Porting Tizen to Odroid-U3 & Tizen Training Course

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Tizen Reference Devices

Exynos 4412
Exynos 4210

http://seoz.egloos.com/viewer/3940983

Dongkun Shin (dongkun.shin@gmail.com)
Top 10 Open SBCs


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Hardkernel Odroid-U3

- UART for system console
- Exynos4412 Prime Quad core processor + 2GBYTE DRAM
- HSIC
- Power management IC
- Audio Codec
- Power protector IC
- Power on switch
- PWM output for cooling fan
- Ethernet RJ-45 Jack
- USB2.0 X 2
- USB2.0 Host x 3
- RTC Bak-up battery connector
- Micro USB connector (Device / Host)
- Micro HDMI connector
- Power LED
- 5V/2A DC Jack
- Heart bit LED
- IO Port #1 (I2C, UART, GPIO)
- Micro SD Card slot
- eMMC Module socket
- Earphone Jack
- IO Port #2 (SPI)
Porting Tizen Platform to Odroid-U3

RD-PQ
Reference Tizen Phone

Odroid-U3
No GPS, Sensors, LCD, Speaker, Battery, and Keys
USB-type WiFi/Bluetooth, HDMI

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Index

- Bootloader (U-boot)
- Kernel Build (3.10)
- Platform Build (2.2)
- Partition Setting & Flash
- Run Tizen
- Troubleshooting

- Useful sites
  - How to Build and Load Tizen on Odroid U3 ([https://wiki.tizen.org/wiki/How_to_Build_and_Load_Tizen_on_Odroid_U3](https://wiki.tizen.org/wiki/How_to_Build_and_Load_Tizen_on_Odroid_U3))
Bootloader: U-boot

- iRom ➔ bl1 ➔ bl2(➔ uboot.bin)

```
$ git clone ssh://your_id@review.tizen.org:29418/platform/kernel/u-boot.git u-boot-tizen
$ cd u-boot-tizen
$ git checkout -b tizen origin/tizen
```
Download Tizen Kernel

• Tizen Kernel is different with Vanilla kernel
• Can check in Gerrit (https://review.tizen.org/gerrit/#/)
  – You need tizen.org account

$ git clone ssh://your_id@review.tizen.org:29418/platform/kernel/linux-3.10.git kernel-tizen
$ cd kernel-tizen
$ git checkout -b tizen origin/tizen

Use This!

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Building Tizen Kernel

• Use the configuration files provided by tizen.org
  – defconfig & dtb

• Change kernel configurations (menuconfig)
  – Enable RF switch subsystem support
  – Enable usb WiFi modules driver
  – Enable Bluetooth device

• Build and use zImage
  – Include initramfs & dtb
  – See https://wiki.tizen.org/wiki/How_to_Build_and_Load_Tizen_on_Odroid_U3
Platform Build

- Source Code Management (SCM) Tools
  - Git, Repo, Gerrit
- Build Tool
  - GBS (Git Build System)
- Packaging Tools
  - MIC, RPM
Platform Build

1. Cloning Source Code

2. Building

3. Making Images

4. Flashing Images

Storage of ODROID (eMMC, SD card)

Tizen Review Server (review.tizen.org)

Tizen Repository

Kernel Source Code

Toolchains

Platform Source Code

Tizen Download Server (download.tizen.org)

Prebuilt Packages

Local Tizen Repository

Kernel Source Code

Toolchains

Platform Source Code

Local Platform Packages

Tizen Kernel (zImage)

Tizen Platform Images

platform.img
data.img
ums.img

mmcblk0p1 (boot)

mmcblk0p2 (platform)

mmcblk0p3 (data)

mmcblk0p4 (ums)

Need new profile for ODROID-U3

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ODROID-U3 Profile

• Profile
  – Defines the features of target device (usually hardware features)
  – Used for making platform image
  – There are only profiles for Tizen reference phones, emulators!

• Different HW features should be applied to the ODROID-U3 profile
  – No 3G/LTE modem, on-board Bluetooth, on-board GPS, camera, on-board sensors ...
  – However it has a touch screen, USB host ports ...

