Pixel On Life Support
Upgrading from Android 12 to Android 16

Apelete SEKETELI, Owner Of MISSENE, Embedded Linux Engineer
<apelete@seketeli.net>
https://www.missene.com
https://www.linkedin.com/in/apelete

Obsolescence In Consumer Smartphone Market ?

- Smartphone manufacturers provide fixed term software support
  - Used to be around 2 years after release, improving to 5+ years lately
- When the term ends, devices no longer receive system updates
  - Exposing users to security vulnerabilities & lack of feature improvements
  - Thanks to economic incentives in upgrading instead for replacing, companies can rely on alternative update providers (cf. emteria @ fosdem'25)
- What about individual users : a case for the Custom ROM community ?

A Case For Android Custom ROM

- Akin to Linux Distributions, Custom ROMs are alternative builds
  - Can replace manufacturers commercial system images
  - Gives the choice to run Android with or without Google applications

- Hardware and software prerequisites
  - Requires manufacturer to allow bootloader to be unlocked
  - Requires Linux kernel & BSP sources to be available
  - With previous requirements, hardware SoC & peripherals could be supported by a custom Android rebuild
    - Project Treble has improved Linux kernel support with unified build versions

Building Android For Your Device

- Sources for a device are usually split in trees
  - Device tree : device and board specific configuration files
  - Vendor tree : proprietary files, binaries and blob for peripheral support
    - Either provided by manufacturer or extracted from OEM system image
    - Search for online repositories for distributed vendor trees
  - Kernel tree : Linux kernel tree with device specific Android configuration
  - Extra trees : some devices may require additional dependencies
    - Additional sources for hardware support and configuration
- Everything else is common base for all devices

Building Evolution X For Pixel 4a

- Pixel 4a infamous “Battery Killer” system update started it all
- Evolution X was a promising start
  - Pixel 4a was supported until Android 14, then maintainer left...
  - Very good documentation to get started building it myself
- Learning curve facilitated by a strong & helpful community
  - First, rebuilding latest official Evolution X 9.2 release
  - Keep up with monthly updates rebuilds for security patches
  - Make the jump to next major version release, from Android 14 to 15

Building Evolution X For Pixel 4a

- Android sources are managed with “repo” tool : start with a manifest

```
<?xml version="1.0" encoding="UTF-8"?>
<manifest>
  <!--Remotes-->
  <remote name="los"          fetch="https://github.com/LineageOS"      revision="lineage-21" />
  <remote name="muppets"  fetch="https://github.com/TheMuppets"    revision="lineage-21" />
  <remote name="gh"           fetch="https://github.com/apelete"          revision="lineage-21" />

  <!--Devices Trees-->
  <project name="android_device_google_gs-common"   path="device/google/gs-common"   remote="los" />
  <project name="android_device_google_sunfish"       path="device/google/sunfish"       remote="gh" />

  <!--Vendors Tree-->
  <project name="proprietary_vendor_google_sunfish"   path="vendor/google/sunfish"       remote="muppets" />

  <!--Kernel Tree-->
  <project name="android_kernel_google_msm-4.14"     path="kernel/google/msm-4.14"     remote="gh" />
</manifest>
```

- Fetch all sources with `repo sync`
- Configure the build with `lunch lineage_$device-$release-$build_type` → `lunch lineage_sunfish-ap2a-userdebug`

Building Evolution X For Pixel 4a

- Start compiling with `m evolution` then…

- Typical build with an AMD Ryzen 7 CPU with 128GB RAM & SSD : 2h30 !
- Rebuilds are usually less than 45 minutes...unless it fails :-)

