PetaLinux Software Integration

60 Series and LWB Series

Application Note *v1.0*

1 Introduction

As you may already know, PetaLinux is a build system that leverages the Yocto project. External layers are used to add support for packages that are not already provided by Yocto. Laird Connectivity offers an external layer to provide support for our Wi-Fi+BT combo modules with recipes for the following:

- Drivers via backports
- Firmware
- Supplicant
- NetworkManager
- Adaptive World Mode (AWM) daemon
- Reference sample images

This layer is updated when new production releases become available. Our backports package replaces the kernel's wireless and Bluetooth subsystems and provides our Wi-Fi and Bluetooth drivers. Backports is based on the latest Linux LTS kernel and corresponds to the major number of the radio release version (7.x is kernel 4.19, 8.x is kernel 5.4, and so on). Backports can port to a range of kernels. Please refer to the module-specific GitHub link below for more detail. The backports and firmware packages are mandatory for operation of our modules. The optional Sterling supplicant and NetworkManager are QA-validated versions of the open source packages and are highly recommended.

For more information on the latest release including release notes and additional documentation, follow the links below.

If integrating a 60 Series radio, please review the reset app note found in the documentation tarball on GitHub.

Note: There are two software stacks for the 60 Series modules which includes different firmware, closed-source supplicant, and closed-source AWM daemon. This requires some slight modifications to the Sterling software integration. Please contact support if considering the Summit stack.

2 Important Links

The LairdCP external layer is hosted on GitHub and provides recipes for all supported Wi-Fi+BT combo modules:

https://github.com/LairdCP/meta-laird-cp

The LWB and LWB5 product pages include firmware that needs to be manually downloaded and documentation including datasheets, DVK reference schematics, certification information, and more:

https://www.lairdconnect.com/wireless-modules/wifi-modules-bluetooth/sterling-lwb-24-ghz-wifi-module

https://www.lairdconnect.com/wireless-modules/wifi-modules-bluetooth/sterling-lwb5-dual-band-wifi-module-bluetooth-42

The LWB series GitHub repo hosts release notes, backports, and supplicant source. It is not necessary to manually download software from this repo when integrating the external layer.

https://github.com/LairdCP/Sterling-LWB-and-LWB5-Release-Packages/releases

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The ST60-SIPT and ST60-2230C product pages include datasheets, DVK reference schematics, certification information, and more:

https://www.lairdconnect.com/wireless-modules/wifi-modules-bluetooth/60-sipt-bluetooth-and-wifi-module

https://www.lairdconnect.com/wireless-modules/wifi-modules-bluetooth/60-2230c-series-bluetooth-and-wifi-module

The 60 Series Summit stack product page provides documentation including the differences between the stock Sterling stack and upgraded Summit version. It also has a link to request an evaluation:

https://www.lairdconnect.com/wireless-modules/wifi-modules-bluetooth/summit-software-stack-60-series

The Sterling 60 Series GitHub repo hosts additional documentation, software release notes, firmware, Sterling supplicant source code, and NetworkManager source code. It is not necessary to download software manually when integrating the external layer.

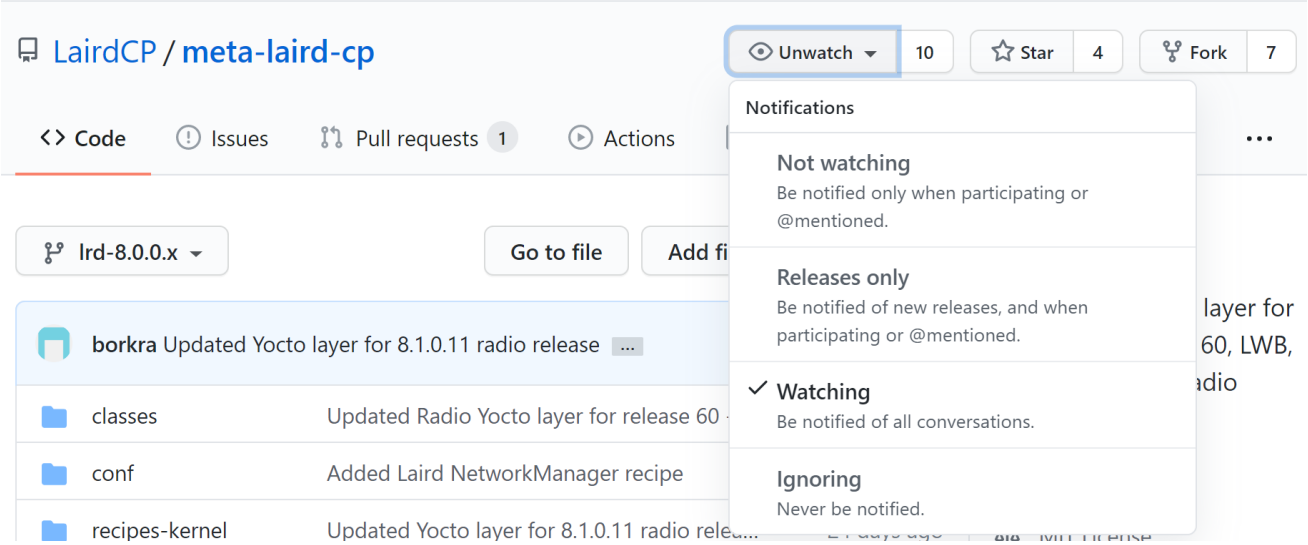
https://github.com/LairdCP/Sterling-60-Release-Packages/releases

