Application Development For ZigBee Wireless Networking

By San Juan Software

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Presentation Overview

- Why ZigBee?
- ZigBee Architecture
- ZigBee Application Development
- Sample Application – Lighting Demo

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Why ZigBee?

A global hardware and software standard for wirelessly networking devices

- Highly reliable
- Low cost
- Low power
- Low data rate
- Highly secure

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ZigBee Standard - Ecosystem

- OEMs
- Platform
- Development Tools
- Training
- Custom Engineering & Services
- Gateways
- Modules

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ZigBee Standard - Interoperable

- ZigBee Alliance ensures interoperability with conformance tests
- Level 1 (L1) – MAC/PHY
- Level 2 (L2) – Networking profile
- Level 3 (L3) – Application profile
- Compatibility ensured through approved test houses and at ZigBee interop events

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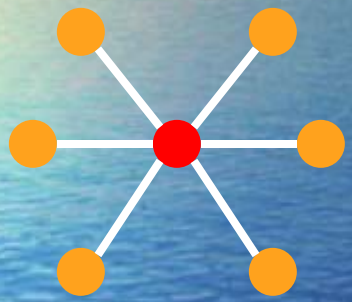
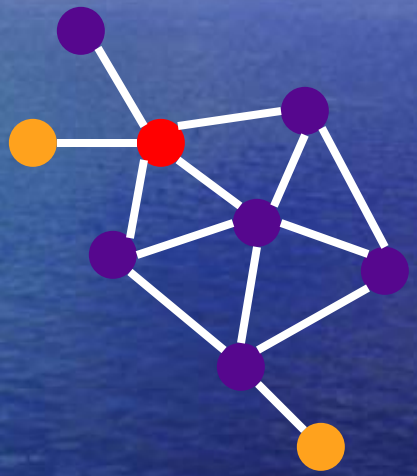
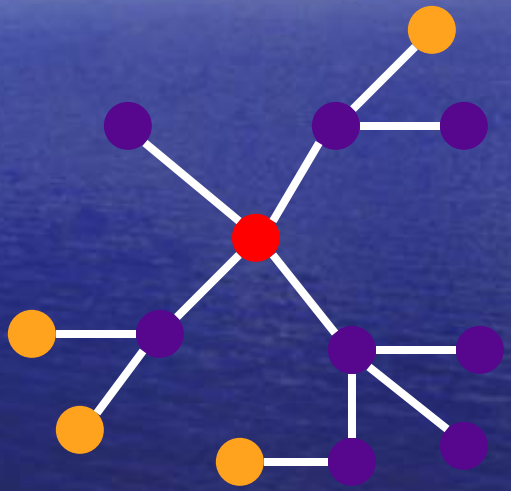
ZigBee Wireless Networking



Star Network
(Simplest)



Mesh Network
(Best Reliability)



Cluster Tree Network
(Large Scale Networks)

Coordinator

Router (FFD)

End Device (RFD)

