Z-Stack: a complete protocol stack conforming to ZigBee standard

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Agenda

- Z-Stack
- Texas Instrument (TI) developer kit
  - Hardware
    - Demonstration and Evaluation Board
  - Software
    - 3rd Party Software: IAR
- Z-Stack Application development
- Example: GenericApp
  - Download
  - Run

What is ZigBee?

- A high level communication protocol using small, low-power digital radios based on the IEEE 802.15.4 standard for wireless networks
- ZigBee is targeted at applications that require a
  - Low data rate
  - Long battery life
  - Secure networking

Z-Stack (I)

- A complete protocol stack conforming to ZigBee Alliance standards
- Provided by Texas Instrument
- Microsoft Windows-based Free Software
- Includes all layers of ZigBee stack (IEEE 802.15.4 layer, ZigBee layer, O.S. layer)

Z-stack (II)

- HAL (Hardware abstraction layer)
- OSAL (Operating system abstraction layer)
- ZigBee Stack + IEEE 802.15.4 MAC
- User Application
- MT (Monitor Test) – Used to communicate with a PC-based test tool via the UART

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Working phases

- **Network formation**: the Coordinator creates the network to which all other nodes will connect.
- **Join**: performed by non-coordinator nodes after powering on. The network topology is created (star, tree). Each node sends a message to the Coordinator or to a Router which registers the node as a child.
- **Binding**: creation of a logical link between two ore more end systems for data exchange.
- **Data transmission**: data exchange between end devices or with the Coordinator.

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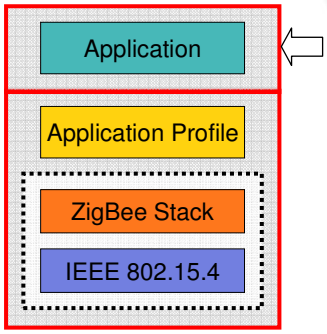
Z-Stack Application Development

- Be event driven
  - Local (key stroke, sensor alarm)
  - Remote (remote message from another device)
  - Timers
- Follow a precise schema
- Interact with the ZigBee stack

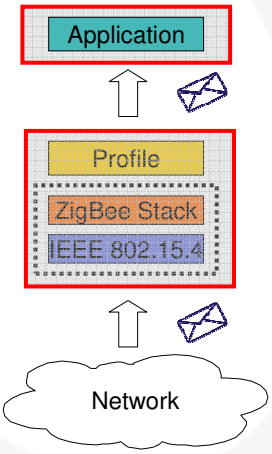


Z-Stack Application structure

- Each application must contain:
  - Init method
    - The application must provide information to the ZigBee stack
      - Node descriptor
      - Hardware specific information
      - Profile information
  - Event-loop method
    - The event loop method is invoked whenever an event is transmitted to the application
      - Mandatory (system events) Application specific (timers)
- Applications can contain
  - Local functions
  - Callbacks
    - to process specific events

Event processing

- Events are received from the ZigBee stack
- Application events are then transmitted to application level
- The corresponding callback or function for each event is activated

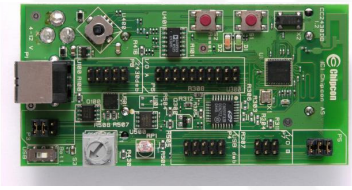


Texas Instrument: Hardware (I)

Chipcon SmartRF04EB Evaluation Boards

- Includes a USB and Serial interfaces
- Fitted with a CC2430EM
- LCD panel
- Can be powered from:
  - Batteries
  - Over the USB interface
  - The 9V DC connectors
- Includes a variety of sensors
  - Potentiometer
  - Pushbuttons and joystick
  - 2 LEDs
  - Audio filter and amplifier enabling transmission and reception of audio signals

Texas Instrument : Hardware (II)



CC2430DB Demonstration Boards

- Includes a USB interface
- Can be powered from:
  - Two AA batteries
  - Over the USB interface
  - The 9V DC connectors
- Includes a variety of sensors
  - Light sensor
  - 2-way accelerometer
  - Temperature sensor
  - Battery monitor
  - Potentiometer
  - Pushbutton and joystick