• We can check the configurable features from https://www.tizen.org/feature
ODROID-U3 Profile

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<model-config version="2.2.0" model="ODROID-U3-REF">
  <platform>
    <!-- Model Name, Platform Name/Version, Processor Name -->
    <key name="tizen.org/system/model_name" type="string">ODROID-U3</key>
    <key name="tizen.org/system/platform.name" type="string">Tizen</key>
    <key name="tizen.org/feature/platform.version" type="string">2.2</key>
    <key name="tizen.org/system/platform.processor" type="string">exynos4412</key>

    <!-- Specification of Features -->
    <key name="tizen.org/feature/camera" type="bool">false</key>
    <key name="tizen.org/feature/camera.back" type="bool">false</key>

    ...
  </platform>
  <custom>
    ...
  </custom>
</model-config>
```
Tizen Storage Partition

- Originally 7 partitions in RD-PQ
- We use only 4 partition: boot, platform, data, ums

<table>
<thead>
<tr>
<th>Partition</th>
<th>Mount Point</th>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/mmcblk0p1</td>
<td>/csa</td>
<td>RW</td>
<td>Configuration Saved Area</td>
</tr>
<tr>
<td>/dev/mmcblk0p2</td>
<td>/boot</td>
<td>RO</td>
<td><strong>Boot</strong>, Kernel image</td>
</tr>
<tr>
<td>/dev/mmcblk0p3</td>
<td>-</td>
<td>-</td>
<td>Reserved for future</td>
</tr>
<tr>
<td>/dev/mmcblk0p4</td>
<td>/mnt/csc</td>
<td>RW</td>
<td>Customer Software Configuration, store customer’s software configuration</td>
</tr>
<tr>
<td>/dev/mmcblk0p5</td>
<td>/</td>
<td>RO</td>
<td><strong>Platform</strong>, root director</td>
</tr>
<tr>
<td>/dev/mmcblk0p6</td>
<td>/opt</td>
<td>RW</td>
<td><strong>Data</strong>, applications, libraries of applications, and the platform database</td>
</tr>
<tr>
<td>/dev/mmcblk0p7</td>
<td>/opt/media</td>
<td>RW</td>
<td><strong>UMS</strong>, default (media) contents.</td>
</tr>
</tbody>
</table>
Flash Images

- Flash u-boot and platform/data/ums images
- Copy kernel image

Based on 8GB SD Card
Connect Device

- SD Card
- Odroid U3
- Odroid VU Touch
- U-ART
- USB
- HDMI
- AC Adapter
- WiFi or Bluetooth Modules

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First Run

Welcome to Tizen 2.2.0 (Tizen)!
Started Replay Read-Ahead Data
Starting Collect Read-Ahead Data...
Starting Runtime DIRECTORY...

Failed to start Resize of File System on /dev/mmcblk0p2
See 'systemctl status resize2fs@dev-mmcblk0p2.service' for details.
Starting /boot...
Starting /csa...
resize2fs[2557]:: 7.274815] EXT4-fs (mmcblk0p1): VFS: Can't find ext4 filesystem
/sbin/resize2fs: Bad magic number in super-block while trying to open /dev/mmcblk0p2
Starting /boot
Starting /lib/modules...
Failed to start /csa
See 'systemctl status csa.mount' for details.
Failed to start /lib/modules
See 'systemctl status lib-modules.mount' for details.
Dependency failed. Aborted start of default SMACK labeling
Dependency failed. Aborted start of default SMACK labeling
Dependency failed. Aborted Start of Resize of File S... /dev/mmcblk0p6
Dependency failed. Aborted Start of File System Check... /dev/mmcblk0p6
Dependency failed. Aborted Start of /opt
Dependency failed. Aborted Start of /opt/usr
Dependency failed. Aborted Start of /var
Dependency failed. Aborted Start of Runtime Directory
Dependency failed. Aborted Start of Initialize the VConf storage
Dependency failed. Aborted start of Resize of File S... /dev/mmcblk0p7
resize2fs[2557]: Couldn't find valid filesystem superblock.
Dependency failed. Aborted Start of File System Check... /dev/mmcblk0p7

FAIL!

Change mount option!!

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Change Partition Mount

- Tizen uses `systemd` for system initializing
- Change mount options in `systemd`

![Image of file system]

- Additional mount option in `/etc/fstab`
  - Remove module image mount (only for reference phone)