The Summit 60 Series GitHub repo is set to private and we provide direct access to approved customers. It hosts the precompiled, closed-source binaries for the Summit supplicant, AWM daemon, and source code for the open-source NetworkManager and backports packages. We provide the link upon request; it requires a GitHub account to access.

If you need technical support, please feel free to reach out to us:

https://www.lairdconnect.com/contact

To receive notifications for the latest releases, sign up for a GitHub account and use the *watch* feature on each repo you are interested in.



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3 Software Integration

For this process, your PetaLinux development environment must be installed and in a working state.

To integrate the software, follow these steps:

1. Navigate to project-spec in the root of the project directory and clone into the LairdCP external layer:

```
cd <project_dir>/project-spec
git clone https://github.com/LairdCP/meta-laird-cp.git
```

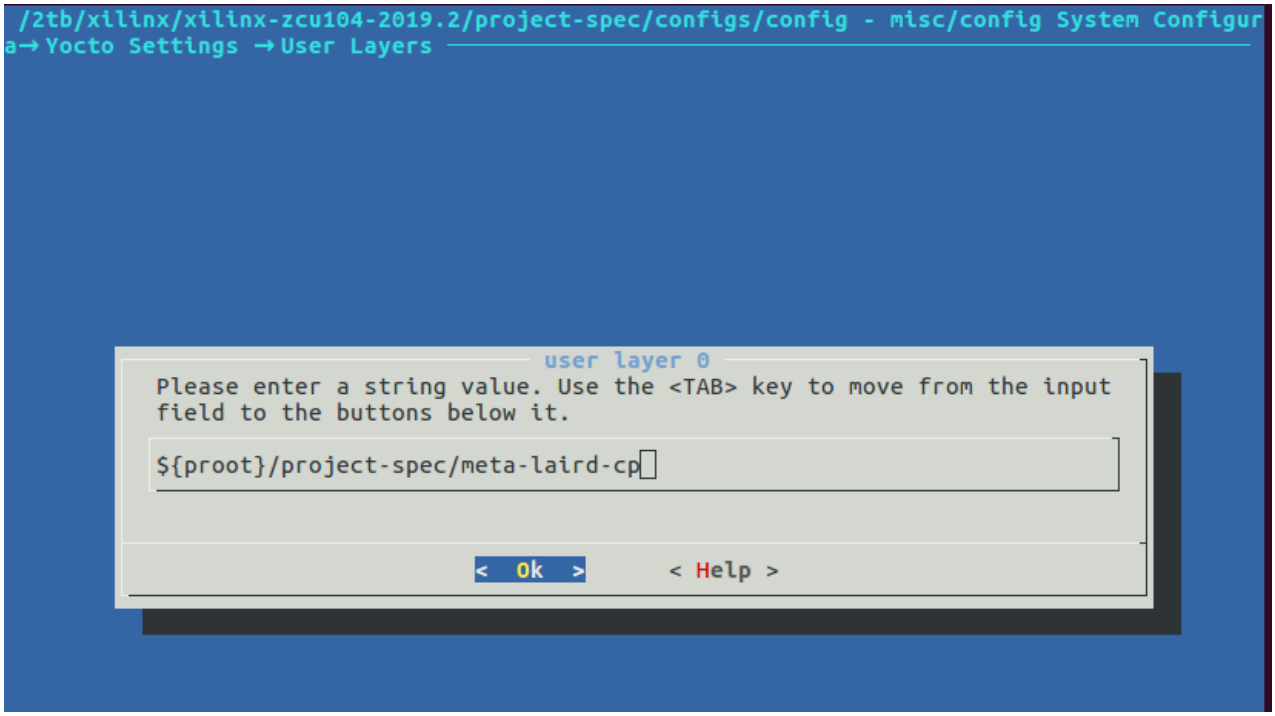
2. Append your BSP configuration file with the following lines if using the Sterling supplicant.

```
(<project_dir>/project-spec/meta-user/conf/petalinuxbsp.conf)

PREFERRED_RPROVIDER_wpa-supplicant = "sterling-supplicant"
PREFERRED_RPROVIDER_wpa-supplicant-cli = "sterling-supplicant"
PREFERRED_RPROVIDER_wpa-supplicant-passphrase = "sterling-supplicant"
```

