MYTHBUSTERS: ANDROID

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Overview

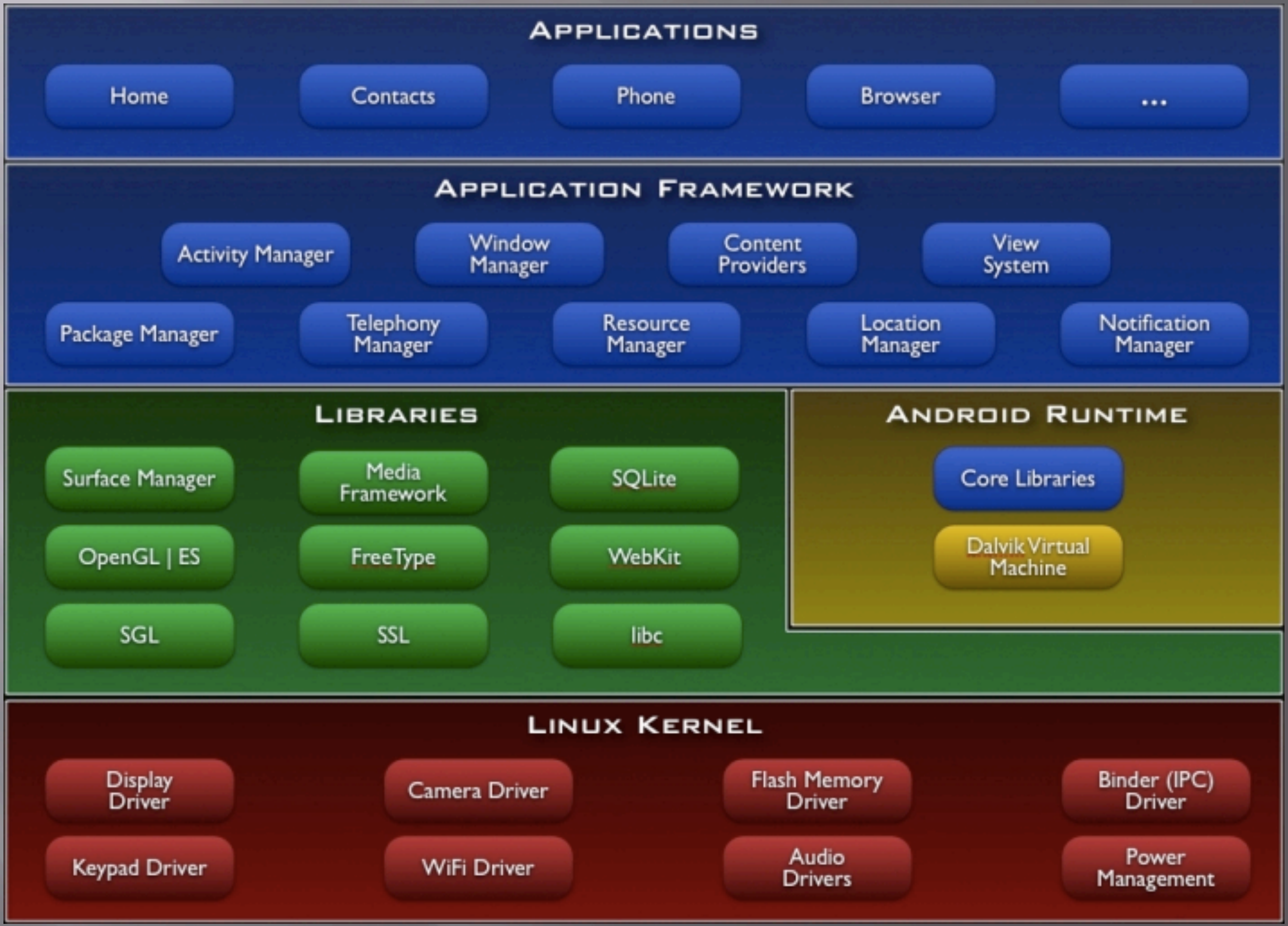
Android platform enablement is a hot topic, everybody seems to want Android on their part/ board/system

We test several Android questions today:

- Is Android “Linux”? What does that mean?
- Does Android “Just Work™”?
- What/where is the Android community?

Looking at some examples will help us answer these questions

Android Architecture



Porting Android

- Linux kernel
  - Android patches
    - Ashmem
    - binder
    - Android PM
  - Arch support
- Android “distro”
  - AOSP
  - Building
- Deploy!

