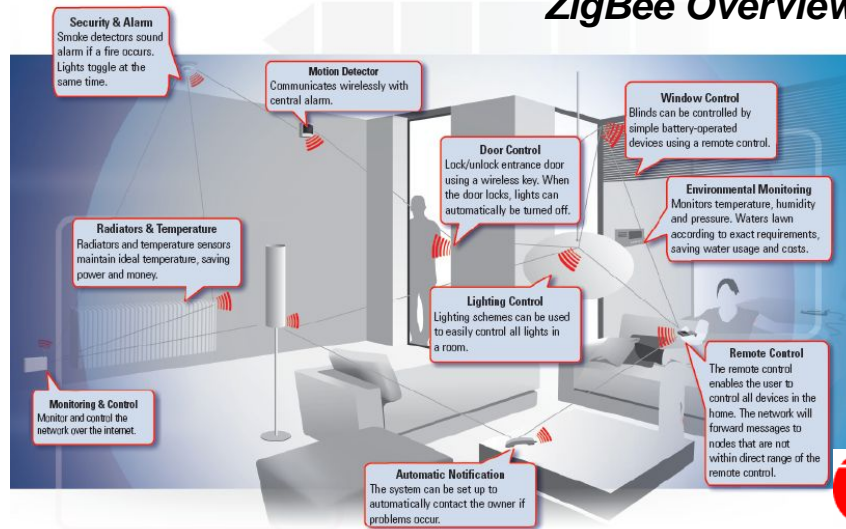




TI Low Power Wireless

ZigBee Overview





Overview

ZigBee overview

Hardware

Topology and routing

Certification

Requirements



Today we will cover the design process and the considerations you need to make during development.

First topic will be to get the right hardware for your product

After that we will talk about topologies in ZigBee and their pros and cons.

Then we will address the need to standardized products when we talk about stack and application profiles.

After that we will talk about how to define your own profile based on your application requirements

By the end of the presentation we will talk about the need for certification and finally we will see what training we provide to get you started.



ZigBee Alliance

“The ZigBee Alliance is an association of companies working together to enable reliable, cost-effective, low-power, wirelessly networked monitoring and control products based on an open global standard”

Source: ZigBee Alliance homepage

Promoters of the ZigBee alliance are:

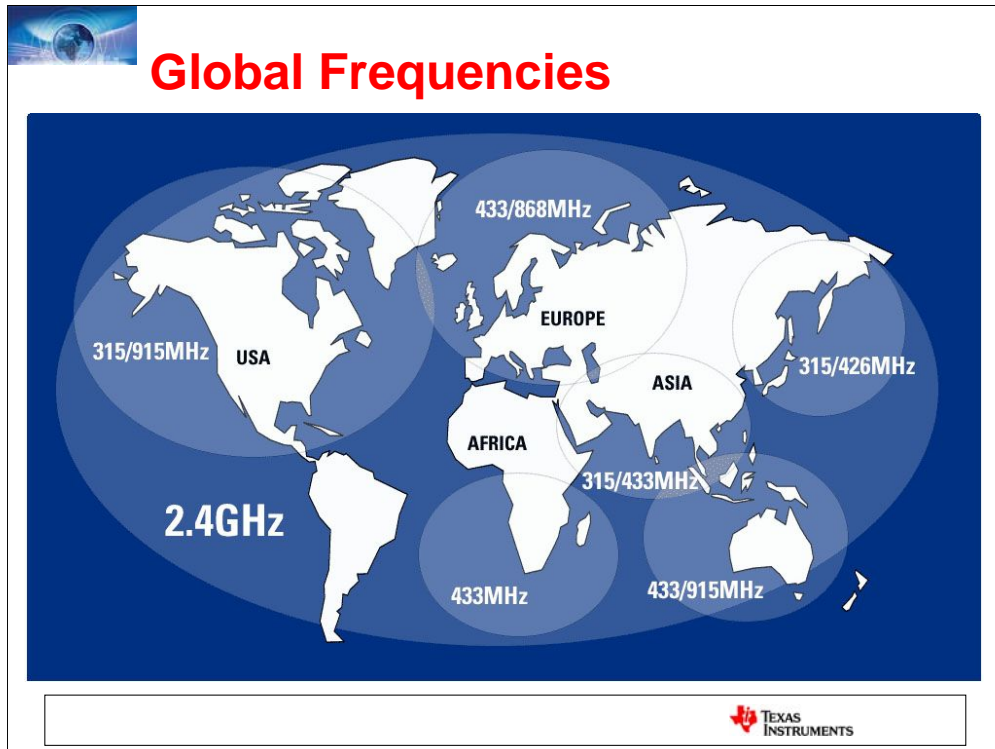


In order to understand what ZigBee is we need to understand the focus on the ZigBee Alliance.

The Alliance wanted to create a reliability, low cost, low power, open global standard for low data rate wireless solutions.

TI, through the acquisition of Chipcon is now one of the promoters of the ZigBee Alliance. Many of the other Promoters are well known within their markets, e.g. Honeywell, Mitsubishi Electric and Philips.

In addition to the promoters the alliance has over 200 members and is continuously growing.



2.4 GHz – (virtually) world-wide frequency band

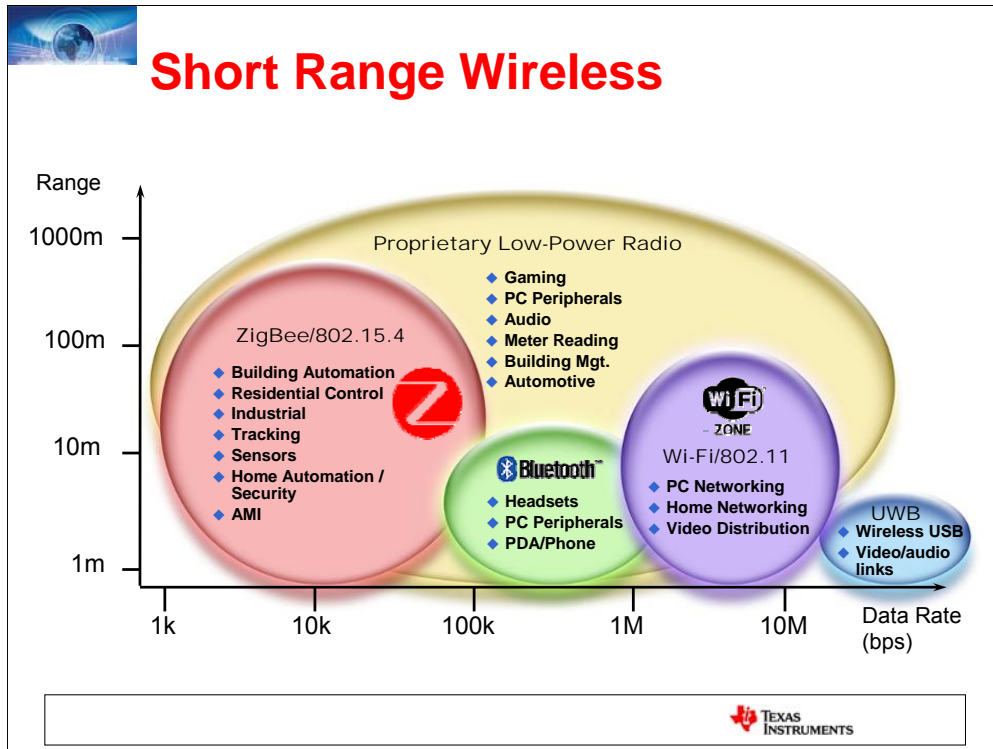
Sub-1 GHz bands are different in different parts of the world