3. Add the meta-laird-cp layer to the PetaLinux config:

```
petalinux-config
Yocto settings  ---> User Layers
```



4. Save, exit, and ensure that the layer was added. The changes are near the end of this file as an absolute path:

```
grep laird <project_dir>/build/conf/bblayers.conf
/<project_dir>/project-spec/meta-laird-cp \
```

Specific bitbake ***.bb*** recipes must be added to the image recipe. Only one firmware and one backports recipe should be added per image recipe. The Sterling 60 SDIO/UART firmware and Sterling backports are specified below. The recipes are translated from the filename as ***recipe-name_version.bb***. In this location, you can find all the options from the layer.

Note: The example is from the latest as of the writing of this document and version numbers will evolve over time.

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```
ls <project_dir>/project-spec/meta-laird-cp/recipes-kernel/radio-firmware
sterling60-firmware-pcie-uart_7.1.0.9.bb
sterling60-firmware-pcie-usb_7.1.0.9.bb
sterling60-firmware-sdio-sdio_7.1.0.9.bb
sterling60-firmware-sdio-uart_7.1.0.9.bb
sterling60-firmware-usb-uart_7.1.0.9.bb
sterling60-firmware-usb-usb_7.1.0.9.bb
summit60-firmware-pcie-uart_7.1.0.9.bb
summit60-firmware-pcie-usb_7.1.0.9.bb
summit60-firmware-sdio-sdio_7.1.0.9.bb
summit60-firmware-sdio-uart_7.1.0.9.bb
summit60-firmware-usb-uart_7.1.0.9.bb
summit60-firmware-usb-usb_7.1.0.9.bb
lwb5-etsi-firmware_7.0.0.326.bb
lwb5-fcc-firmware_7.0.0.326.bb
lwb5-ic-firmware_7.0.0.326.bb
lwb5-jp-firmware_7.0.0.326.bb
lwb-etsi-firmware_7.0.0.326.bb
lwb-fcc-firmware_7.0.0.326.bb
lwb-jp-firmware_7.0.0.326.bb
```

sterling60-firmware-sdio-uart_7.1.0.9.bb translates to recipe name *sterling60-firmware-sdio-uart*

```
ls <project_dir>/project-spec/meta-laird-cp/recipes-kernel/backports-laird
lwb-backports-laird_7.0.0.326.bb
sterling-backports-laird_7.1.0.9.bb
summit-backports-laird_7.1.0.9.bb
```

sterling-backports-laird_7.1.0.9.bb translates to recipe name *sterling-backports-laird* which is used for the 60 Series radios and Sterling stack.

The PetaLinux project used in this example did not include the iw tool in the default rootfs configuration. The Linux iw tool allows control of WiFi interfaces from user space and is added in the following step.

5. Append the select recipes to the following files.

   60 Series with PetaLinux 2019.2:

```
(project-spec/meta-user/conf/user-rootfsconfig)
CONFIG_sterling60-firmware-sdio-uart
CONFIG_sterling-backports-laird
CONFIG_sterling-supplicant
CONFIG_laird-networkmanager
CONFIG_iw
```

   60 Series with PetaLinux 2019.1 and older:

