Porting OpenWrt/LEDE on QorIQ Layerscape ARMv8 Platforms

OpenWrt is a highly extensible GNU/Linux distribution for embedded devices (typically wireless routers), OpenWrt is built from the ground up to be a full-featured, easily modifiable operating system for your router. LEDE is based on OpenWrt, targeting a wide range of wireless SOHO routers and non-network device. This document introduces how to porting and running OpenWrt/LEDE on QorIQ LS1012/LS1043 platform.

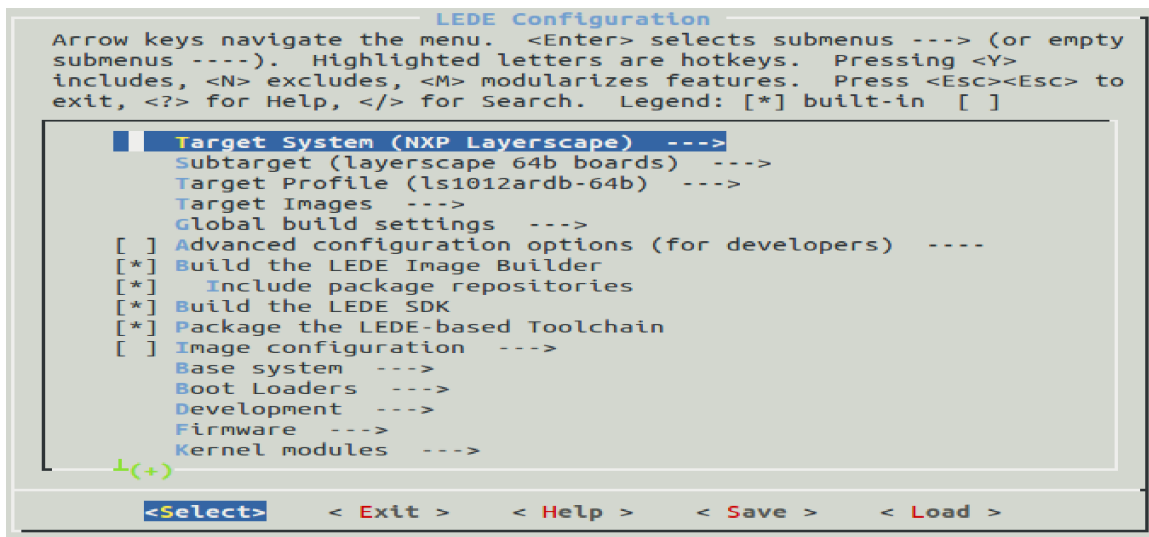## 1. Porting OpenWrt/LEDE Source on QorIQ Layerscape Platforms

The user could download OpenWrt/LEDE from the following links, and apply the attached QorIQ Layerscape related patches for LS1012/LS1043 on OpenWrt.

LEDE: https://github.com/lede-project/source

OpenWrt: https://openwrt.org/

The following demonstrates configuring build project for LS1012 platform.

$ make menuconfig

Target Root filesystem image configuration.

