Mainline Linux on Qualcomm SoCs, are we here now?

Yes, and we’re in pretty good shape!

Neil Armstrong - Linaro Developers Services

FOSDEM’24
Brussels / 3 & 4 February 2024
Introduction

- Qualcomm Landing Team @ Linaro
  - Qualcomm upstream maintenance
  - U-Boot Qualcomm baseport co-maintainer
  - Bringup/addition of new platforms
- I also maintain other upstream pieces
  - Amlogic SoCs
    - Linux & U-Boot architecture
    - Clocks
    - Pinctrl, Serial, CEC …
  - DRM
    - Bridge drivers
    - Panel drivers
    - Amlogic Display driver
- Primarily focussed on Linux Kernel
  - 1194 patches in mainline from v3.1 to v6.8-rc1, 176 Qualcomm related
- But also in U-Boot (265 patches in mainline as v2024.01)
Linaro is the software engine of the Arm Ecosystem

Linaro empowers rapid product deployment within the dynamic Arm Ecosystem.

- Our cutting-edge solutions, services and collaborative platforms facilitate the swift development, testing, and delivery of Arm-based innovations, enabling businesses to stay ahead in today’s competitive technology landscape.

- Our expertise and contributions spread from Testing & LTS, Security, Cloud & Edge Computing, IoT, AI, CI/CD, Toolchain and Virtualization to vertical projects like Windows on Arm and Android Ecosystem enabling and maintenance.

- Linaro fosters an environment of collaboration, standardization and optimization among businesses and open source ecosystems to accelerate the deployment of Arm-based products and technologies along with representing a pivotal role in open source discovery and adoption.

Linaro has enabled trust, quality and collaboration since 2010
Linaro & Qualcomm

- Qualcomm joined Linaro in 2014
  - When a company joins as a member, they work together on joint engineering projects
  - Originally focused on the Linux kernel but now collaborate in many other areas
    - OpTEE, U-Boot, QEMU, SOAFEE, ...
  - Member companies also participate in setting Linaro's strategic direction
  - Qualcomm Membership included the Landing Team
    - Linaro engineers work closely with Qualcomm on their objectives
    - Everyone involved is happy with how things are going
    - Has increased its cooperation with Linaro over the years
Linaro & Qualcomm

- Collaborated on multiple key pieces of the Android and Linux ecosystem
  - Power frameworks
  - Energy Aware Scheduler
  - Arm servers – standards and software architecture
  - 96Boards DragonBoards (410c, 820c, RB1, RB2, RB3, RB5, etc,...)
  - CodeLinaro
    - Became the principal development platform for Linaro projects
  - Flagship mobile platforms upstreaming
    - Snapdragon 8 Gen 1 - upstream support in the year after the announcement
    - Snapdragon 8 Gen 2 - upstream support in the 6 months after the announcement
    - Snapdragon 8 Gen 3 - upstream support in the 2 months after the announcement
Agenda

1. Where we came from
2. Where we are now
3. A tour of supported devices
4. Demo time!
5. What’s remaining
6. We need your help!
## Qualcomm Downstream Changes in 2015

### Kernel Mainline Status of Mobile Chipsets

*September, 2015*

Tim Bird  
LF CE Workgroup

### Downstream Changes for mobile phones

<table>
<thead>
<tr>
<th>Company</th>
<th>SOC</th>
<th>Files</th>
<th>Insertions</th>
<th>Deletions</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG</td>
<td>Msm</td>
<td>5775</td>
<td>2.616M</td>
<td>40K</td>
</tr>
<tr>
<td>Motorola</td>
<td>Msm</td>
<td>4490</td>
<td>1.795M</td>
<td>40K</td>
</tr>
<tr>
<td>Samsung</td>
<td>Exynos</td>
<td>2877</td>
<td>1.100M</td>
<td>51K</td>
</tr>
<tr>
<td>Samsung</td>
<td>Msm</td>
<td>6096</td>
<td>3.105M</td>
<td>53K</td>
</tr>
<tr>
<td>Sony</td>
<td>Msm</td>
<td>4625</td>
<td>1.784M</td>
<td>41K</td>
</tr>
<tr>
<td>Sony</td>
<td>Mediatek</td>
<td>3689</td>
<td>1.935M</td>
<td>7K</td>
</tr>
<tr>
<td>Acer</td>
<td>Mediatek</td>
<td>3122</td>
<td>1.411M</td>
<td>6K</td>
</tr>
<tr>
<td>Asus</td>
<td>Atom</td>
<td>7351</td>
<td>2.163M</td>
<td>22K</td>
</tr>
<tr>
<td>Huawei</td>
<td>Hisilicon</td>
<td>5082</td>
<td>2.659M</td>
<td>43K</td>
</tr>
</tbody>
</table>
Qualcomm Downstream Kernel Changes