```
# /boot/modules.img       /lib/modules       ext4  loop 0 0
```

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Second Run

Success...? Not yet!

after a few seconds

No Display

Enter sleep mode
Freeze u-art connection

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Prevent Sleep Mode

- Power-manager Service
  - Control the power states
  - Four states: Normal / LCD Dim / LCD Off / Sleep
- Change power state working of power-manager
  - Modify `pm_core.c`

<table>
<thead>
<tr>
<th>State 0</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>LCD Dim</td>
<td>LCD Off</td>
<td>Sleep</td>
</tr>
</tbody>
</table>

Don’t enter sleep mode

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Display Output

• DDX(Device Dependency X) Problem
  – The default DDX connection in Tizen is LCD(LVDS)
  – exynos_drv.so
Third Run

But many problems...

- Touch coordinate error
- No exist hardware key (Home/Menu/Back)
- Non working WiFi / Bluetooth
- Battery low error
- No sound
- No openGL support

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Touch Coordinate Error

- Touch coordinate error in Odroid-VU

- Use calibration function of X11
  - Calculate calibration value using `xinput_calibrator`

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No Hardware Keys

• Can’t go home screen, can’t back to the previous screen

RD-PQ
Tizen Reference Phone

Menu Home Back

Only one key (Power)

No key

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No Hardware Keys

- Use USB-connected Keyboard
- Use mapping function of X11
  - Edit `/etc/X11/Xmodmap` (Key mapping table)

keycode 67 = XF86AudioRaiseVolume
keycode 68 = XF86AudioLowerVolume
keycode 69 = Cancel
keycode 70 = XF86Send (Menu)
keycode 71 = XF86Phone (Home)
keycode 72 = XF86Stop (Back)
keycode 73 = XF86Search
WiFi

- WiFi enable

- Edit wlan.sh script for USB WiFi Module
  - use ifconfig wlan0 up/down

- Add WiFi module firmware (rtl8192)
  - /lib/modules/

Run shell script

`/usr/bin/wlan.sh`

Device enable / disable

Firmware load for each working
- Normal
- Hotspot
- MFT
- WiFi-Direct