Boot Loaders Configuration

```
                         Boot Loaders
    Arrow keys navigate the menu.  <Enter> selects submenus ---
    submenus ----).  Highlighted letters are hotkeys.  Pressing
    includes, <N> excludes, <M> modularizes features.  Press <E
    exit, <?> for Help, </> for Search.  Legend: [*] built-in

        <*> uboot-layerscape-64b-ls1012ardb
        < > uboot-layerscape-64b-ls1043ardb
```
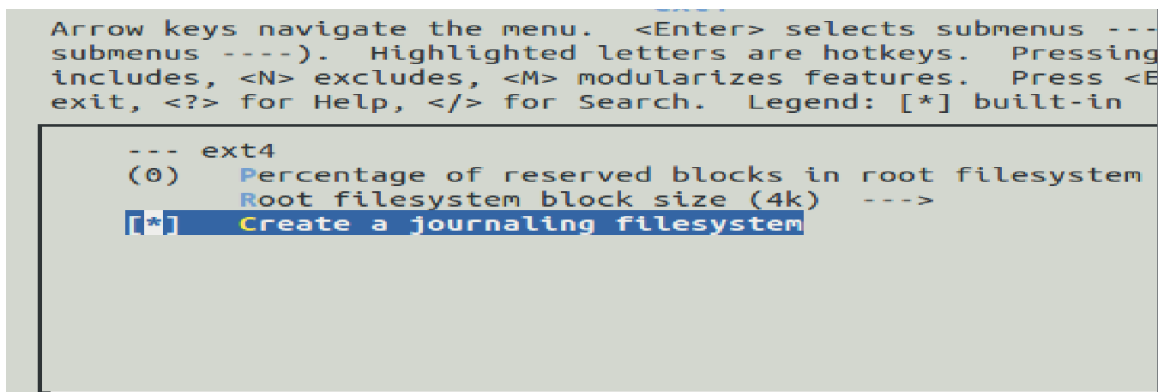
Firmware Configuration

```
  *(-)
    <*> ppfe-ls1012ardb
    < > prism54-firmware..............................
    < > r8169-firmware................................ R
    <*> rcw-layerscape-ls1012ardb
    < > rcw-layerscape-ls1043ardb
    < > rt2800-pci-firmware................. Ralink RT28x
    < > rt2800-usb-firmware................... Ralink R
    < > rt61-pci-firmware...........................
    < > rt73-usb-firmware...........................
    < > rtl8188eu-firmware..................... Rea
  *(+)
```

Build RCW, u-boot, Kernel, dtb and rootfs filesystem.

$ make -j8

2. Deploy OpenWrt/LEDE Images to Boot up the System
Deploy RCW:

=>i2c mw 0x24 0x7 0xfc; i2c mw 0x24 0x3 0xf5

=>tftp 0x80000000 PBL_0x35_0x08_800_250_1000_default.bin

=>sf probe 0:0

=>sf erase 0x0 40000

=>sf write 0x80000000 0x0 $filesize

Deploy u-boot image:

=>tftp 0x80000000 u-boot-ls1012ardb.bin
=>sf probe 0:0
=>sf erase 0x100000 a0000
=>sf write 0x80000000 0x100000 $filesize
=> reset

Deploy Kernel images and the rootfs filesystem:
=>tftp 0xa0000000 ls1012ardb-ext4-firmware.bin
=>sf probe 0:0
=> protect off all
=> sf erase 0x900000 3700000

=> sf write 0xa0000000 0x900000 $filesize

Set u-boot bootargs and boot up the system
=>setenv loadaddr 82000000
=> setenv ramdiskaddr 88000000
=> setenv fdtaddr 8f000000
=> setenv wrtbootext4rfs 'pfe stop && sf probe 0:0 && setenv bootargs root=/dev/mtdblock9
rootfstype=ext4 noinitrd console=ttyS0,115200 earlycon=uart8250,mmio,0x21c0500
mtdparts=1550000.quadspi:1M(rcw),1M(u-boot),1M(u-boot-
env),1M(fman),1M(uefi),2M(ppa),2M(secboot),1M(dtb),5M(kernel),49M(ext4rfs) && sf read
$fdtaddr 0x900000 100000 && sf read $loadaddr 0xa00000 500000 && bootm $loadaddr -
$fdtaddr'
=>save
=>run wrtbootext4rfs

The system boots up with LEDE logo:

Please press Enter to activate this console.
[8.136609] i2c /dev entries driver
[8.143300] i2c i2c-0: IMX I2C adapter registered
[8.148284] i2c i2c-0: can't use DMA
[8.156555] e1000e: Intel(R) PRO/1000 Network Driver - 3.2.6-k
[8.162474] e1000e: Copyright(c) 1999 - 2015 Intel Corporation.
[8.168880] e1000e 0000:01:00.0: Interrupt Throttling Rate (ints/sec) set to dynamic
conservative mode
[8.353042] e1000e 0000:01:00.0 eth0: (PCI Express:2.5GT/s:Width x1) 00:15:17:1e:22:9e
[8.361021] e1000e 0000:01:00.0 eth0: Intel(R) PRO/1000 Network Connection
[8.368006] e1000e 0000:01:00.0 eth0: MAC: 1, PHY: 4, PBA No: D50854-002
[33.067915] 8021q: adding VLAN 0 to HW filter on device eth0
[33.087623] device eth0 entered promiscuous mode
[33.092870] IPv6: ADDRCONF(NETDEV_UP): br-lan: link is not ready
[35.068281] e1000e: eth0 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: None
[35.080545] br-lan: port 1(eth0) entered forwarding state
[35.085988] br-lan: port 1(eth0) entered forwarding state
[35.109086] IPv6: ADDRCONF(NETDEV_CHANGE): br-lan: link becomes ready
[37.076926] br-lan: port 1(eth0) entered forwarding state