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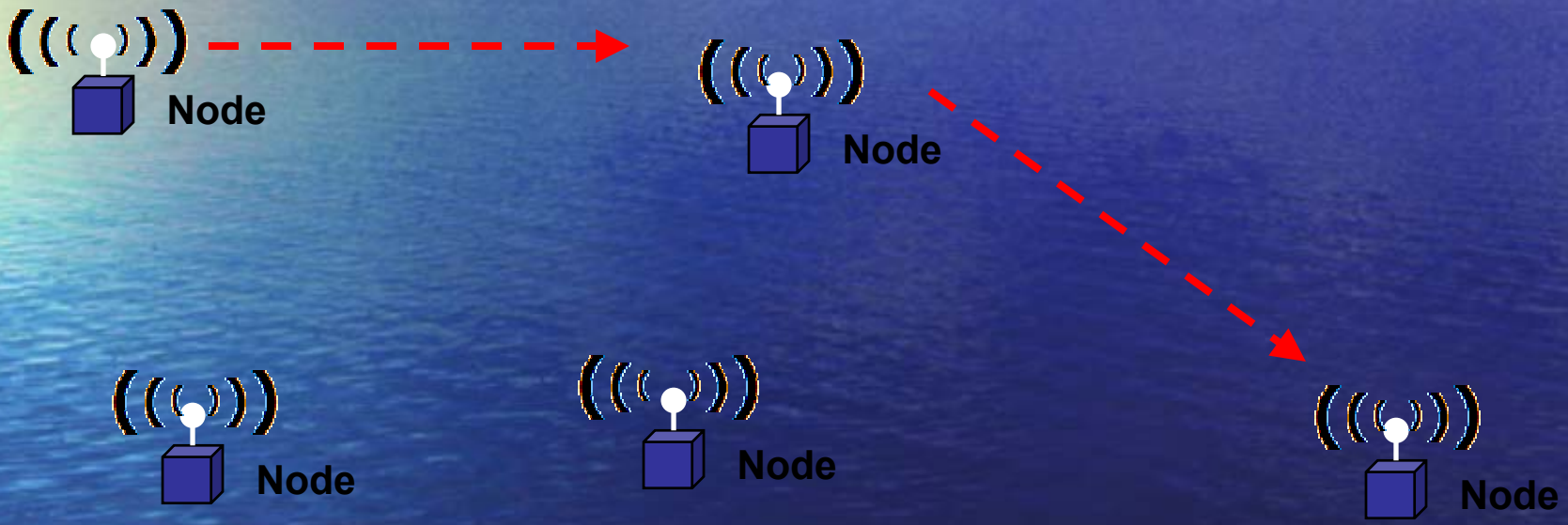
ZigBee Mesh Networking

Increase range, increased reliability (self-healing), and ad-hoc network formation



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ZigBee Mesh Networking

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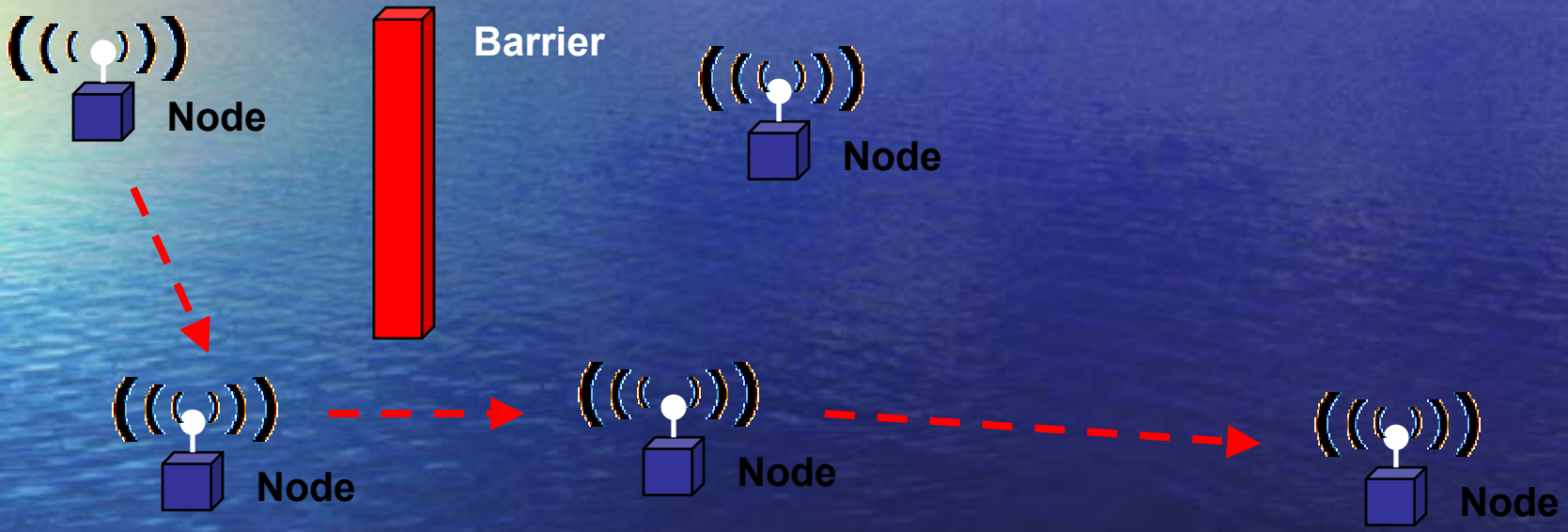

