What’s the Buzz Around Zigbee
Agenda

- Zigbee high level overview
- Zigbee 3.0
- TI’s Zigbee products
- TI’s Multiprotocol solution: DMM
- TI Launchpad and SimpleLink SDK Ecosystem
What is Zigbee?
High level overview

Zigbee is a low power, wireless, **mesh** networking solution that allows smart objects to work together.

- **Highly interoperable**, products undergo ZCP (Zigbee Compliant Platform) testing
- **Standardized application layer via Zigbee cluster library**
- **Self-organizing** and **self-healing** dynamic mesh networking
- Intended to support low data rate, green power applications
- Enables **over 250 devices** and provides **whole house coverage**
What is Zigbee?
Architecture and technical details

Zigbee Devices
- Zigbee-PRO APS
- Zigbee-PRO NWK
- IEEE 802.15.4 MAC
- IEEE 802.15.4 PHY

Manufacturers Application
- Zigbee Devices
- Zigbee-PRO APS
- Zigbee-PRO NWK
- IEEE 802.15.4 MAC
- IEEE 802.15.4 PHY

*Zigbee Green Power Proxy Basic is required for all routing devices

Zigbee 3.0 Base Device & Clusters
- Zigbee Coordinator
  - Starts the network
  - Routes the packets
  - Manages security
  - Associates routers and end devices
  - Example: Smart hub, Heating Central
- Zigbee Router
  - Routes packets
  - Associates routers and end devices
  - Example: Light
- Zigbee End Device
  - Battery powered
  - Typically asleep
  - Does not route packets
  - Example: Light Switch

Zigbee Software Architecture

Zigbee Mesh Network Topology
Zigbee Network Design
Electronic Door Lock and Light Bulb Example Application

Router
- **Power**: Typically AC powered
- **Range**: Specific to application, AC powered routers more likely to have Power Amplifier
- **Memory**: Needs a reasonable amount of flash for containing routing information of neighbors.
- **Application**: Range extender, light bulbs, any nodes that are AC powered.

End Device
- **Power**: Battery powered
- **Range**: Varies, with nearby coordinators range can be short. When no router is nearby, Power Amplifier can be used to span longer ranges.
- **Memory**: Does not need abundance of flash, RAM can be application specific
- **Application**: Sleepy sensor nodes, devices that run on batteries.

Coordinator
- **Power**: AC powered
- **Range**: Centralized node, generally with Power Amplifier to cover an entire home
- **Memory**: Flash and RAM appropriate for size of network
- **Application**: Gateway or smart hub.
Why use Zigbee?

<table>
<thead>
<tr>
<th>Benefits</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>✔</td>
<td>Interoperable</td>
</tr>
<tr>
<td></td>
<td>Secure</td>
</tr>
<tr>
<td></td>
<td>Years of operation on single coin cell battery</td>
</tr>
<tr>
<td></td>
<td>Robust</td>
</tr>
<tr>
<td></td>
<td>Complete Protocol stack</td>
</tr>
<tr>
<td></td>
<td>Scalable</td>
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<tr>
<td></td>
<td>Full-house coverage</td>
</tr>
<tr>
<td></td>
<td>Half a billion devices sold worldwide</td>
</tr>
</tbody>
</table>
**Zigbee 3.0: The Latest Standard**

**Unification of application segments**
- Single certification mark
- Backward compatibility with legacy Home Automation, Green Power, Lighting, Retail and Building Automation profiles

**Simplified device on-boarding**
- Commissioning
- Service discovery
- Security policy harmonization across legacy profiles

**Enhanced security**
- Install Codes eliminate the use of well-known keys via out-of-band scheme
- Well-defined security procedures to request and change keys

**Unified approach for interoperability**
- Unified testing tool-set distributed by the ZigBee Alliance
- Certified testing lab

**Green Power**
- Designed to work with energy harvesting and ultra-low power products
- All routing devices required to implement Green Power proxy assuring green power support
Zigbee 3.0 – Green Power
Try TI’s Zigbee Green Power Examples for Battery-less Devices

- Zigbee Green Power allows battery-less Zigbee products such as sensors, switches and more to securely join a network.
- How it works:
  - Energy for communication can be captured by often wasted energy from switches, dimmers, and more.
  - Green Power Devices implement secure Green Power commands using a minimalistic stack footprint.
  - The “Sink” commissions devices and executes Green Power commands.
  - The “Proxy” forwards Green Power Commands.
- Compatible with any Zigbee 3.0 certified device network.
Zigbee with TI – Did You Know?

