New solutions for Bluetooth support on Android platform
BlueZ
Android 4.1 and before

Bluedroid
Android 4.2 and later
Data collected during a 7-day period ending on February 4, 2014.
Android 4.2 introduces Bluetooth HAL

Source: https://source.android.com/devices/bluetooth.html

- packages/apps/Bluetooth 50,000 SLOC (Java and C++)
- external/bluetooth/bluedroid 286,000 SLOC (C and C++)
Bluedroid architecture from Broadcom’s point of view
Bluedroid requires forking of its source

- Build time configuration for the stack itself, the enabled profiles and also silicon features
- AOSP provides only silicon integration for Nexus 4, Nexus 5 and Nexus 7 devices (Broadcom and Qualcomm)
- Requires shim kernel drivers for silicon integration
- Bus power management done in userspace
- Large new code base (over 286,000 lines of code)
- GIT history starts in December 2012 (only 140 commits)
- No documentation or unit tests are provided
- Extensive audio latency overhead
- Context switches for every HCI packet, audio frame, network packet, HID report and RFCOMM stream
- Limited debugging capabilities
- Missing IA optimization
- Unclear status of 64-bit support
- Only commercial AirForceBT is Bluetooth SIG certified
- Bluetooth 4.1 support is left to the OEM
Current Android Bluetooth world

### AOSP
- **Apps**
- **Bluetooth Service**
- **Bluetooth HAL**
- **Bluedroid**
  - bt-vnd-qcom
  - bt-vnd-bcrm
  - SMD
  - UART

### AirForceBT
- **Apps**
- **Bluetooth Service**
- **Bluetooth HAL**
- **Bluedroid** (Broadcom proprietary)
- **SMD**
- **UART**
Bluedroid with HCI User Channel

BlueZ for Android
Bluedroid with HCI User Channel

Bluetooth Subsystem

- USB
- SDIO
- UART
- PCMCIA
- Vendor
- Virtual

Bluedroid

Android Bluetooth Service

Bluetooth HAL

Same process context

bt-vnd-linux

HCI User Channel

H:4 Packets

Monitor

btmon

Runtime tracing

hcoutool

Runtime debugging

HCI

Direct Access

Monitor Protocol

hci tool

Runtime debugging
Easy Bluetooth hardware integration

AOSP

Apps

Bluetooth Service

Bluetooth HAL

Bluedroid

bt-vnd-qcom

bt-vnd-bcrm

SMD

UART

AOSP with HCI User Channel

Apps

Bluetooth Service

Bluetooth HAL

Bluedroid

bt-vnd-linux

Bluetooth Subsystem

AirForceBT

Apps

Bluetooth Service

Bluetooth HAL

Bluedroid

AirForceBT

(Broadcom proprietary)

UART
HCI User Channel benefits Bluedroid

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Bluedroid architecture

Bluetooth service

Bluedroid (transport, protocols, profiles, audio encoder)

Bluetooth HAL

Audio service

Audio HAL

Bluedroid (raw audio)

bt-vendor

UART

TUN/TAP

uinput

uHID

AF_UNIX

Bluetooth Silicon

Ethernet Packets

HCI Packets

Input Events

HID Reports

RFCOMM Stream

PCM Frames

Kernel
Bluedroid details

Monolithic architecture without kernel support

- Provides `bluetooth.default.so` and `audio.a2dp.default.so`
- Loaded into process context of Bluetooth Service (JNI)
- Loaded into process context of Audio Service (JNI)
- Expensive communication via Unix Sockets
- Copy of PCM audio frames
- SBC audio encoding is only ARM optimized
- No AES optimization / `HCI_LE_Rand` for random numbers
- Copy of Ethernet frames for Tethering
- Copy of HID reports through userspace
- Multiple context switches for every single packet
BlueZ for Android

Replace Bluedroid with BlueZ
• Provide drop-in replacement for Bluedroid
• Similar to what Broadcom does with AirForceBT
• Substitute D-Bus APIs for Android HAL integration

