Bluetooth 4.2
New Features for Linux and IoT

Johan Hedberg & Marcel Holtmann
Intel Open Source Technology Center

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WITH BLUETOOTH® 4.2

THE SKY’S

THE LIMIT
Bluetooth 4.2 was brought to life by some of the brightest minds & companies in technology. Their mission: To provide you with the freedom to create anything you can imagine.
Bluetooth 4.0

**Smart Ready**
for dual-mode devices with Bluetooth Classic (BR/EDR) and Bluetooth Low Energy (LE) support

**Smart**
for single mode devices with Bluetooth Low Energy (LE) support
Bluetooth 4.1

**BR/EDR secure connections** with P-256 ECDH and AES encryption

**Dual mode topology** allowing BR/EDR and LE connections at the same time

**Link layer topology** allowing LE Central and LE Peripheral mode at the same time

**Low duty cycle directed advertising** for peripheral connections

**L2CAP LE connection oriented channels** with credit based flow control

Inclusion of CSA 2, CSA 3 and CSA 4
Bluetooth 4.2

LE secure connections with P-256 ECDH
Link layer based privacy with controller based address resolution
Extended scanner filter policies for directed advertising with random address
Data length extension with 2.5x speed increase

Internet Protocol Support Profile (IPSP) adoption
SMARTER & WORRY FREE
It’s the best of all worlds – improved privacy protection with lower power consumption.

**Industry-leading privacy.** Keeps Bluetooth Smart devices from being tracked.

**Highly secure.** Features industry-standard encryption ensuring confidential data stays that way.

**More power efficient.** Introduces refinements that make Bluetooth Smart even more power-stingy.
Secure connections feature

<table>
<thead>
<tr>
<th>Bluetooth Version</th>
<th>P-192 ECDH E0 Encryption</th>
<th>P-256 ECDH AES Encryption</th>
<th>Legacy Pairing AES Encryption</th>
<th>P-256 ECDH AES Encryption</th>
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<tbody>
<tr>
<td>Bluetooth 4.2</td>
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<tr>
<td>Bluetooth 4.1</td>
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<tr>
<td>Bluetooth 4.0</td>
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</table>
## Secure connections integration

<table>
<thead>
<tr>
<th>Host</th>
<th>Controller</th>
<th>BR/EDR simple pairing</th>
<th>BR/EDR + LE</th>
<th>BR/EDR + LE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LE secure connections</td>
<td>Secure connections</td>
<td>Secure connections</td>
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<tr>
<td></td>
<td></td>
<td>Cross transport pairing</td>
<td>Cross transport pairing</td>
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<td>P-256 ECDH</td>
<td>P-256 ECDH</td>
<td>P-256 ECDH</td>
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<td>BR/EDR</td>
<td>BR/EDR</td>
<td>BR/EDR</td>
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<td>LE</td>
<td>LE</td>
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<td>P-192 ECDH</td>
<td>P-256 ECDH</td>
<td>P-192 ECDH</td>
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<td></td>
<td></td>
<td>E0</td>
<td>E0 + AES</td>
<td>E0 + AES</td>
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<td></td>
<td></td>
<td>AES</td>
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</tbody>
</table>

- **Bluetooth 4.0**
- **Bluetooth 4.1**
- **Bluetooth 4.2**
Linux and secure connections

Linux 3.15  
BR/EDR secure connections support  
BR/EDR out-of-band pairing support

Linux 3.17  
BR/EDR debug key generation support

Linux 3.19  
LE secure connections support  
LE debug key generation support  
Cross-transport pairing support

Linux 4.1*  
LE out-of-band pairing support

* Not yet released
## Linux and low energy privacy support

<table>
<thead>
<tr>
<th>Version</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux 3.15</td>
<td>LE privacy support</td>
</tr>
<tr>
<td>Linux 3.19*</td>
<td>Extended scanner filter policies support</td>
</tr>
<tr>
<td>TBD*</td>
<td>Link layer based privacy support</td>
</tr>
</tbody>
</table>

* Requires Bluetooth 4.2 controller
FASTER & MORE RELIABLE
Sync data quickly and reliably. In 4.2, Bluetooth Smart is up to 2.5x faster with a huge packet capacity increase – nearly 10x more versus previous versions.
Linux and faster low energy data transfers

Linux 3.19*  Data length extension support

* Requires Bluetooth 4.2 controller
TAKE FULL CONTROL OF INTERNET CONNECTIVITY
Bluetooth® Core Specification 4.2 makes the Internet of Things (IoT) better with multiple ways to connect to the Internet:

**Low-power IP connectivity**

The latest version of internet protocol (IPv6/6LoWPAN) for Bluetooth Smart devices.