**Experience**
- Texas Instruments has delivered more than 40 compliant platform stack versions and 60 certified products over the past 8 years.

**Commitment**
- Texas Instruments has been a promoter member of the Zigbee Alliance for more than 10 years.

**Industry Leading Platforms**
- Millions of units shipped, including the new SimpleLink ultra-low power family of wireless SoCs.
# Texas Instruments Zigbee 3.0 Solutions

<table>
<thead>
<tr>
<th></th>
<th>CC2530</th>
<th>New! CC2652R</th>
<th>New! CC1352P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Industry Proven, Cost Effective Zigbee Solution</td>
<td>Ultra-low power 2.4GHz SimpleLink Multi-Standard Wireless MCU for Zigbee, Thread, Bluetooth and more</td>
<td>World’s lowest power Wireless MCU with integrated PA, 2.4 and Sub-1GHz Multi-Band operation</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td>High Performance, Low-Power 8051</td>
<td>ARM® Cortex M4F</td>
<td>ARM® Cortex M4F</td>
</tr>
<tr>
<td><strong>Max TX Output Power</strong></td>
<td>+4.5dBm</td>
<td>+5dBm</td>
<td>+20dBm</td>
</tr>
<tr>
<td><strong>RX Sensitivity</strong></td>
<td>-97dBm</td>
<td>-100dBm</td>
<td>-101dBm</td>
</tr>
<tr>
<td><strong>2.4GHz TX Current Consumption (0dBm)</strong></td>
<td>28.7mA (+1dBm)</td>
<td>7.5mA</td>
<td>6.3mA, 79mA @ 20dBm</td>
</tr>
<tr>
<td><strong>RX Current Consumption</strong></td>
<td>24mA</td>
<td>6.9mA</td>
<td>6.9mA</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>256kB Flash, 8kB RAM</td>
<td>352kB Flash, 256kB ROM, 80kB RAM</td>
<td>352kB Flash, 256kB ROM, 80kB RAM</td>
</tr>
<tr>
<td><strong>SimpleLink MCU Platform Compliant</strong></td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Zigbee Certification</strong></td>
<td>Zigbee 3.0/Zigbee PRO 2015 (R21)</td>
<td>Zigbee 3.0 Compliant Stack with SDK available today. Certification available upon RTM: April 2019</td>
<td></td>
</tr>
</tbody>
</table>

**Featured CC2592 Range Extender for CC2530:**
- Seamless Interface to TI’s 2.4-GHz Low-Power RF Devices
- +22-dBm Output Power
- Low-Transmit Current Consumption: 155 mA at 3 V for +22 dBm
# CC1352P

## Industry’s lowest power PA

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio TX, high power PA, 868/915 MHz 20-dBm output power</td>
<td></td>
<td>60</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Radio TX, high power PA, 2.4 GHz 20-dBm output power</td>
<td></td>
<td>78</td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>F = 868 MHz, CW, 20 dBm match, PAVDD connected directly to external 3.3V supply</td>
<td></td>
<td>79.7</td>
<td>106.7</td>
<td>mA</td>
</tr>
<tr>
<td>F = 2.4 GHz, CW, 19.5 dBm output power, PAVDD connected directly to external 3.3V supply</td>
<td></td>
<td>131</td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>

## Competitor (integrated)

## Dedicated PA

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power = +20 dBm, high-efficiency 2.4 GHz</td>
<td></td>
<td>90</td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>
SimpleLink Zigbee
Excellent Standby current over temperature