```
(project-spec/meta-user/recipes-core/images/petalinux-image-full.bbappend)
IMAGE_INSTALL_append = " sterling60-firmware-sdio-uart"
IMAGE_INSTALL_append = " sterling-backports-laird"
IMAGE_INSTALL_append = " sterling-supplicant"
IMAGE_INSTALL_append = " laird-networkmanager"
IMAGE_INSTALL_append = " iw"
```

   LWB FCC with PetaLinux 2019.2:

```
(project-spec/meta-user/conf/user-rootfsconfig)
CONFIG_lwb-fcc-firmware
CONFIG_lwb-backports-laird
CONFIG_sterling-supplicant-lwb
CONFIG_laird-networkmanager
CONFIG_iw
```


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LWB FCC with PetaLinux 2019.1 and older:

```
(project-spec/meta-user/recipes-core/images/petalinux-image-full.bbappend)
IMAGE_INSTALL_append = " lwb-fcc-firmware"
IMAGE_INSTALL_append = " lwb-backports-laird"
IMAGE_INSTALL_append = " sterling-supplicant-lwb"
IMAGE_INSTALL_append = " laird-networkmanager"
IMAGE_INSTALL_append = " iw"
```

Note: For LWB5, follow the LWB examples above using LWB5 firmware instead.

6. After integrating these changes into the environment, reconfigure the kernel using menuconfig (in this order):

```
petalinux-config -c kernel
Go to Device Drivers  ---> Network device support  --->
      Deselect [ ]   Wireless LAN  ----
Go back to the main menu
Go to Networking support  --->
      Deselect < >   Bluetooth subsystem support  ----
      Deselect [ ]   Wireless  ----
Go back to the main menu
Use search (forward slash '/' key) and select the following (if the other systems
were previously selected, these are most likely still selected):
CRYPTO_SHA256
CRYPTO_ARC4
CRYPTO_AES
CRYPTO_CCM
CRYPTO_GCM
CRYPTO_CMAC
CRC32
CRYPTO_ECDH
CRYPTO_ECB
CRC16
CRYPTO_BLKCIPHER
```

7. Save the new configuration, exit and recompile/redeploy the kernel:

```
petalinux-build -c kernel -x compile -f
petalinux-build -c kernel -x deploy -f
```

8. Select the newly added packages in the rootfs configuration:

```
petalinux-config -c rootfs
Go to user packages   --->
Select:
[*] iw (optional)
[*] laird-networkmanager (optional)
[*] sterling-backports-laird
[*] sterling-supplicant
[*] sterling60-firmware-sdio-uart
```

If you are using NetworkManager, you must modify the ifupdown interfaces file by removing the interfaces you want NetworkManager to control. This example has wlan0 and eth0 removed:

```
(project-spec/meta-plnx-generated/recipes-core/init-ifupdown/files/interfaces)

# /etc/network/interfaces -- configuration file for ifup(8), ifdown(8)

# The loopback interface
auto lo
iface lo inet loopback

iface atml0 inet dhcp
```


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```
# Ethernet/RNDIS gadget (g_ether)
# ... or on host side, usbnet and random hwaddr
iface usb0 inet static
    address 192.168.7.2
    netmask 255.255.255.0
    network 192.168.7.0
    gateway 192.168.7.1

# Bluetooth networking
iface bnep0 inet dhcp
```

You can now build the image.

4 TROUBLESHOOTING

You may have to purge any Wi-Fi firmware that was included in your original build as the files provided are no longer necessary and may conflict with the Laird Connectivity-provided files (such as regulatory.db). This is also true if replacing the in-tree wpa_supplicant.

Backports generate kernel modules based on the radio target selected and install them in:

/lib/modules/`uname -r`/

These modules have the following filesystem structures:

60 Series

```
updates
├── compat
│   └── compat.ko
├── drivers
│   ├── bluetooth
│   │   ├── btmrvl.ko
│   │   ├── btmrvl_sdio.ko
│   │   ├── btusb.ko
│   │   └── hci_uart.ko
│   └── net
│       └── wireless
│           └── laird
│               └── lrdmwl
│                   ├── lrdmwl.ko
│                   ├── lrdmwl_pcie.ko
│                   ├── lrdmwl_sdio.ko
│                   └── lrdmwl_usb.ko
└── net
    ├── bluetooth
    │   ├── bluetooth.ko
    │   └── rfcomm
    │       └── rfcomm.ko
    ├── mac80211
    │   └── mac80211.ko
    └── wireless
        └── cfg80211.ko
```