Changes across releases:

- New SoC Support
  - Accumulated over time

Better alignment to LTS Kernels, changes existing code instead of adding new code

Year 2019
Qualcomm Upstream State in 2016

ELC-E 2016 Neil Armstrong - No, it's never too late to upstream your legacy linux based platform

Why should I push code for my (legacy) linux based platform?

Hopefully, we can count some vendors that really participate in the upstream work like:

- Intel
- IBM
- Texas Instruments
- Atmel (Microchip)
- Broadcom
- Renesas
- Freescale (NXP)
- ...

FOR QUALCOMM UPSTREAM SUPPORT

STILL WAITING
Linaro Qualcomm Landing Team work

Linaro has worked on big features in the last 10 years:

● RemoteProc/rpmsg to handle DSPs
● Interconnect
● Venus Video Encoder/Decoder
● DSP Audio/Audioreach
● MSM DRM Driver
● Soundwire
● And plenty of other time-consuming subjects!
Qualcomm Linaro Upstream Contributions

Timeline of Qualcomm major changes vs Qualcomm Related commits:

for id in $(git tag | grep -E "^v\[0-9.\][0-9]+\$" | sort -V); do echo -n $id, ; git log --oneline --author=linaro -G "qcom|msm|qualcomm" $PREV..$id | wc -l; PREV=$id; done

10y ago

today
Mainline Supported boards over time

for id in $(git tag | grep -E "^v\[0-9].\[0-9].*" | sort -V); do echo -n $id, ; git ls-tree --name-only -r $id | grep -E "arch/.*/boot/dts/*qcom.*.dts" | wc -l; done
New Supported boards over time

10y ago

Today (v6.8-rc1)

Manually corrected since arm32 DTs were moved in subdirectories in V6.5...

for id in $(git tag | grep -E "^v[0-9].[0-9]+$" | sort -V); do echo -n $id, ; BOARDS=$(git ls-tree --name-only -r $id | grep -E "arch/.*/boot/dts/*qcom.*.dts$"); diff -u <(git ls-tree --name-only -r $PREREV | grep -E "arch/.*/boot/dts/*qcom.*.dts$") <(git ls-tree --name-only -r $id | grep -E "arch/.*/boot/dts/*qcom.*.dts$") | grep "\+arch" | wc -l; PREREV=$id; done
Historical Dragonboards

The 96board DragonBoards were the first widely available Qualcomm Development platforms in SBC form-factor and boosted the upstreaming effort.

DragonBoard 410c

DragonBoard 820C
Qualcomm Robotic Boards

These are the mid-end development boards offered by Qualcomm, using robust and well-supported platforms

RB1 / RB2

RB3

RB5
Commercial Phones

An handful of commercial phones are running mobile oriented mainline Linux-based distros like postmarketOS

OnePlus 6T
FairPhone 4
FairPhone 5
Tablets/Convertibles

An handful of tablets/convertibles can run mobile oriented mainline Linux-based distros like postmarketOS or bare Ubuntu
Qualcomm High-End Reference Devices

The Qualcomm Reference Devices & Development Kits are the primary development devices for upstreaming Snapdragon 8 Gen 1 & 2 Hardware Development Kits with debug test points & connectors
Snapdragon 8 Gen 3 Support Status

- Supported as Linux v6.8-rc1
  - Display👍
  - UFS, PCIe, USB & Bluetooth👍
  - Thermal Sensors & CPU Frequency Scaling👍
  - USB-C👍
  - Suspend/Resume👍
  - Crypto Accelerators👍