Bionic

- Bionic is Android's libc
- Not glibc
- BSD derived
- ARM/x86 support only
- Partial pthreads support
- No SysV IPC support
- No STL support
- Prelink is unique to bionic/Android

Bionic

- No linux-headers package
- Makes adding new native binaries to Android an annoyance
- Minimal "scrubbed" set of headers
  - Why?
- Results in a lot of this:

```
diff --git a/libc/kernel/common/linux/uinput.h b/libc/kernel/common/linux/uinput.h
new file mode 100644
index 0000000..827d99d
--- /dev/null
+++ b/libc/kernel/common/linux/uinput.h
```

Device Node Management

- Sorry, no udev here
- Android’s new init replaces udev…poorly

```
static struct perms_ devperms[] = {
  { "/dev/null",        0666,   AID_ROOT,       AID_ROOT,       0 },
  { "/dev/zero",        0666,   AID_ROOT,       AID_ROOT,       0 },
  { "/dev/full",        0666,   AID_ROOT,       AID_ROOT,       0 },
  { "/dev/ptmx",        0666,   AID_ROOT,       AID_ROOT,       0 },
  { "/dev/tty",         0666,   AID_ROOT,       AID_ROOT,       0 },
  { "/dev/random",      0666,   AID_ROOT,       AID_ROOT,       0 },
  { "/dev/urandom",     0666,   AID_ROOT,       AID_ROOT,       0 },
    …
```

- Yes, that’s policy hardcoded into the init binary

Hotplug

- No hotplug scripts or udev/hal
- Init/Vold replaces that infrastructure
- Types of hotplug events processed are hardcoded in init

```
/* this should probably be configurable somehow */
    if(!strncmp(uevent->subsystem, "graphics", 8)) {
        base = "/dev/graphics/";
        mkdir(base, 0755);
    } else if (!strncmp(uevent->subsystem, "oncrpc", 6)) {
        base = "/dev/oncrpc/";
        mkdir(base, 0755);
    } else if (!strncmp(uevent->subsystem, "adsp", 4)) {
        base = "/dev/adsp/";
        mkdir(base, 0755);
   } else if(!strncmp(uevent->subsystem, "input", 5)) {
        base = "/dev/input/";
        mkdir(base, 0755);
    } else if(!strncmp(uevent->subsystem, "mtd", 3)) {
        base = "/dev/mtd/";
        mkdir(base, 0755);
    } else if(!strncmp(uevent->subsystem, "misc", 4) &&
                !strncmp(name, "log_", 4)) {
      …
```

Hotplug

- Storage devices are not managed by HAL
- Replacement is vold
  - vold only designed to handle mount/unmount of an MMC subsystem device
  - Needs help to handle a USB Mass Storage device

```
if (!(d = opendir(SYSFS_CLASS_MMC_PATH))) {
    LOG_ERROR("Unable to open '%s' (%m)",
 SYSFS_CLASS_MMC_PATH);
    return -errno;
 }
```

Input

- Android input uses standard Linux Input
- EventHub auto-discovers input devices
  - At boot
  - Upon event queue creation (hotplug usb HID)
- Input devices categorized by probing EV_* capabilities
  - Keyboard
  - Trackball
  - Touchscreen
  - Mouse (by non-mainline patch from Android-x86)

Keyboard/Keypad

- Key mapping handled using a key layout and key character map infrastructure
- Problem: key layout/charmap used is matched by the input device name string

```
if (err <= 0) {
        // a more descriptive name
        ioctl(mFDs[mFDCount].fd, EVIOCGNAME(sizeof(devname)-1), devname);
        devname[sizeof(devname)-1] = 0;
        device->name = devname;
        strcpy(tmpfn, devname);
        // replace all the spaces with underscores
        for (char *p = strchr(tmpfn, ' '); p && *p; p = strchr(tmpfn, ' '))
          *p = '_';
    }

    // find the .kl file we need for this device
    const char* root = getenv("ANDROID_ROOT");
    snprintf(keylayoutFilename, sizeof(keylayoutFilename),
          "%s/usr/keylayout/%s.kl", root, tmpfn);
```

- This doesn’t work at all for USB keyboards!

