Release for 4.14 kernel
2018-09-11	**0.2**	Minor improvements
2018-12-19	**0.3**	Added comments on FMC
2021-10-11	**1.0**	Update to LSDK 20.12
2021-11-18	**2.0**	Update to LSDK 21.08 and added support for SBC-LX2160A
2021-12-01	**2.1**	Added support for AIP-LX2160A
2022-04-26	**2.2**	Update link to curl tool

Table 7-1 Document history