US, Canada use FCC rules

EU 433/868 is (mostly) harmonized throughout Europe

426 MHz ARIB in Japan – very strict narrowband requirements, similar regulations in Korea

Rest of world has available frequency bands on a country-by-country basis

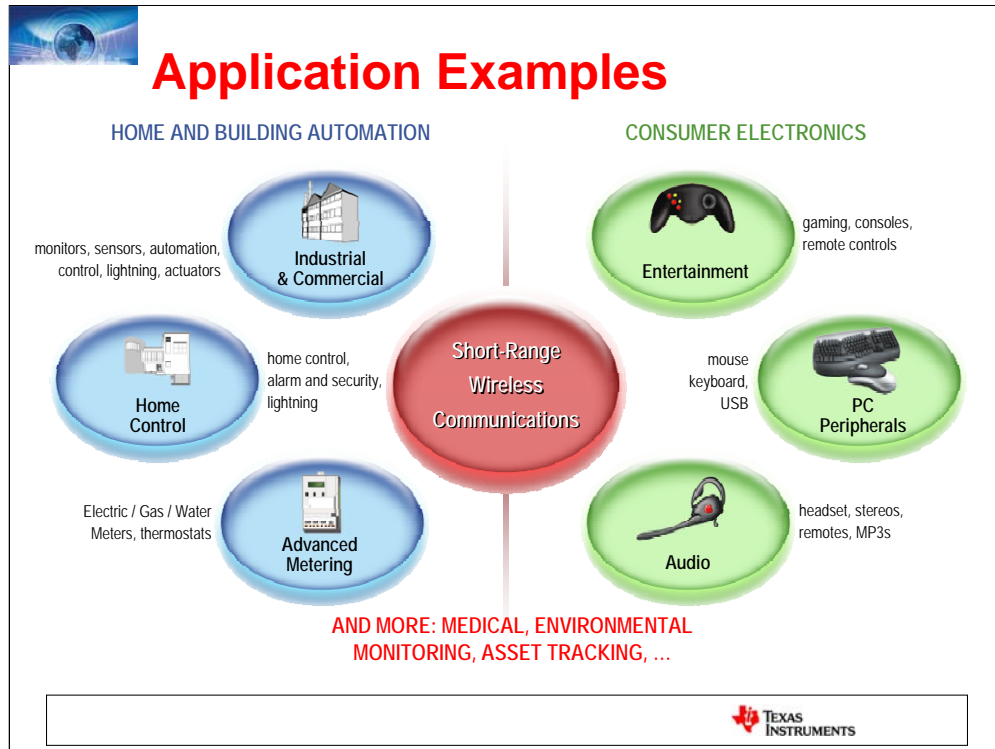


TI has solutions for many wireless standards but within the low power wireless group the focus is on

Low power (devices are often battery powered)

Short range (often below 100 m)

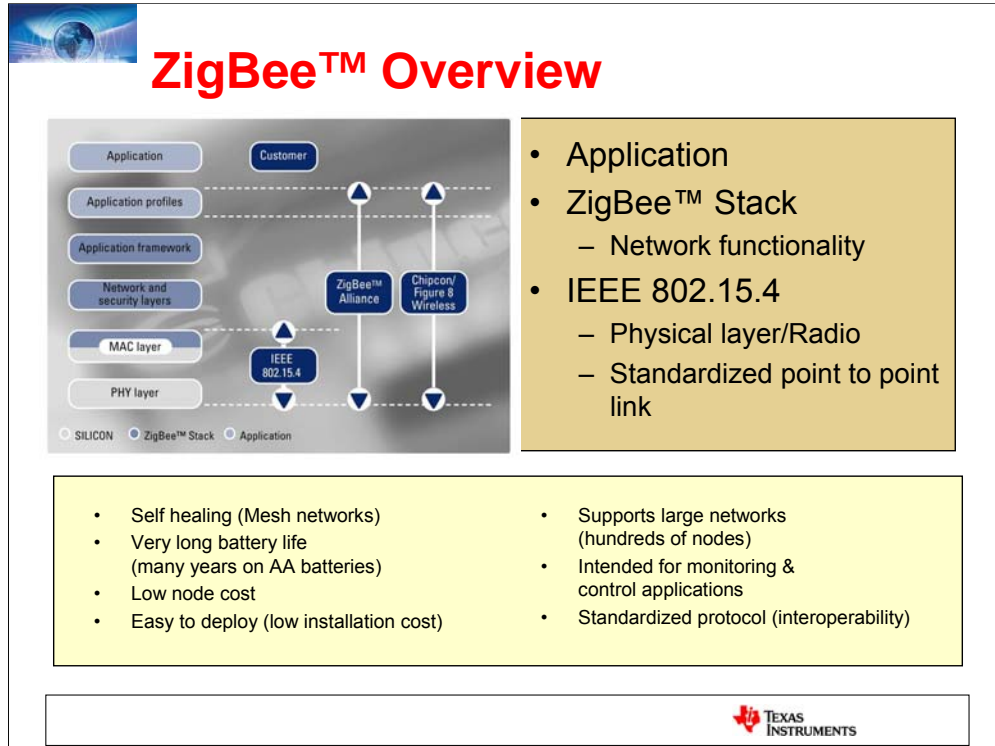
Low data rate (From a few kbps up to 1 Mbps)