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ZigBee – Highly Reliable

- Mesh and tree networking protocol provides redundant paths
- Automatic retries and acknowledgements
- Broadcast delivery scheme ensures reliable broadcasts across the network
- Parents keep track of messages for sleeping children

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ZigBee – Highly Secure

- Utilizes AES 128-bit encryption
- Concept of a "trust center"
- Link and network keys
- Authentication and encryption
- Security can be customized for the application
- Keys can be "hard-wired" into application

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ZigBee

Wireless Control that Simply Works

BUILDING AUTOMATION

security
HVAC
AMR
lighting control
access control

CONSUMER ELECTRONICS

TV
DVD/CD
remote
cell phone

PERSONAL HEALTH CARE

patient monitoring

fitness monitoring

PRECISION AGRICULTURE

irrigation
fertilizer
golf course
farm
ranch

INDUSTRIAL CONTROL

asset mgt
process control
environmental
energy mgt

RESIDENTIAL/ LIGHT COMMERCIAL CONTROL

security
HVAC
lighting control
access control
lawn & garden
irrigation

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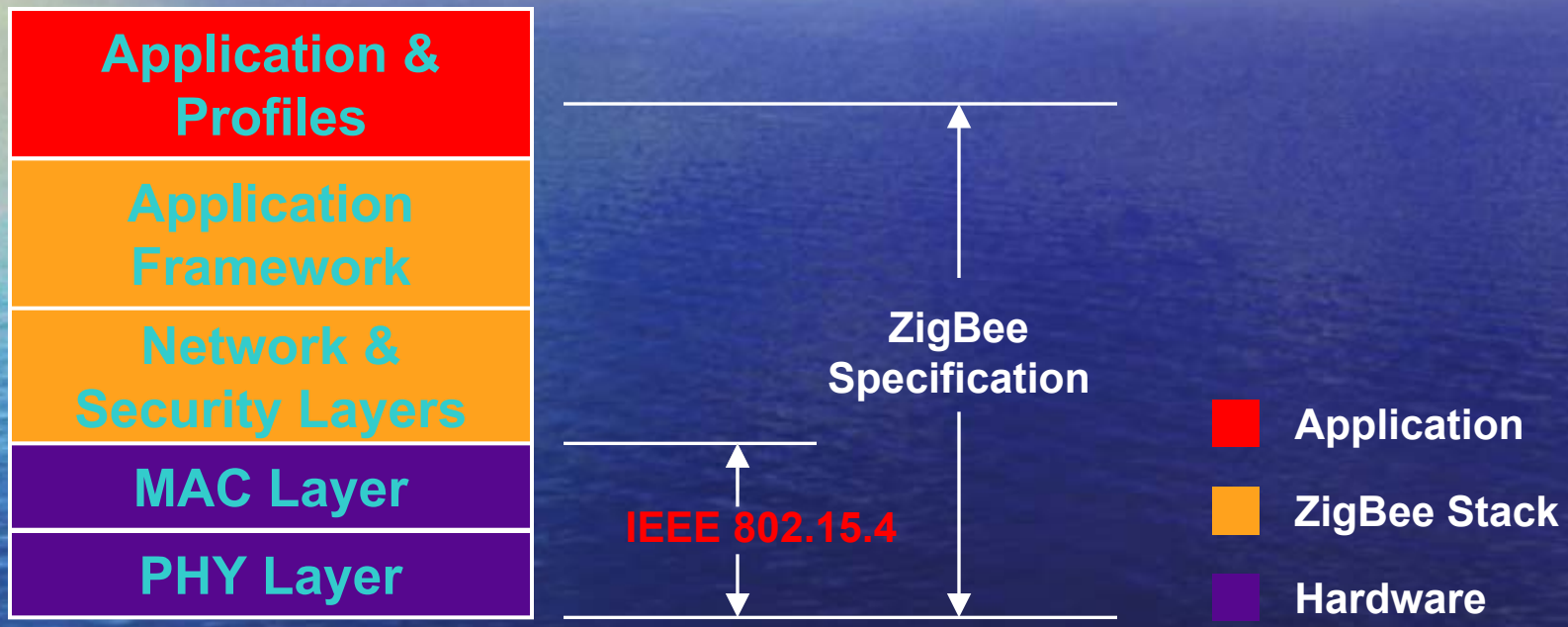
ZigBee Framework