- Work in Progress
  - Audio (Codec, USB-C Audio Accessory Mode)
  - DisplayPort Altmode (👍 on Gen 1 & Gen 2)
  - DSPs (Modem, Compute & Audio DSP) (👍 on Gen 1 & Gen 2)
  - USB-C PD/Charger (👍 on Gen 1 & Gen 2)
  - GPU (👍 on Gen 1 & Gen 2)
Lenovo X13s

Qualcomm SC8280xp based Laptop

Status maintained by Johan Hovold: https://github.com/jhovold/linux/wiki/X13s

X13s Running KDE on Armbian

X13s Running Quake3

X13s Running Crysis with FEX Emu

https://www.youtube.com/watch?v=7HuPhM03aBw
Lenovo X13s

Support Status (also for SC8280xp SoC):

- GPU Acceleration, Display & Backlight 👍
- PCIe, WiFi & Bluetooth 👍
- NVMe 👍
- KeyBoard & Trackpad 👍
- Thermal Sensors & CPU Frequency Scaling 👍
- USB-C and DisplayPort Altmode 👍
- Suspend/Resume 👍
- Audio 👍
- UEFI Boot with EFI Variables 👍

But there’s obviously some Work In Progress!
Lenovo X13s

Work In Progress:

● Built-in Camera is a work in progress and is not available upstream/publicly
● Embedded Controller is a work in progress
  ○ Needed to support Keyboard's Special Keys and system events
● Active Work to improve power management
  ○ Constant incremental improvements being made there (Suspend/Resume, ...)
● Some WiFi and Bluetooth issues remain, but they are relatively minor.
● Audio works, requires Active speaker protection
  ○ DisplayPort Audio is a work in progress
● Miscellaneous
  ○ Fingerprint reader
  ○ Video acceleration
  ○ USB-C Power Delivery
Linux Distributions for the X13s

- Fedora Rawhide images are bootable as of the 15th of December, 2023
  - https://fedoraproject.org/wiki/Thinkpad_X13s
- Armbian Maintained Port
  - https://www.armbian.com/lenovo-x13s/
- Ubuntu 23.10 will install “as is”
  - May require some slight configurations
- As of October 11, 2023, Debian Trixie can be installed on the Thinkpad X13s using the daily `netinst` image.
  - https://wiki.debian.org/InstallingDebianOn/Thinkpad/X13s
- Scripts Available to boot other distros
  - Arch Linux/EndeavourOS
Demo time!

If everything went fine, presentation should run on a Qualcomm platform!

If not, I’ll show you a running device!
What’s remaining

● Power optimization
  ○ Qualcomm SoCs are known to be very complex in this regard
● Performance Optimization
  ○ Add Bus scaling on all needed busses (PCIe, UFS,...)
● Advanced Graphics Features (HDR, ...)
● Video Decoding Accelerator
  ○ Support for Snapdragon 8 Gen 2 is on the lists
● Camera support on new platforms
● Audio support on new platforms
  ○ + DisplayPort Audio
  ○ Speaker Protection
● Miscellaneous features
  ○ Sensor Hub
  ○ Haptic Feedback & Vibrator
● Next platforms !
We need your help!

- The Upstream Linux Qualcomm is a very active community!
  - Has the largest ARM64 changes in the last year
- Now ready to support mainstream devices
  - Phones
  - Laptops
  - Modem
  - Accessories
- Work is also in Progress in U-boot
  - Universal Bootloader becomes true!
- Global status: [https://linaro.github.io/msm/](https://linaro.github.io/msm/) ->
- => linux-arm-msm@vger.kernel.org
- => #linux-msm on [https://www.oftc.net/](https://www.oftc.net/)
## Platform Specifications

### WIFI Capability

<table>
<thead>
<tr>
<th>Platform</th>
<th>WiFi Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>APQ8054</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>MSM8955</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>MSM8978</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SC7280</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SC7290</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SC8895X/8897P</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SDM665</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SDM860</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SME850</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SDM850</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>S8650</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SDM875</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SM9520</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SM9550</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>SM9550</td>
<td>2.4 GHz</td>
</tr>
</tbody>
</table>

### Bluetooth Connection

- Bluetooth connection details are not provided in the specified manner. Please refer to the source document for detailed specifications.
Thank you

Slides?

Visit www.linaro.org

Reach out to me at neil.armstrong@linaro.org or narmstrong on Libera.Chat & OFTC