```
IFACE_NAME=wlan0
start()
{
/sbin/ifconfig ${IFACE_NAME} up
}
stop()
{
/sbin/ifconfig ${IFACE_NAME} down
}
```
Bluetooth

- Bluetooth enable

Run shell script

Four shell script
- Bt-stack-up.sh
- Bt-stack-down.sh
- Bt-stack-env.sh
- Bt-set-addr-sh

Device enable / disable Bluetooth env reset

- Edit each shell script for USB bluetooth module

bt-stack-up.sh
/usr/sbin/hciconfig hci0 up
/usr/sbin/bluetoothd -d
/usr/bin/bluetooth-share &

bt-stack-down.sh
/usr/sbin/hciconfig hci0 down
killall bluetooth-share
kcall bluetoothd

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Low Battery Problem

• No battery in Odroid-U3
  – System can’t get battery info
  – Some apps are not launched

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Low Battery Problem

- Edit battery function in OAL (OEM Adaptation layer)

Tizen F/W

OAL

Kernel

Battery

always return 100 %

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No Sound

• Different output device

- Earphone jack
- Speaker

• Change default sound device of pulse audio
  – /etc/pulse/system.pa
OpenGL Support

- Need to install OpenGL library
OpenGL Support

• Samsung offers library packages for OpenGL acceleration
  – For mali400 GPU in Exynos4412
  – Three packages (for kernel 3.10)
    • libump-mali-400.rpm (Unified Memory Provider Library)
    • libtbm-exynos4412.rpm (Tizen Buffer Manager Library)
    • gpu-ddk-mali-400.rpm (X11 Driver Development Kit)
  – Source code is under the standard ARM commercial license to Mali GPU customers

rpm -ivh --force *.rpm

Just install!
Porting Completed

Success...? Success!

YouTube: http://www.youtube.com/watch?v=IrZK37pNRPM

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Web Benchmarking

Acid3
http://acid3.acidtests.org/

HTML5TEST
http://html5test.com/

Browsermark
http://browsermark.rightware.com/

Sunspider
https://www.webkit.org/perf/sunspider/sunspider.html

V8 Benchmark Suite
http://v8.googlecode.com/svn/data/benchmarks/v7/run.html

WebGL Bench
https://webgl-bench.appspot.com/

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# Benchmark Results

<table>
<thead>
<tr>
<th>benchmark</th>
<th>RD-PQ</th>
<th>Odroid-U3</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTML5 Test</td>
<td>465</td>
<td>465</td>
<td>Higher is better</td>
</tr>
<tr>
<td>Acid 3</td>
<td>100</td>
<td>100</td>
<td>Total: 100</td>
</tr>
<tr>
<td>HTML5-Benchmark</td>
<td>1152</td>
<td>1490</td>
<td>Higher is better</td>
</tr>
<tr>
<td>Browsermark</td>
<td>-</td>
<td>1198</td>
<td>Higher is better</td>
</tr>
<tr>
<td>Sunspider</td>
<td>1088.8ms</td>
<td>1087.8ms</td>
<td>Lower is better</td>
</tr>
<tr>
<td>V8 Benchmark Suite</td>
<td>1556</td>
<td>1551</td>
<td>Higher is better</td>
</tr>
<tr>
<td>webgl-bench</td>
<td>-</td>
<td>success</td>
<td></td>
</tr>
</tbody>
</table>

Perfect!
Tizen Training Course
Tizen is Open Source

• Fully Open Sourced Cross-device Platform
• Support both HTML5-based Web App and Native Apps & Services
• Suitable platform for training students to understand and contribute to open sources

• Graduate students want to study Tizen internals rather than Tizen App Development

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Documents on Tizen

• **Book**
  – “Professional Tizen Application Development”

• **Website**
  – Tizen Dev Guide

• **Presentations**
  – Tizen Developer Conference 2012~2014
    • 54% of speeches are about App developments, IDE, and Introductions
    • 35% of speeches are about usage of frameworks (functional features)
    • only 11% of speeches on the development features of kernel and system

• **Few documents on Tizen Internals**

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Training Course Outline

To develop Tizen platform development skills
• Porting Tizen platform into Odroid-U3
• Tizen Platform Architecture
• Tizen Internals
• Team Projects – add useful features on Tizen platform
• Experience on open source developments

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# Training Course Outline

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction on Tizen</td>
<td>8</td>
<td>Graphics &amp; UI F/W (EFL, X)</td>
</tr>
<tr>
<td>2</td>
<td>Tizen SDK and App Development</td>
<td>9</td>
<td>Multimedia F/W (Gstreamer)</td>
</tr>
<tr>
<td>3</td>
<td>Tizen Kernel &amp; Booting Platform Dev. Environment - Git, Gerrit, GBS</td>
<td>10</td>
<td>Web F/W (Webkit, WRT, Device API)</td>
</tr>
<tr>
<td>4</td>
<td>Building Platform &amp; Kernel</td>
<td>11</td>
<td>Future of Tizen - Tizen 3.0, wayland, crosswalk/blink</td>
</tr>
<tr>
<td>5</td>
<td>Porting Tizen into Odroid-U3 Project Example</td>
<td>12</td>
<td>Invited Talk – Understanding Open Source</td>
</tr>
<tr>
<td>6</td>
<td>Project Proposal</td>
<td>13</td>
<td>Project Demo</td>
</tr>
<tr>
<td>7</td>
<td>Base, App &amp; System F/W</td>
<td>14</td>
<td>Final Exam</td>
</tr>
</tbody>
</table>

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Tizen Overall Architecture

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Sample Project – Tizen Remote Key

- Odroid-U3 has no button for home, back, menu
  - Tizen Virtual Key Device Driver
    - [https://github.com/wangmir/virtual_inputdevice](https://github.com/wangmir/virtual_inputdevice)
  - Tizen Remote Key Server Service
    - [https://github.com/RedCarrottt/remote-key-framework-service](https://github.com/RedCarrottt/remote-key-framework-service)
  - Android Client Application
    - [https://github.com/RedCarrottt/remote-key-framework-client](https://github.com/RedCarrottt/remote-key-framework-client)

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Project Proposal 1 – App Prefetch

- Prefetch application data for fast application launch
  - Profiling system calls in VFS
  - Register profile results at App Info. DB
  - AUL daemon prefetch data
  - Need to understand Application framework
Project Proposal 2 – Remote Sensor FW

- **Remote sensor virtualization**
  - Virtualize remote sensor as internal sensor
  - Abstract the connection of remote sensor
    - Modify the sensor framework of Tizen
    - Middle layer between sensor plugin and sensor server
  - **Need to understand Sensor framework**

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Project Proposal 3 – Chameleion Display

- Change the display color according to the weather condition
  - Get temperature and humidity information from Oduino device
    - Develop sensor plug-in for Oduino humidity and temperature sensor
  - Adjust display color
  - Need to understand on UI & graphics framework
Project Proposal 4 – Battery Usage Info.

• **Tizen has no service on Per-App battery usage info.**
  – Profile runtime, CPU time and I/O time (storage, network)
  – Service daemon collects power consumption info. from system-server, devman (device manager), and power manager
  – **Need to understand the interface between platform and kernel**

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KOREA LINUX
FORUM 2014
Project Proposal 5 – Gem+Tizen

• Gemdroid
  – GEM5: Cycle accurate core simulator
  – Capture instruction-level trace from QEMU and replay with GEM5
  – Can be used to conduct various studies: core, memory, individual IPs, system-level performance/power

• GemTizen: Tizen QEMU emulator and GEM5
  – Evaluate the CPU and memory behavior of Tizen
  – Compare HTML5-based Web App vs. C++-based native App
  – Need to understand Tizen emulator architecture
We are waiting for final demos
Future Plan

• We will open the Tizen porting code to the public
• Tizen 3.0
  – Full open-development (anyone can contribute to Tizen platform)
  – Students are able to contribute to the Tizen platform via this course.
  – Need Tizen 3.0 porting to Odroid-U3
Special Thanks To

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Gyeonghwan Hong
Daejong Kim
Minji Kim
Eunsoo Park

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