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IEEE 802.15.4 Frequency and Data Rates

BAND	COVERAGE	DATA RATE	# OF CHANNEL(S)
2.4 GHz	ISM	Worldwide	250 kbps	16
868 MHz		Europe	20 kbps	1
915 MHz	ISM	Americas	40 kbps	10

802.15.4 Technical Details

- Direct Sequence Spread Spectrum provides excellent performance in low SNR environments
- CSMA-CA used for collision avoidance
- O-QPSK and BPSK minimize power consumption and reduce complexity
- Half-duplex operation

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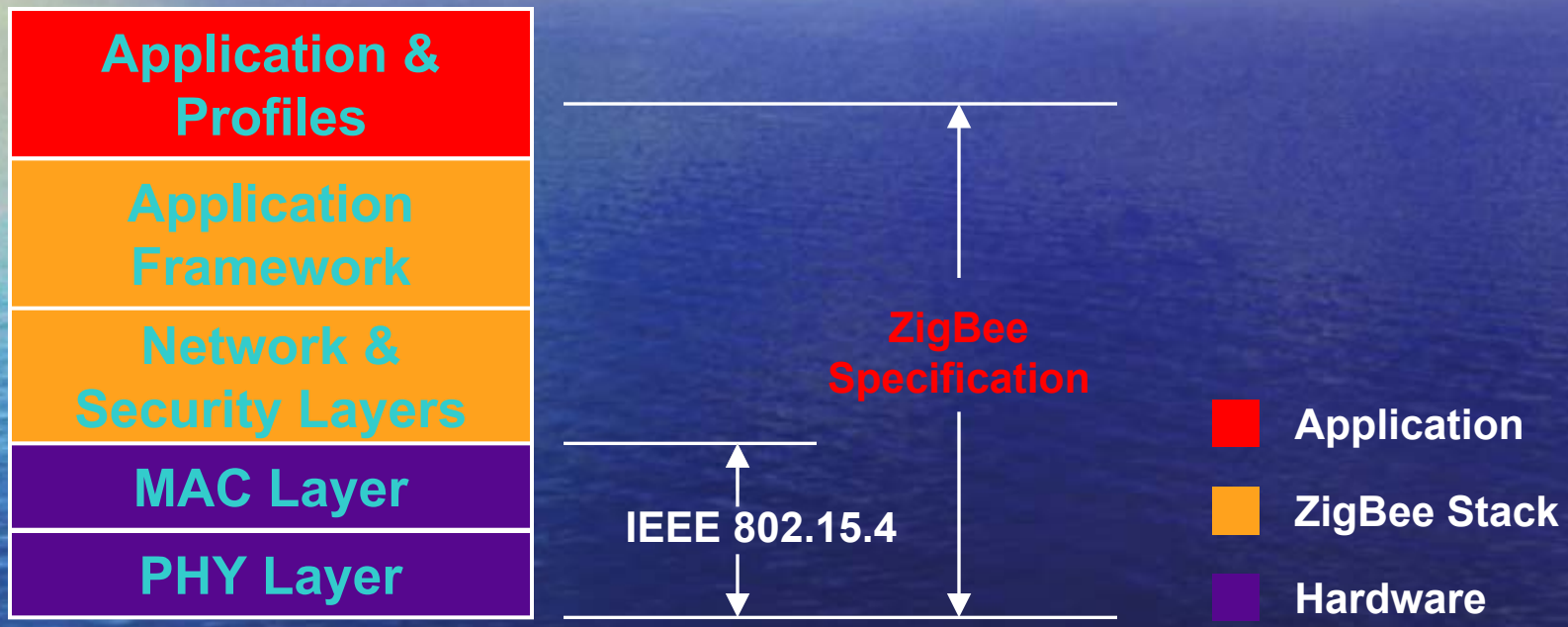
ZigBee Framework