Since ZigBee is used in both for industrial and consumer applications we can divide the most applications into two groups.

Typical industrial applications are within the home and building automation sector and includes alarm systems, lighting and automatic meter reading.

For consumer applications audio applications, gamepads and PC peripherals are common.



The ZigBee stack is divided into many layers.

The lower layers of ZigBee are defined by the IEEE standard 802.15.4. On top of that the ZigBee alliance has defined the network layer, application framework, security functionality etc

On top of the stack you have application Profiles.



ZigBee Alliance Roadmap

- IEEE 802.15.4-2003 defines PHY/MAC
- ZigBee-2006
 - Product shipping today
- ZigBee-2007
 - Two stack profiles: ZigBee and ZigBee PRO
 - 3 golden units have passed certification
- Profiles
 - Home Automation (HA)
 - Profile released and tested
 - Advanced Metering Infrastructure (AMI)
 - Profile released. Testing to complete in by Q2 '08
 - Commercial Building Automation (CBA)
 - Under development. To be finalized by end '08.



ZigBee Specification

	ZigBee 2004	ZigBee 2006	ZigBee 2007
Stack profiles	•Home Controls	•ZigBee	•ZigBee •ZigBee PRO
App profiles	•Home Controls Lighting	•Home Automation •Manufacture Specific Profile	•Home Automation (HA) •Commercial Building Automation (CBA) •Advanced Metering (AMI)
Z-Stack	≤ 1.3.X	1.4.X+	2.X.X+
Available	2005	2006	March 2008



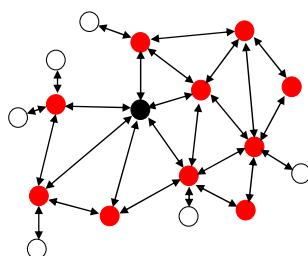
This slide describes what is included in the different versions of the ZigBee specifications and how they relate to TI's ZigBee stack, Z-Stack.



ZigBee-2006

Benefits to Consider

- Extremely well tested by a variety of companies
- Base of products and networks on market and in use today!
- Many certified stacks and silicon providers available
- Simple = less code & less overhead



- ZigBee Coordinator
- ZigBee Router
- ZigBee End Device





ZigBee-2007: ZigBee and ZigBee PRO

- ZigBee
 - Based on proven 2006 feature set plus frequency agility and optional fragmentation
 - Basic features require less memory
- ZigBee PRO
 - Enhanced features optimize performance and RAM utilization under select scenarios
 - Feature enhancements based on identified limitations of ZigBee-2006 for specific network deployments
- Profiles
 - HA and AMI are defined to work with ZigBee and ZigBee PRO
 - CBA is specified to work for ZigBee PRO
- Interoperability
 - PRO devices will operate as End Devices (EDs) on a ZigBee network, and vice versa