Standby current consumption, VDD=3.3V, 32kHz RCOSC
CC1352/CC2652: 80k RAM
Competitor: 32k RAM
SimpleLink Sensor controller

The Sensor Controller is an Ultra-low power, 16-bit CPU core that runs independently of the rest of the system (Arm Cortex-M4F and RF core)

- Can read and process sensor data while the rest of the system sleeps
- Is user-programmable and executes code from a dedicated 4KB of RAM
- Has access to analog and digital peripherals
- Can read / write values to dedicated memory (4KB SRAM) and notify the main MCU to read the data on wake-up
- Can perform advanced tasks like capacitive touch and inductive sensing

Power numbers for various applications:
- 1-Hz ADC sampling: 1 uA
- SPI (20 reads / second): 1.4 uA
- 100-Hz comparator reading: 1.5 uA
- Inductive sensing for flow meter (16-Hz): 1.7uA
- Capacitive touch (two buttons @33-Hz): 9uA
Zigbee + BLE: 1 chip, Multi-protocol Solution
Introducing the DMM: The Dynamic Multi-protocol Manager

- Using TI’s multi-protocol solution, the DMM can allow Zigbee and BLE to run **concurrently** on a single chip.
- For example, adding a light switch into a Zigbee home network becomes highly simplified by using a BLE interface.
- With a Zigbee end device, you can add BLE connectivity to your phone. This end device will be in RX most of the time, and BLE will have periodic connection events.
Free SimpleLink Zigbee 3.0 SDK
Numerous examples and projects

Z-Stack 3.2.0 User’s Guide
• Comprehensive user’s guide for customers developing Zigbee Devices

SimpleLink Academy Labs
• Zigbee Fundamentals
• Project Zero: Light and Switch
• Designing a Custom Certifiable Project

Z-Stack Projects
• Home automation examples
  • Light and switch
  • Door lock and controller
  • Thermostat and temperature sensor
• Green Power sink and device examples
  • Light and switch
  • Thermostat and temperature sensor
• OTA cluster server and client examples
• Bare-bones generic application
• Zigbee Network Processor (ZNP)

Example Projects Memory Footprint

<table>
<thead>
<tr>
<th>Project</th>
<th>Flash (kB)</th>
<th>RAM (kB)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZC Generic App</td>
<td>162</td>
<td>34.3</td>
<td>No UI or Zigbee clusters implemented, only commissioning and factory reset functionality</td>
</tr>
<tr>
<td>ZC Light</td>
<td>182</td>
<td>35.1</td>
<td>UART UI, On/Off and Level Control clusters</td>
</tr>
<tr>
<td>ZED Switch</td>
<td>140</td>
<td>33.5</td>
<td>UART UI, On/Off cluster</td>
</tr>
<tr>
<td>ZC Light Sink</td>
<td>187</td>
<td>35.3</td>
<td>GP light sink for GP source switch device</td>
</tr>
<tr>
<td>GPD Switch</td>
<td>62.7</td>
<td>30.1</td>
<td>TIMAC implementation, does not include full Z-Stack</td>
</tr>
<tr>
<td>ZC OTA Server</td>
<td>169</td>
<td>36.0</td>
<td>UART control and OTA cluster</td>
</tr>
<tr>
<td>ZED OTA Switch</td>
<td>202</td>
<td>36.5</td>
<td>OTA cluster, BIM, download and application memory segments</td>
</tr>
</tbody>
</table>

*Total 352 kB Flash and 80 kB RAM per device
The TI RF Development Toolkit

- **E2E Community**
  - Comprehensive Support
- **Range Calculators**
- **Sensor Controller Studio**
- **TI Resource explorer**
- **SmartRF Studio**
- **SimpleLink Academy**
Start Development Today!
Scalable Development with the TI LaunchPad Ecosystem

Step 1: Purchase a LaunchPad Development Kit

Step 2: Download the TI SimpleLink SDK

Step 3: Reference our documentation on TI resource explorer