Fixing Issues Along The Way

- Framework Compatibility Matrix (FCM) changes : XML files defining what version of which software component shall be used for the specific Android build (eg. HAL intefaces, kernel configurations, security policies, etc...)

```
The following HALs in device manifest are not declared in FCM <= level 5:
  android.hardware.audio.effect@7.0::IEffectsFactory/default
  android.hardware.audio@7.0::IDevicesFactory/default
  android.hardware.boot.IBootControl/default (@1)
  android.hardware.camera.provider.ICameraProvider/internal/0 (@1)
  android.hardware.contexthub.IContextHub/default (@3)
  android.hardware.drm.IDrmFactory/clearkey (@1)
  android.hardware.drm.IDrmFactory/widevine (@1)
  android.hardware.identity.IIdentityCredentialStore/default (@4)
  android.hardware.input.processor.IInputProcessor/default (@1)
  android.hardware.memtrack.IMemtrack/default (@1)
  android.hardware.nfc.INfc/default (@1)
  android.hardware.power.IPower/default (@5)
  android.hardware.thermal.IThermal/default (@2)
  android.hardware.usb.IUsb/default (@1)
  android.hardware.vibrator.IVibrator/default (@2)
  android.hardware.wifi.IWifi/default (@2)
  android.hardware.wifi.hostapd.IHostapd/default (@2)
  android.hardware.wifi.supplicant.ISupplicant/default (@3)
  vendor.lineage.livedisplay.IPictureAdjustment/default (@1)
INCOMPATIBLE
2025-08-21 22:24:45 - check_target_files_vintf.py - INFO    : stderr: ERROR: files are incompatible:
The following instances are in the device manifest but not specified in framework compatibility matrix:
    vendor.lineage.livedisplay.IPictureAdjustment/default (@1)
Suggested fix:
1. Update deprecated HALs to the latest version.
2. Check for any typos in device manifest or framework compatibility matrices with FCM version >= 5.
3. For new platform HALs, add them to any framework compatibility matrix with FCM version >= 5 where applicable.
4. For device-specific HALs, add to DEVICE_FRAMEWORK_COMPATIBILITY_MATRIX_FILE or DEVICE_PRODUCT_COMPATIBILITY_MATRIX_FILE.: Success
[...]
RuntimeError: VINTF compatibility check failed
```

Fixing Issues Along The Way

- Linux kernel userspace api type needed to be redefined locally to avoid musl/glibc breakage : fix backported from upstream into Pixel 4a's kernel 4.14 :
  https://github.com/apelete/android_kernel_google_msm-4.14/commit/1cf522edbe21b861c0c2e9cafb868e9257fca031

```
error: redefinition of ‘struct sched_param’
```

- ABI breakage due to a missing symbol in an obscure WiFi-Direct library binary file : solved by writing a weak C++ definition of the missing symbol in a luckily open-source component loading the library :
  https://github.com/apelete/frameworks_native/commit/af9056ed70e957ec4a7fd64033f6bf365f8ca3da

```
error: Unresolved symbol: _ZTVN7android21SurfaceComposerClient11TransactionE
out/soong/.intermediates/vendor/google/sunfish/libsecureuisvc_jni/android_arm64_armv8-a_shared/libsecureuisvc_jni.so:
note: Some dependencies might be changed, thus the symbol(s) above cannot be resolved.
out/soong/.intermediates/vendor/google/sunfish/libsecureuisvc_jni/android_arm64_armv8-a_shared/libsecureuisvc_jni.so:
note: Please re-build the prebuilt file:
"out/soong/.intermediates/vendor/google/sunfish/libsecureuisvc_jni/android_arm64_armv8-a_shared/libsecureuisvc_jni.so"
```

Maintaining For The Community

- Successful experiment got me hooked : renewed the challenge with Pixel 4a 5G and Pixel 5 “Abandon-ware” :-)
- As an official maintainer I added 3 devices into Evolution X roster
- Benefit of the project CI/CD infrastructure and OTA updates is a huge win for users
- Small phones are getting rare and reliable “old” devices are surprisingly still in use by people…

What’s Next ?

- Strive for monthly security updates...and major version upgrades as long as technically possible !
- Google will publish Android source code to AOSP in Q2 and Q4 of each year from now on, instead developing in the open : challenge for custom ROM community ?
- Continue learning about Android & AOSP intrinsics in order to contribute more : Evolution X and others depend on contributions to LineageOS and Linux kernel open-source projects !

Questions ?

- My Devices
  - Pixel 4a https://evolution-x.org/devices/sunfish
  - Pixel 4a 5G https://evolution-x.org/devices/bramble
  - Pixel 5 https://evolution-x.org/devices/redfin
- Documentation & sources
  - Evolution X Wiki https://wiki.evolution-x.org/
  - Evolution X Core Repository https://github.com/Evolution-X
  - Evolution X Devices Repository https://github.com/Evolution-X-Devices
- The Mother of all Custom ROM https://wiki.lineageos.org