Note: TI has ZigBee and ZigBee PRO Solutions available based on your needs





ZigBee-2007 Feature Set

ZigBee

- Tree Addressing
- AODV Routing
- Backup Tree Routing
- Fragmentation
- Frequency Agility
- Basic Group Addressing
- Security

ZigBee PRO

- Stochastic Addressing
- AODV Routing
- Many to One / Source Routing
- Asymmetric Link Handling
- Fragmentation
- Frequency Agility
- Basic Group Addressing
- Limited Broadcast Addressing
- Security
- High Security



What is “Smart Energy”

- The ZigBee public profile which supports AMI is called “Smart Energy”
 - Specification available on the ZigBee web site
- Smart Energy supports:
 - Metering
 - Multiple commodities including electric, gas, water, and thermal
 - Real-time consumption / production information
 - Historical price information
 - Support for meter-as-gateway and meter-as-device on a ZigBee network
 - Demand Response and Load Control
 - Scheduling of multiple events
 - Built in support for customer override
 - Pricing
 - Public distribution via Inter-PAN
 - Text Messaging
 - Security
 - Elliptic curve support via 3rd party library
 - Preliminary Devices



Overview

ZigBee overview

Hardware




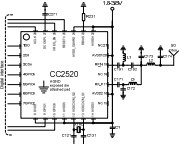
Topology and routing

Certification

Requirements



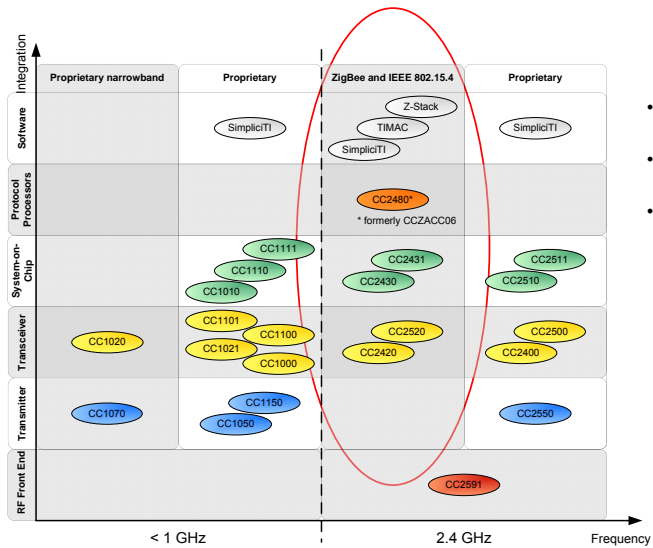
Three paths to ZigBee

	<i>Small footprint High integration Available today</i>	<i>Z-Accel is flexible, easy to use and will reduce time to market</i>	<i>Ultra low power Available today</i>
Application & Profile	CC2430	Any Processor	MSP430
ZigBee stack - Z-Stack		 ZigBee Processor – CC2480	
Radio			CC2520 





Product Portfolio



- CC2480 Q1'08
 - ZigBee Processor
- CC2591 Q2'08
 - Range extender
- SimpliciTI Q4'07
 - For IEEE802.15.4





CC2430 / CC2431

Low-Power IEEE 802.15.4 and ZigBee® SoC

Features . . .

- 32 MHz single-cycle low power MCU
- CC2430 has different flash sizes 32/64/128 KB
- Hardware AES encryption engine
- Industry leading ZigBee® protocol stack
- Excellent selectivity and blocking performance
- CC2431 includes a hardware location engine

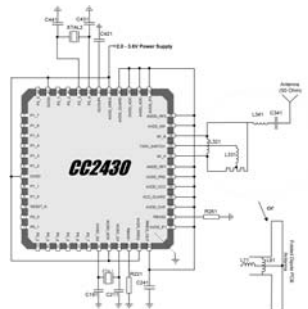
Applications

- Home and building automation
- Industrial monitoring and control
- Sensor networks
- Asset tracking / patient monitoring