Texas Instrument : Hardware (III)

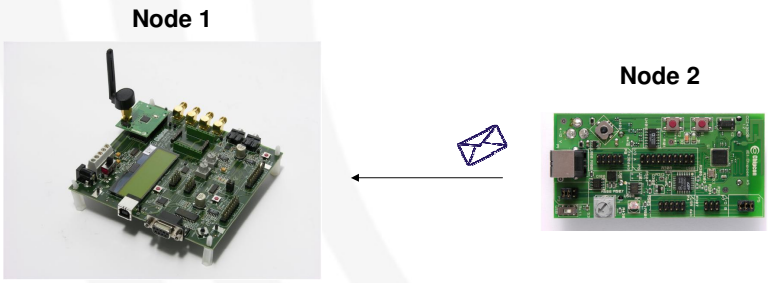
Chipcom SOC_BB Battery Board

- Fitted with a CC2430EM
- Can be powered from:
  - Two AA batteries
- Includes a variety of sensors
  - Temperature sensor
  - Battery monitor
  - Pushbutton

IAR C-compiler

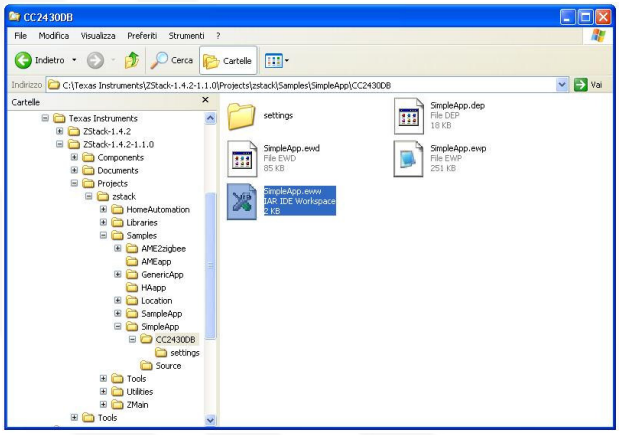
- IAR Embedded Workbench (EW8051) suite
- It supports project management, compiling, assembling, linking, downloading, and debugging for various 8051-based processors
  - Chipcon CC243x family

Example: “GenericApp”



- The GenericApp example provides a simple interface:
  - the ZigBee node finds an appropriate peer upon one button being pressed
  - It binds to that peer upon another button being pressed
  - It sends a packet containing “Hello World” every 5 seconds. Upon receiving a packet, it would display the contents on the LCD in the evaluation.

Project File for IAR

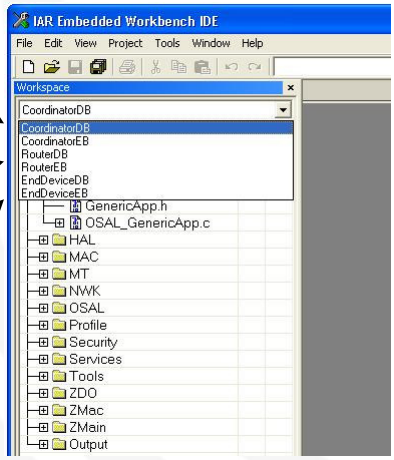


Application Type

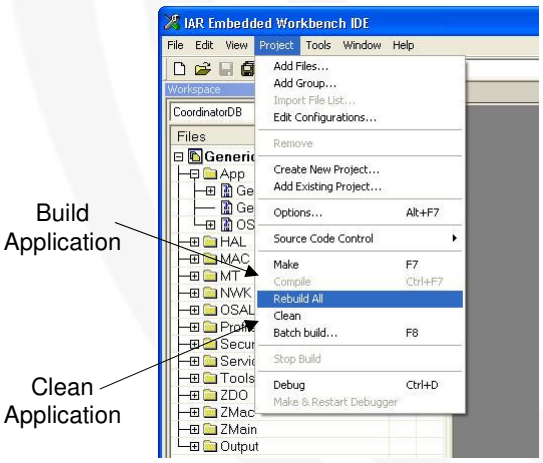
Coordinator (Demonstration Board Evaluation Board)

Router (Demonstration Board Evaluation Board)