BusyBox v1.24.2 () built-in shell (ash)

```
    _____
   /      /\    _    ___ ___ ___
  / LE   /  \  || | |__|  \/ __|
 /  DE  /    \ ||_|__|_|| |) | _|
/_____/ LE \ |____|___|___/|___|          lede-project.org
\     \ DE /
 \  LE \  / -------------------------------------------------------
  \ DE  \ /   Reboot (HEAD, r1262+324)
   _____V   -------------------------------------------------------
```

3. Verify VLAN Interface and PFE in LEDE System
The interface br-lan is used to make multiple virtual or physical network interfaces act as if they were just one network interface, can also be used for VPN and bridged interfaces. This bridge

can be used for connecting multiple Ethernet devices together, and the connection is fully transparent.
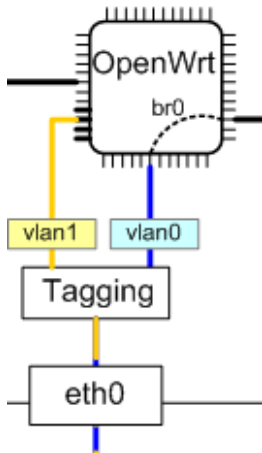

```
root@lede:/# ifconfig -a
br-lan   Link encap:Ethernet   HWaddr 00:15:17:1E:22:9E
         inet addr:192.168.1.1  Bcast:192.168.1.255  Mask:255.255.255.0
         inet6 addr: fe80::215:17ff:fe1e:229e/64 Scope:Link
         inet6 addr: fdd5:6e9d:a4df::1/60 Scope:Global
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:104 errors:0 dropped:0 overruns:0 frame:0
         TX packets:31 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:10190 (9.9 KiB)  TX bytes:3727 (3.6 KiB)

eth0     Link encap:Ethernet   HWaddr 00:15:17:1E:22:9E
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:177 errors:0 dropped:0 overruns:0 frame:0
         TX packets:28 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:18528 (18.0 KiB)  TX bytes:3557 (3.4 KiB)
         Interrupt:26 Memory:4046000000-4046020000

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         inet6 addr: ::1/128 Scope:Host
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:116 errors:0 dropped:0 overruns:0 frame:0
         TX packets:116 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:9164 (8.9 KiB)  TX bytes:9164 (8.9 KiB)

root@lede:/# ifconfig br-lan 192.168.2.154
root@lede:/# ping 192.168.2.1
PING 192.168.2.1 (192.168.2.1): 56 data bytes
64 bytes from 192.168.2.1: seq=0 ttl=64 time=0.575 ms
64 bytes from 192.168.2.1: seq=1 ttl=64 time=0.251 ms
```

LS1012A uses a hardware packet forwarding engine to provide high performance Ethernet interfaces. The device includes two Ethernet ports. Both Ethernet ports support SGMII.

Connect *eth0 to VLAN(100.1.1.1):*
Mapped: LS1012ARDB-1_RGMII1 -> lan1 (resource)
LS1012ARDB-1_RGMII1   LAN_1:7(100.1.1.1)
LS1012ARDB-1_SGMII1   MRV2_2:19
LS1012ARDB-1_Slot1_PCIe_NIC NW_1:8
LS1012ARDB-1_serial0   OG_1:8