CC2430DK
EVM CC2430ZDK
CC2431DK
CC2431ZDK

. . . *Benefits*

- Ideal for battery operated systems
- Suitable for proprietary and ZigBee® systems
- Supports high security systems
- Standardized, robust mesh network
- Excellent co-existence with Bluetooth and WiFi
- Easily add support for locationing awareness
 - Accuracy 3-5 meters





CC2430/CC2431 System on Chip



- Excellent performance
 - Low current consumption, short transition times
 - Selectivity/Co-existence
- Supported by Z-Stack
 - Supported by TI's industry leading ZigBee stack
 - Z-Stack is golden unit as TÜV Rheinland
- Well known core (8051)
 - Supported by well known development environments, e.g. IAR
 - Lots of source code available for this platform
 - Few external components, only one crystal needed
 - Many useful peripherals including USARTs, ADCs, timers etc.
 - IEEE 802.15.4 hardware support including AES128 security engine
- CC2431 - adds location functionality

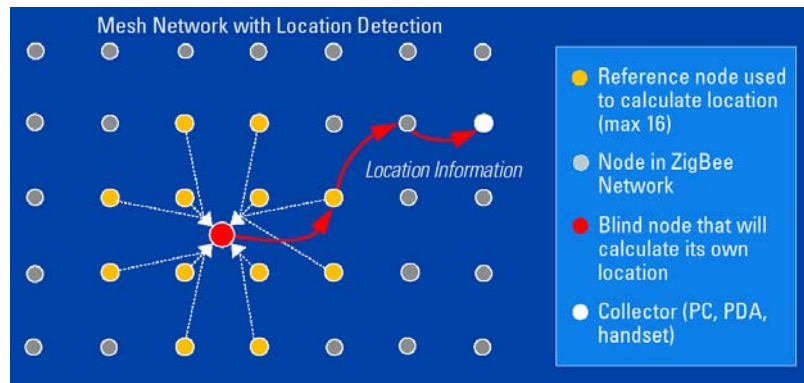


The CC2430 is a System on Chip based on the CC2420 RF Transceiver. If size is a issue in your application the CC2430 is a very good solution. The performance is similar to the two chip solution since the 8051 core is modified but it still fits into the same package size.

The CC2431 has a location engine which enables it to calculate its own position given information from reference nodes within range. It is possible to get an accuracy down to 3 meters in good rf environments. This feature makes a lot of sense for many applications but also for commissioning.



Mesh Network w/ Location



Reference Node (Yellow)

- ◆ CC2430 or CC2431
- ◆ Used for locationing
- ◆ Placed at known static location
 - ◆ One node for each 100 m²
- ◆ Provide signals for blind nodes

Blind Node (Red)

- ◆ CC2431
- ◆ Collects RSSI and coordinates
- ◆ Calculates its own position



This illustration shows how CC2431 works.

A blind node, i.e. a node that does not know its own location, will receive packets from the nearest reference nodes. Each reference node knows its own location. The x and y coordinate for each reference node is written to the location engine together with the Received Signal Strength Indicator included in each packet.

In some applications the blind node needs to know its own location and in some someone else needs to know where the blind node is. In the later case the blind node will send its location to a collector on the ZigBee network.



CC2520

Second generation 2.4 GHz ZigBee®/IEEE 802.15.4 RF transceiver

Features

- Best-in-class co-existence and selectivity properties
- Excellent link budget (103dBm)
- Extended temperature range
- AES-128 security module
- CC2420 interface compatibility mode
- Supports ZigBee-2007 (ZigBee and ZigBee PRO) w/ MSP430

Benefits

- Reliable RF link with interference present
- 400m line-of-sight range with the development kit
- Ideal for industrial applications
- No external processor needed for secure communication
- Easy upgrade for existing CC2420 customers