Touchscreen

- Touchscreen support makes no use of tslib
- Touchscreen events from the kernel driver are passed on uncooked directly to the Android “key event queue”

```
if(ioctl(mFDs[id_to_index(device->id)].fd, EVIOCGABS(axis), &info)) {
        LOGE("Error reading absolute controller %d for device %s fd %d\n",
            axis, device->name.string(), mFDs[id_to_index(device->id)].fd);
        return -1;
    }
    *outMinValue = info.minimum;
    *outMaxValue = info.maximum;
    *outFlat = info.flat;
    *outFuzz = info.fuzz;
    return 0;
```

- This results in kernel drivers being hacked for one-off calibration of absolute events being returned
- Patches exist to add tslib support now

Large screen sizes

- Running Android on Framebuffers with larger resolutions (1024x768+) quickly runs into this:

```
// create the surface Heap manager, which manages the heaps
// (be it in RAM or VRAM) where surfaces are allocated
// We give 8 MB per client.
mSurfaceHeapManager = new SurfaceHeapManager(this, 8 << 20);
```

- On higher resolution FB's this hardcoded limit results in surfaceflinger allocation failures and the eventual restart of Android

UI elements

- Assumes a certain set of peripherals
  - Telephony (3G signal indicator hardcoded)
  - Wifi (Wifi signal indicator hardcoded
  - Ringer volume slider assumes telephony present
- Settings screen option assumes a handset
  - USB debugging option
  - SD card mount/unmount

services/java/com/android/server/status/StatusBarPolicy.java:

```
 // phone_signal
mPhone =
(TelephonyManager)context.getSystemService(Context.TELEPHONY_SERVICE);
mPhoneData = IconData.makeIcon("phone_signal",
        null, com.android.internal.R.drawable.stat_sys_signal_null, 0, 0);
mPhoneIcon = service.addIcon(mPhoneData, null);
 service.setIconVisibility(mPhoneIcon, !hwNoPhone);
```

Hardcoded product policy

- Installation of non-marketplace .apks
  - Custom Android-based product may want this out-of-the-box instead of a settings option
- Enabling adb debugging
  - Many devices may want this enabled by default, except for a closed device

Endian Issues

- Dalvik VM internal structures
- JValue is implemented in a LE specifc way:

```
typedef union JValue {
   u1      z;
   s1      b;
   u2      c;
   s2      s;
   s4      i;
   s8      j;
   float   f;
   double  d;
   void*   l;
} JValue;
```

- **Requirement to access same value stored as byte as an integer**

```
JValue *jv = foo;
jv->b = 0x54;

print jv->i -> should output 0x54;
```

- Key Character maps are LE
- Prebuilt icu4c LE maps
- Lots of missing htons/htonl use

Ethernet support

- Off the shelf Android doesn't have good Ethernet support
- Early efforts just used a script to run the cmdline Android netcfg app to force dhcp configuration
- Requires registration of new connection type to manage link status and network available information similar to Wifi
- android-x86 project has a partially working Ethernet monitor
  - Problems with not always detecting link changes and re-dhcping
  - Doesn't update Android-specific DNS properties
    - Yes, resolv.conf isn't used in Android

Community issues

- Android Open Source Project (AOSP)
  - Relatively immature compared to traditional Linux communities
  - Huge lag in code being used by OHA member and what is dumped into the AOSP trees
  - Google developers generally don't develop in the AOSP tree
  - Slowness in accepting code into the AOSP tree
  - OTOH, Google people on the AOSP lists are very responsive and helpful
- Alternative architectures (x86) are hosted at different sites

Pixelflinger JIT portability

- Codeflinger JIT designed with ARM opcodes in mind
- Other arches are able to be supported (MIPS/PPC), but it is significant work

Power Management

- Android layers its PM model on top of standard Linux PM
  - Android wakelock concept
    - Applications can hold wakelocks to prevent system from sleeping
    - Once wakelocks are released cpu and peripherals may sleep
- Android PM policy is hardcded to a handset model
  - Full wakelock keeps CPU active and backlights at full brightness
  - Partial wakelock allows bakclights to dim while CPU acive
  - Modifying this policy for non handset designs requires modification of the PowerManager code.

Testing

- Google provides lots of nice unit tests using the JUnit framework and a harness to execute them
- Unfortunately, many of them fail on the AOSP tree
  - Even on the emulator!

```
Goldfish results (1.5r1 release)
passed: 67 test(s)
failed: 4 test(s)
failed: 044-proxy
failed: 057-iteration-performance
failed: 062-character-encodings
failed: 071-dexfile
```

Google Apps

- Running Android on your device does not mean you can leverage the Marketplace
- Google's App suite is proprietary software and use in devices is carefully controlled
  - Marketplace
  - Maps
  - CalendarProvider
- Cyanogen learned this in a widely publicized manner (http://android-developers.blogspot.com/2009/09/note-on-google-apps-for-android.html)

Conclusion

- Android is different from traditional Linux
  - When most people think of Linux, they think of a GNU/Linux distro
  - Departure from accepted userspace components (HAL, udev, etc.)
- Android has a lot of handset-focused policies hardcoded in the userspace code
  - This is better than policy in kernel space
- Solution is to continue to grow the AOSP community
  - Community will need to unify

Q&A

- Questions