root@lede:/# modprobe pfe.ko
[228.534485] cbus_baseaddr: ffffff8001e00000, ddr_baseaddr: ffffffc003400000,
ddr_phys_baseaddr: 83400000, ddr_size: c00000
[228.545614] pfe_hw_init
[228.548076] CLASS version: 20
[228.551043] TMU version: 1011231
[228.554271] BMU1 version: 21
[228.557162] BMU2 version: 21
[228.560043] EGPI1 version: 50
[228.563010] EGPI2 version: 50
[228.565976] HGPI version: 50
[228.568865] GPT version: 0
[228.571571] HIF version: 10
[228.574364] HIF NOPCY version: 10
[228.577690] bmu_init(1) done
[228.580571] bmu_init(2) done
[228.585675] class_init() done
[228.598688] tmu_init() done
[228.601484] gpi_init(1) done
[228.604366] gpi_init(2) done
[228.607257] gpi_init(hif) done
[228.610311] bmu_enable(1) done
[228.613364] bmu_enable(2) done
[228.616419] pfe_hif_lib_init
[228.619987] pfe_hif_init
[228.622520] pfe_hif_alloc_descr
[228.625704] pfe_hif_init_buffers
[228.629201] pfe_firmware_init
[228.651103] pfe_load_elf
[228.653651] pe_load_ddr_section: load address(3fb0000) and elf file address(ffffff80002db000)
rcvd
[228.687107] PFE binary version: pfe_ls1012a_00_3-3-g1fa4da1-dirty
[228.693214] pfe_firmware_init: class firmware loaded 0xa60 0xc3010000
[228.699673] pfe_load_elf
[228.703226] WARNING: PFE firmware binaries from incompatible version
[228.709598] pfe_firmware_init: tmu firmware loaded 0x200
[228.714935] pfe_ctrl_init
[228.717926] pfe_ctrl_init finished
[228.721331] pfe_eth_init
[228.723908] pfe_eth_mdio_init
[228.727019] pfe_ctrl_timer
[228.730791] libphy: Comcerto MDIO Bus: probed
[228.746117] pfe_phy_init interface 3
[228.827143] eth1: pfe_eth_init_one: created interface, baseaddr: ffffff8002000000
[228.840702] pfe_phy_init interface 7
[228.917317] eth2: pfe_eth_init_one: created interface, baseaddr: ffffff8002020000
[228.924883] pfe_debugfs_init
root@lede:/#
root@lede:/# ifconfig -a

```
br-lan    Link encap:Ethernet  HWaddr 00:15:17:1E:22:9E
          inet addr:192.168.2.154  Bcast:192.168.2.255  Mask:255.255.255.0
          inet6 addr: fe80::215:17ff:fe1e:229e/64 Scope:Link
          inet6 addr: fdd5:6e9d:a4df::1/60 Scope:Global
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:125 errors:0 dropped:0 overruns:0 frame:0
          TX packets:35 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:11972 (11.6 KiB)  TX bytes:4007 (3.9 KiB)

eth0      Link encap:Ethernet  HWaddr 00:15:17:1E:22:9E
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:200 errors:0 dropped:0 overruns:0 frame:0
          TX packets:32 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:20880 (20.3 KiB)  TX bytes:3889 (3.7 KiB)
          Interrupt:26 Memory:4046000000-4046020000

eth1      Link encap:Ethernet  HWaddr 00:1A:2B:3C:4D:5E
          BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

eth2      Link encap:Ethernet  HWaddr 00:AA:BB:CC:DD:EE
          BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:128 errors:0 dropped:0 overruns:0 frame:0
          TX packets:128 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:10112 (9.8 KiB)  TX bytes:10112 (9.8 KiB)

root@lede:/# ifconfig eth1 100.1.1.8
[  246.882405] eth1: pfe_eth_open
[  246.885789] hif_process_client_req: register client_id 0
[  246.891152] pfe_hif_client_register
[  246.894662] eth1: pfe_gemac_init
root@lede:/# ifconfig
br-lan    Link encap:Ethernet  HWaddr 00:15:17:1E:22:9E
          inet addr:192.168.2.154  Bcast:192.168.2.255  Mask:255.255.255.0
          inet6 addr: fe80::215:17ff:fe1e:229e/64 Scope:Link
          inet6 addr: fdd5:6e9d:a4df::1/60 Scope:Global
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:135 errors:0 dropped:0 overruns:0 frame:0
          TX packets:35 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:12532 (12.2 KiB)  TX bytes:4007 (3.9 KiB)
```

```
eth0      Link encap:Ethernet  HWaddr 00:15:17:1E:22:9E
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:211 errors:0 dropped:0 overruns:0 frame:0
          TX packets:32 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:21702 (21.1 KiB)  TX bytes:3889 (3.7 KiB)
          Interrupt:26 Memory:4046000000-4046020000

eth1      Link encap:Ethernet  HWaddr 00:1A:2B:3C:4D:5E
          inet addr:100.1.1.8  Bcast:100.255.255.255  Mask:255.0.0.0
          inet6 addr: fe80::21a:2bff:fe3c:4d5e/64 Scope:Link
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:608 (608.0 B)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:136 errors:0 dropped:0 overruns:0 frame:0
          TX packets:136 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:10744 (10.4 KiB)  TX bytes:10744 (10.4 KiB)

root@lede:/# [ 251.827232] eth1: Link is Up - 1Gbps/Full - flow control off

root@lede:/# ping 100.1.1.1
PING 100.1.1.1 (100.1.1.1): 56 data bytes
64 bytes from 100.1.1.1: seq=0 ttl=64 time=4.722 ms
64 bytes from 100.1.1.1: seq=1 ttl=64 time=4.496 ms
^C
--- 100.1.1.1 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 4.496/4.609/4.722 ms
root@lede:/# ifconfig eth1 down
[ 266.609065] eth1: pfe_eth_shutdown
[ 266.646928] hif_lib_client_unregister : client: ffffffc039ede788, client_id: 0, txQ_depth: 2048,
rxQ_depth: 256
[ 266.657049] hif_process_client_req: unregister client_id 0
[ 266.662541] pfe_hif_client_unregister
root@lede:/# [ 266.826940] eth1: Link is Down

root@lede:/# ifconfig  eth2 100.1.1.7
[ 274.496442] eth2: pfe_eth_open
[ 274.499895] hif_process_client_req: register client_id 1
[ 274.505213] pfe_hif_client_register
[ 274.508732] eth2: pfe_gemac_init
root@lede:/# ifconfig
br-lan    Link encap:Ethernet  HWaddr 00:15:17:1E:22:9E
          inet addr:192.168.2.154  Bcast:192.168.2.255  Mask:255.255.255.0
          inet6 addr: fe80::215:17ff:fe1e:229e/64 Scope:Link
          inet6 addr: fdd5:6e9d:a4df::1/60 Scope:Global
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
```