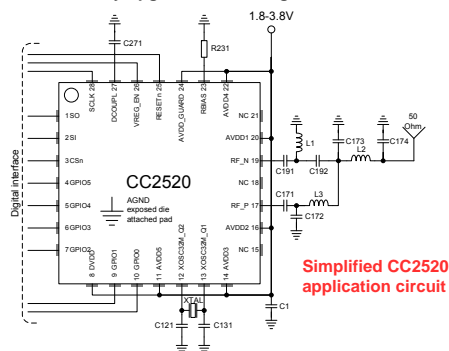
Applications

- IEEE 802.15.4 and ZigBee based products
- Industrial monitoring and control
- Home and building automation
- Low power RF sensor networks
- Set-top boxes and remote controls

EVM



- CC2520DK



Simplified CC2520 application circuit





SmartRF05

Development Platform

SmartRF05 is the next generation development platform from Low Power Wireless

- Designed to operate with MSP430 plug-in boards
 - CCMSP-EM430F2618
- Base board and plug-in Boards support TI LPW radios
 - CC2420, CC2430
 - CC1110, CC2510
 - CC2500, CC1100, CC1101
 - CC2520





CC2480

Z-Accel 2.4 GHz ZigBee® Processor

Features ...

- Standard SPI or UART interface
- Configurable device type and network settings
- Industry leading ZigBee® protocol stack
- Excellent selectivity and blocking performance
- Simple API makes development easy

Applications

- Home and commercial building automation
- Industrial monitoring and control
- Sensor / actuator networks
- Asset tracking

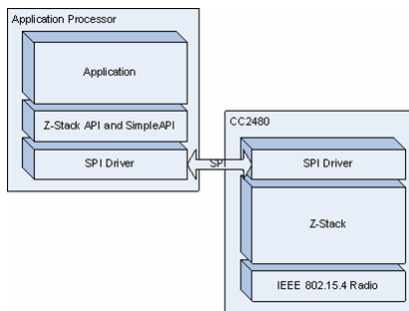
EVM



eZ430-RF2480 Demo Kit

... *Benefits*

- Flexibility to choose a host processor
- Simplify and shorten product development time
- Easy path to ZigBee benefits
- Ideal for battery operated systems
- Standardized, robust mesh network
- Excellent co-existence with Bluetooth and WiFi





What is Z-Accel?

Z-Accel is a ZigBee Network Processor solution where a host microcontroller communicates with a TI network processor over SPI or UART

CC2480 is the first generation ZigBee certified network processor in the Z-Accel family

Z-Accel makes it SIMPLE to add ZigBee to new or existing products, and allows customers to work with their favorite microcontrollers for application development.



Host microcontroller (4kB+) for your application code



SPI or UART communication



CC2480A1 runs the certified ZigBee compliant Z-Stack





eZ430-RF2480 Demonstration Kit

Evaluate Z-Accel Today!

The eZ430-RF2480 Demo Kit

- Allows fast evaluation of Z-Accel in action
- Interfaces an MSP430F2274 to the ZigBee Processor (CC2480A1)
- Demonstrates the Simple API command interface to CC2480
- \$99 - Available Today

USB or Battery Powered



ZigBee Processor

MSP430F2274
(backside)



Note: Chip antenna optimizes packaging at the expense of RF performance



The ZigBee processor can be regarded as a ZigBee black box. The user does not need to know the details of the ZigBee stack in order to send/receive packets.



Overview

ZigBee overview

Hardware

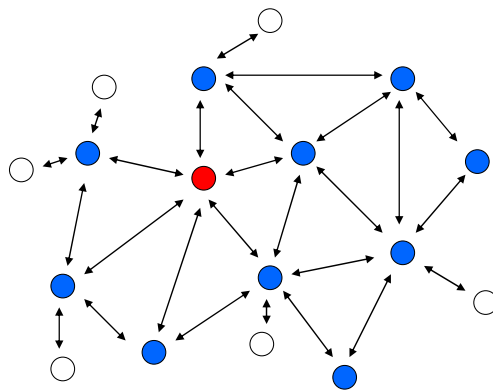
Topology and routing

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Requirements



ZigBee™ – Mesh Network Devices



- ◆ Devices are pre-programmed for their network function
- ◆ Coordinator can be removed

- **ZigBee Coordinator**
Starts the Network
Routes packets
Manages security
Associates Routers and End Devices
Example: Heating Central
- **ZigBee Router**
Routes packets
Associates Routers and End Devices
Example: Light
- **ZigBee End Device**
Sleeps most of the time
Can be battery powered
Does not route
Example: Light switch



Mesh networking is one of the key features in ZigBee. Mesh is a decentralized network with many similarities to Internet.