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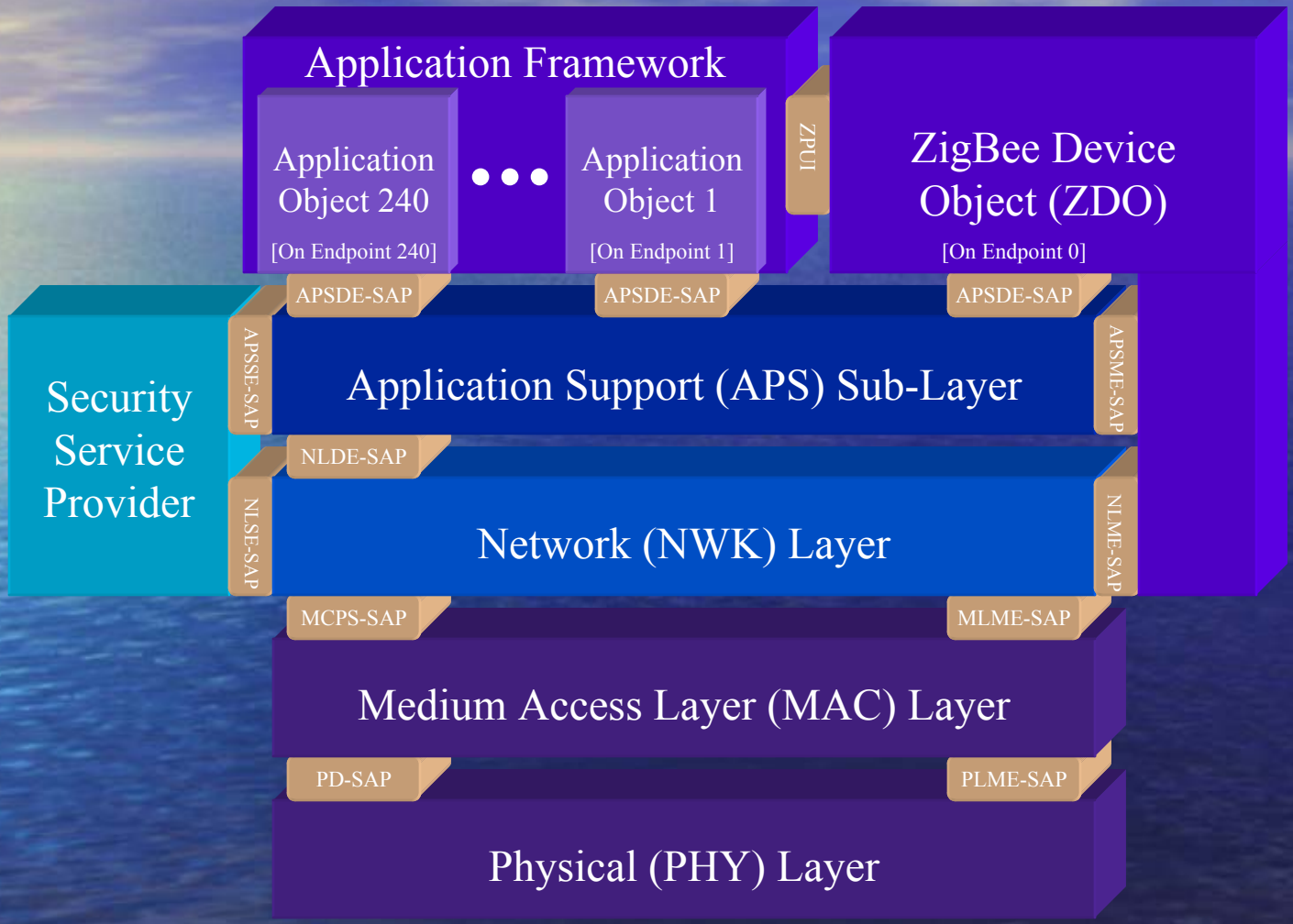
ZigBee Architecture



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ZigBee Networking Stack Features

- Reliable 2-way wireless communications
- Choice of star, mesh and tree topologies
- Device service discovery
- Broadcast services
- Gateway (multi-network) services
- Device interoperability through profiles
- Security management
- No common C API among stack vendors