End-Device (Demonstration Board Evaluation Board)

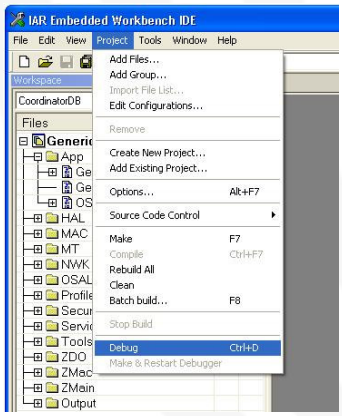


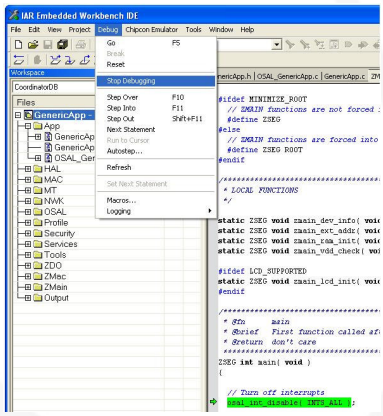
Build/Clean Application



Executable file generation:
- a51 (HEX file: text file)
- s51 file (binary file with debug information)

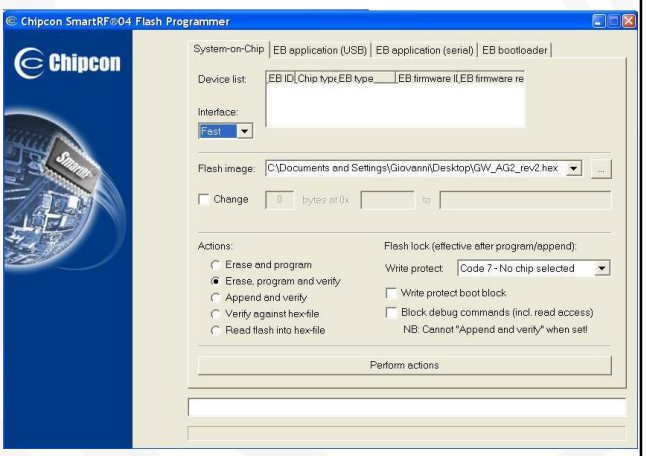
Download Application (I)





Download Application (II)

Chipcom Flash Programmer
• Device select
• Read/Write IEEE Address
• Download application on the Flash

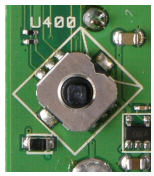


GenericApp (I)

1. Build and Download GenericApp
   - Node1
     - Uses EndDeviceEB configuration
     - Receive packets
   - Node2
     - Uses CoordinatorDB configuration
     - Send packets

GenericApp II

2. Start Node1 (Coordinator)
   - Red led light on
   - Network formation
3. Start Node2 (End Device)
   - Led orange light on
   - Join Network
4. SW4 Key Press on the Node1
   - Auto Find: start match description request
   - Led green light on



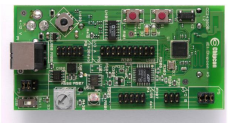
GenericApp (III)

5. Node2 sends “Hello world” packets to the Node1 every 5 seconds
   - View results on the LCD
   - View results on the Z-Tool provided by Texas Instrument
     - By using serial port

Example: “SimpleApp”

Node 1
Collector

Node 2
Temperature sensor



- The SimpleApp example allows:
  - the ZigBee node finds an appropriate peer upon one button being pressed
  - It binds to that peer upon another button being pressed
  - It sends a packet containing “Temperature” data. Upon receiving a packet, it would display the contents sending it to the serial interface.

SimpleApp (I)

1. Build and Download SimpleApp
   - Node1
     - Uses SimpleControllerEB configuration
     - Receive packets containing temperature data
   - Node2
     - Uses SimpleSensorDB configuration
     - Send temperature data

SimpleApp II

2. Start Node1 (SimpleCollector) and Node2 (End Device)
   - Allow Bind mode by pressing SW1 Key on Node1
   - Turn on LED1 on Node1
3. On the Node 1 (SimpleCollector device), any received sensor data are written to the serial port