In a mesh network you have nodes capable of routing packets to other nodes in the network. These nodes are called Routers and should be mains powered since they are awake 100% of the time. One node is responsible for starting the system. This node is referred to as the coordinator and has very similar capabilities as the Routers.

Simple battery operated devices that do not route are also allowed in the network. These nodes are called End Devices and will be sleeping most of the time.



Overview

ZigBee overview

Hardware

Topology and routing

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Requirements



Compliance and Certification

- ZigBee Qualification Group (ZQG) is responsible for:
 - Establishing an independent test house program
 - Selecting test houses
 - National Technical Systems of Culver City, California
 - TÜV Rheinland of North America of Pleasanton, California
 - Write Protocol Implementation Conformance Statement (PICS)
- ZigFest
 - ZigBee Alliance Interoperability testing events
 - Participating in a ZigBee Alliance interoperability testing event is mandatory for compliance



The ZigBee alliance focuses a lot on compliance and certification. A special group, ZQG, has been initiated to take care of this. The alliance has also selected two test houses, NTS and TÜV that are responsible for ZigBee testing.

There are also interoperability events which all members can attend to verify that their products are interoperable with other vendors.



What can be tested?



- ZigBee Compliant Platform
 - IEEE 802.15.4 PHY and MAC
 - ZigBee network, security and application layer functions
 - TI ZigBee development kits are based on ZigBee Compliant Platforms
- ZigBee Compliant Product
 - Product based on a ZigBee Compliant Platform
 - Can use the ZigBee name and logo
 - Can co-exist with other ZigBee systems
 - Interoperable if a public profile is used



There are three things that can be tested.

The first one is the ZigBee Compliant Platform. This is the basic ZigBee functionality that is tested.

If you do not want to use a ZigBee profile you can still test for ZigBee Network Capable. This enables you to coexist with other networks without harming them.

Finally you can test for End Product Certification.



Overview

ZigBee overview

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Development cost for ZigBee

- Development kit: e.g. CC2430 ZigBee DK
 - Kit (9 boards + Tools + packet sniffer)
 - For price please see: <http://www.ti-estore.com/>
- Compiler from IAR (\$2395/seat)
 - 30+60 day evaluation version included in the kit
 - Volume prices available. Please contact IAR directly: <http://www.iar.com/>
- Regulatory certification (FCC, ETSI, ARIB etc.)
 - Price determined by the local test house
 - Same as for non-ZigBee products
- ZigBee certification (TÜV or NTS) ([Certification FAQ](#))
 - Price decided by test houses (~\$3k-10k/product)
- IEEE addresses
 - \$1650 for all the addresses you will ever need (2⁴⁰)



Additional costs for ZigBee

- ZigBee alliance membership (Benefits)
 - Adopter (\$3500/year)
 - Additional \$1000 for 1st product, \$500 each additional product for **logo certification** to the Alliance
 - Participant (\$9500/year)
 - Early access to specification
 - No additional cost for certification to the Alliance

In order to use the intellectual property built into ZigBee, any customer using Z-Stack, a ZigBee module, or the Z-Accel network processor **must become a member** of the ZigBee Alliance at least at the Adopter level and then pay additional costs based on the number of products released.

Please visit http://www.zigbee.org/en/certification/certification_policies.asp
For more information on ZigBee certification





Questions?

Please send questions or comments about this presentation to: lpw_pme_zigbee@list.ti.com



Thank you