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         RX packets:163 errors:0 dropped:0 overruns:0 frame:0
         TX packets:35 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:14590 (14.2 KiB)  TX bytes:4007 (3.9 KiB)

eth0     Link encap:Ethernet  HWaddr 00:15:17:1E:22:9E
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:244 errors:0 dropped:0 overruns:0 frame:0
         TX packets:32 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:24648 (24.0 KiB)  TX bytes:3889 (3.7 KiB)
         Interrupt:26 Memory:4046000000-4046020000

eth2     Link encap:Ethernet  HWaddr 00:AA:BB:CC:DD:EE
         inet addr:100.1.1.7  Bcast:100.255.255.255  Mask:255.0.0.0
         inet6 addr: fe80::2aa:bbff:fecc:ddee/64 Scope:Link
         UP BROADCAST MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:5 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:518 (518.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         inet6 addr: ::1/128 Scope:Host
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:160 errors:0 dropped:0 overruns:0 frame:0
         TX packets:160 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:12640 (12.3 KiB)  TX bytes:12640 (12.3 KiB)

root@lede:/# ping 100.1.1.1[  278.917242] eth2: Link is Up - 1Gbps/Full - flow control off

PING 100.1.1.1 (100.1.1.1): 56 data bytes
64 bytes from 100.1.1.1: seq=0 ttl=64 time=2.325 ms
64 bytes from 100.1.1.1: seq=2 ttl=64 time=3.511 ms
64 bytes from 100.1.1.1: seq=3 ttl=64 time=4.372 ms
```