Provide real value add
• Bluetooth 4.1 support
• Full documentation
• Unit tests and end-to-end tests for the whole stack
• PICS, PIXIT and PTS for Bluetooth SIG qualification
• Low-latency and low-power audio support
• 64-bit support
• IA optimized
• Superior architecture
BlueZ for Android details

Modular architecture with kernel subsystem

- Provides profiles via `bluetooth.default.so`
- Provides audio integration via `audio.a2dp.default.so`
- Provides core protocols as kernel subsystem
- Provides additional protocols via userspace daemon
- Bluetooth daemon is started on demand
- All HCI processing is done inside the kernel
- Native L2CAP and RFCOMM sockets
- BNEP Ethernet frames handled inside the kernel
- AES-NI and RDRAND integration
- IA optimized SBC audio codec (libsbrc)
More open source choices

AOSP

Apps

Bluetooth Service

Bluetooth HAL

Bluedroid

bt-vnd-qcom

bt-vnd-bcrm

SMD

UART

AOSP with HCI User Channel

Apps

Bluetooth Service

Bluetooth HAL

Bluedroid

bt-vnd-linux

Bluetooth Subsystem

BlueZ for Android

Apps

Bluetooth Service

Bluetooth HAL

Bluedroid

BlueZ

(open source)

Bluetooth Subsystem
BlueZ for Android to the rescue

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BlueZ for Android status

Available Android features

- Generic Access Profile (GAP)
- Generic Attribute Profile (GATT)
- Device ID Profile (DID 1.3)
- Headset Profile (HSP 1.2)
- Handsfree Profile (HFP 1.5)
- Audio/Video Control Profile (AVRCP 1.3)
- Advanced Audio Distribution Profile (A2DP 1.2)
- Phonebook Access Profile (PBAP 1.1)
- Message Access Profile (MAP 1.1)
- Object Push Profile (OPP 1.0)
- Human Input Devices (HID 1.1)
- Personal Area Networking (PAN 1.0)

Work in progress

- Health Device Profile (HDP)
BlueZ for Android value add

BlueZ only features

- Dual-mode topology (Bluetooth 4.1)
- BR/EDR Secure Connections (Bluetooth 4.1)
- L2CAP LE Connection Oriented Channels (Bluetooth 4.1)
- IPv6 over LE – 6loWPAN (Internet of Things)
- LE Privacy mode (Tracking protection)
- HFP version 1.6 with Wideband Speech
- AVRCP version 1.5
- A2DP version 1.3
- AAC codec support
- aptX codec support
- SCO over HCI support
- Remote HCI tracing over ADB (including Wireshark)
BlueZ for Android availability

Developed as open source project
- Part of bluez.git upstream source repository
- See android/README to get started
- Qualification instructions at android/{pics,pixit,pts}-*.txt
- Testing overview at doc/test-coverage.txt

Development team credits

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<tr>
<th>Name</th>
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<tr>
<td>Szymon Janc</td>
<td>535</td>
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</tr>
<tr>
<td>Luiz Augusto von Dentz</td>
<td>291</td>
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<td>Jakub Tyszkowski</td>
<td>213</td>
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<td>Andrei Emeltchenko</td>
<td>210</td>
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<tr>
<td>Grzegorz Kolodziejczyk</td>
<td>134</td>
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<tr>
<td>Ravi Kumar Veeramally</td>
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<tr>
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<td>102</td>
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<tr>
<td>Lukasz Rymanowski</td>
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<tr>
<td>Marcin Kraglak</td>
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<td>Sebastian Chlad</td>
<td>64</td>
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<tr>
<td>Jerzy Kasenberg</td>
<td>55</td>
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<tr>
<td>Marcel Holtmann</td>
<td>51</td>
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<tr>
<td>Johan Hedberg</td>
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<tr>
<td>Anderson Lizardo</td>
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<td>Claudio Takahasi</td>
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<tr>
<td>Frederic Danis</td>
<td>4</td>
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New BlueZ world view

Fedora, Ubuntu etc.  Genivi  Jolla  Tizen  ChromeOS  Android

User interfaces

BlueZ

Shared Bluetooth Protocols and Profiles

BlueZ for Android

Bluetooth Subsystem

Bluetooth Driver

Bluetooth Silicon