**Bluetooth Smart technology gateways**

Internet connectivity with the flexible Bluetooth Smart Generic Attribute Profiles (GATT) architecture.*

*Available early 2015

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Number of “things” connected to the Internet by 2020 (estimated)

**28 billion**

SOURCE: hbr.org
## Linux and Internet of Things

<table>
<thead>
<tr>
<th>Version</th>
<th>Feature</th>
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<tbody>
<tr>
<td>Linux 3.14</td>
<td>L2CAP LE connection oriented channels support</td>
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<tr>
<td>Linux 3.16</td>
<td>6LoWPAN over Bluetooth LE support</td>
</tr>
<tr>
<td>TBD</td>
<td>Internet Protocol Support Profile (IPSP) support</td>
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<tr>
<td></td>
<td>HTTP Proxy Service (HPS) support</td>
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<td>GAP + GATT REST API support</td>
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</tbody>
</table>
6LoWPAN and Linux

Introduced with IEEE 802.15.4 subsystem (2009)

Bluetooth subsystem adopts IP Header and Next Header compression (2013)
6LoWPAN fragmentation is handled by Bluetooth L2CAP layer

IP Header and Next Header compression have been moved into its own net/6lowpan/ directory and are now independent modules

New mailing list at linux-wpan@vger.kernel.org
6LoWPAN integration

- **HTTP**
- **RTP**
- **TCP**
- **UDP**
- **ICMP**
- **IPv6**
- **Ethernet MAC**
- **Ethernet PHY**

**Layer 2**

- **IPv6 + 6LoWPAN**
- **802.15.4 MAC**
- **802.15.4 PHY**

**Layer 3**

- **UDP**
- **ICMP**

**Layer 4**

- **HTTP**
- **RTP**
- **TCP**
- **UDP**
- **ICMP**

**Layer 5**

- **Application**
- **UDP**
- **ICMP**

**Layer 6**

- **IPv6 + 6LoWPAN**
- **802.15.4 MAC**
- **802.15.4 PHY**

**Layer 7**

- **Application**
- **UDP**
- **ICMP**

**Layer 8**

- **IPv6 + 6LoWPAN**
- **L2CAP**
- **Bluetooth Link Layer**
- **Bluetooth Physical Layer**
Setup of Bluetooth 6LoWPAN connections

On the slave side (peripheral) do this:

$ modprobe bluetooth_6lowpan
$ echo 35 > /sys/kernel/debug/bluetooth/6lowpan_psm
$ btmgmt advertising on

On the master side (central) do this:

$ modprobe bluetooth_6lowpan
$ echo 35 > /sys/kernel/debug/bluetooth/6lowpan_psm
$ echo 'connect E0:06:E6:B7:2A:73 1' > /sys/kernel/debug/bluetooth/6lowpan_control

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Bluetooth 4.1 host stack
*Linux 3.16 and later*

Bluetooth 4.0 controller
BlueZ for Android and Bluetooth 4.2

Bluetooth 4.1 and 4.2 features are integrated with BlueZ for Android on KitKat and Lollipop

01.org/bluez-android
code.google.com/p/aosp-bluez
Bluetooth 4.2

Smarter. Faster. Ideal for the Internet of Things.
Bluetooth future

Bluetooth® Technology Adding Mesh Networking to Spur New Wave of Innovation

*Bluetooth SIG sets course to revolutionize smart home, automation, and the IoT with Bluetooth Smart Mesh*

“The value proposition for Bluetooth technology in the Internet of Things (IoT) is unmatched – it consumes the least amount of power, is the lowest cost, and most widely available wireless solution enabling the IoT today,” added Powell. “Bringing mesh networking to the Bluetooth specification will propel the technology to entirely new market segments.”

The Smart Mesh Working Group expects to have the specification ready for prototype testing later this year, and the SIG will look to officially adopt profiles in 2016.
Q & A