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LWB Series:

```
updates
├──── compat
│    └──── compat.ko
├──── drivers
│    ├──── bluetooth
│    │    ├──── btbcm.ko
│    │    └──── hci_uart.ko
│    └──── net
│         └──── wireless
│              └──── broadcom
│                   └──── brcm80211
│                        ├──── brcmfmac
│                        │    └──── brcmfmac.ko
│                        └──── brcmutil
│                             └──── brcmutil.ko
└──── net
     ├──── bluetooth
     │    ├──── bluetooth.ko
     │    └──── rfcomm
     │         └──── rfcomm.ko
     └──── wireless
          └──── cfg80211.ko
```

If you find that some or all the kernel modules are not building, it is likely a kernel configuration issue.

A common issue during backports compilation is *duplicate symbol* which means backports is attempting to build something that is already selected in the kernel, such as the Bluetooth subsystem.

Another common issue is not including a dependency in the kernel that a component of backports relies upon. An example is if ECDH support is disabled, the compilation log will not have any errors as this configuration is invalid and will not attempt to build the Bluetooth subsystem and drivers. The only evidence of this is the lack of Bluetooth kernel modules. Confirm your kernel config against the steps covered above, clean backports, and rebuild the kernel.

The compile log is found in the following location. If you need support, please include this file and console output from petalinux-build commands.

```
<project_dir>/build/tmp/work/<machine_target>-xilinx-linux/<radio_target>-backports-laird/<release_version>-r0/temp/log.do_compile
```

It is not necessary to manually insert the kernel modules as backports performs *depmod -a* during installation. Below is what a good firmware load looks like (this output varies slightly between SDIO, PCIe, and USB).

LWB Series

```
brcmfmac: brcmf_c_preinit_dcmds: Firmware: BCM43430/1 wl0: Oct 22 2019 01:57:42
version 7.45.98.94 (r723000 CY) FWID 01-73a5ed62
```

60 Series

```
Loading modules backported from Laird Linux version LRD-REL-7.1.0.9-0-g48ea769c7d93
Backport generated by backports.git v7.1.0.9
PMU_EN GPIO not configured
ieee80211 phy0: priv->pcmd_buf = (____ptrval____)
ieee80211 phy0: lrdmwl: found firmware image <lrdmwl/88W8997_usb.bin>
ieee80211 phy0: start to download FW...
ieee80211 phy0: info: FW download over, size 382896 bytes, ret 0
ieee80211 phy0: Firmware download complete, port will reset with new interface...
lrdmwl_usb: probe of 1-1:1.0 failed with error -115
usbcore: registered new interface driver lrdmwl_usb
```


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```
usb 1-1: USB disconnect, device number 2
usb 1-1: new high-speed USB device number 3 using xhci-hcd
usb 1-1: New USB device found, idVendor=1286, idProduct=204e, bcdDevice=32.01
usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
usb 1-1: Product: Bluetooth and Wireless LAN Composite Device
usb 1-1: Manufacturer: Marvell
usb 1-1: SerialNumber: 0000000000000000
PMU_EN GPIO not configured
ieee80211 phy1: priv->pcmd_buf = (____ptrval____)
ieee80211 phy1: lrdmwl: found firmware image <lrdmwl/88W8997_usb.bin>
ieee80211 phy1: Skipping FW download, continuing with initialization...
ieee80211 phy1: OTP data len = 0
ieee80211 phy1: mwl_reg_notifier set=0 core 00
ieee80211 phy1: Sending regulatory hint for US
ieee80211 phy1: Radio Type ST60 (0x0)
ieee80211 phy1: Num mac 2 : OTP Version (1)
ieee80211 phy1: Firmware version: 5.6.27.5
ieee80211 phy1: Firmware OTP region code: 10
ieee80211 phy1: Deep Sleep is disabled
ieee80211 phy1: 2G enabled, 5G enabled
ieee80211 phy1: 2 TX antennas, 2 RX antennas. (00000003)/(00000003)
usb 1-1: Direct firmware load for lrdmwl/regpwr.db failed with error -2
ieee80211 phy1: /lib/firmware/lrdmwl/regpwr.db not found.
```

Note: The regpwr.db error can be safely ignored for Sterling 60 integrations as this is a Summit feature.

5 Revision History

Version	Date	Notes	Contributor(s)	Approver
1.0	11 Aug 2020	Initial Release		John Nosky

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