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Components For ZigBee Development

- Development platform
  - 802.15.4 radio
  - Development board
  - ZigBee compatible networking stack
- Development tools
  - Editor/IDE
  - Cross compiler
  - Debugging tools
- Workstation

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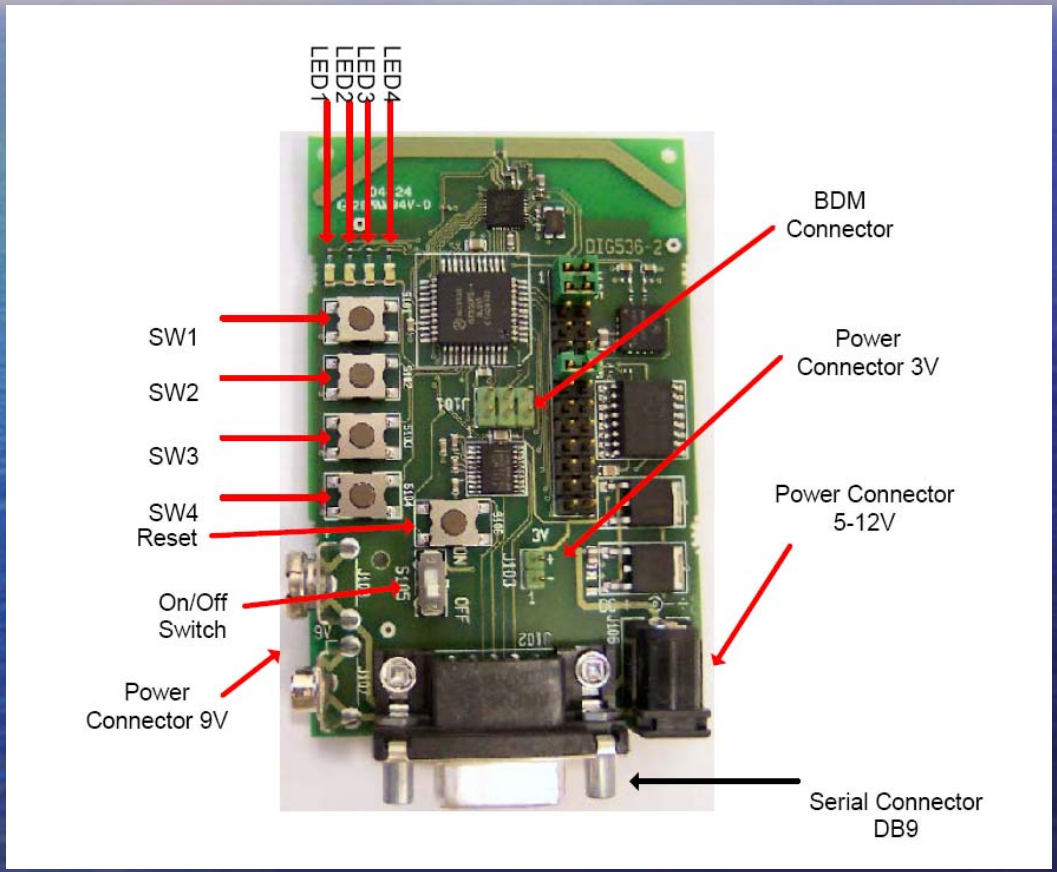
Freescale SARD (DIG 536) Board



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ZigBee RF Modules

- Panasonic ZigBee Module
  - Will be available through Arrow Q2 2005
  - Freescale MC13193, HCS08, Dipole Antenna
- Maxstream XBee™ ZigBee Module
  - Available now
  - Freescale MC13193, HCS08, Dipole Antenna

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Development Process

- Write the ZigBee application
- Compile for target MCU
- Download binary code into ZigBee nodes using BDM/JTAG, serial port or over-the-air
- Reset nodes and debug them
- Repeat as necessary

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Debugging The Network

- BDM/JTAG – one node at a time
- Packet "Sniffers"
- Debug info (e.g. printf() / monitor)
- LEDs, other on-board indicators
- Simulation – NS2
- Keep it simple

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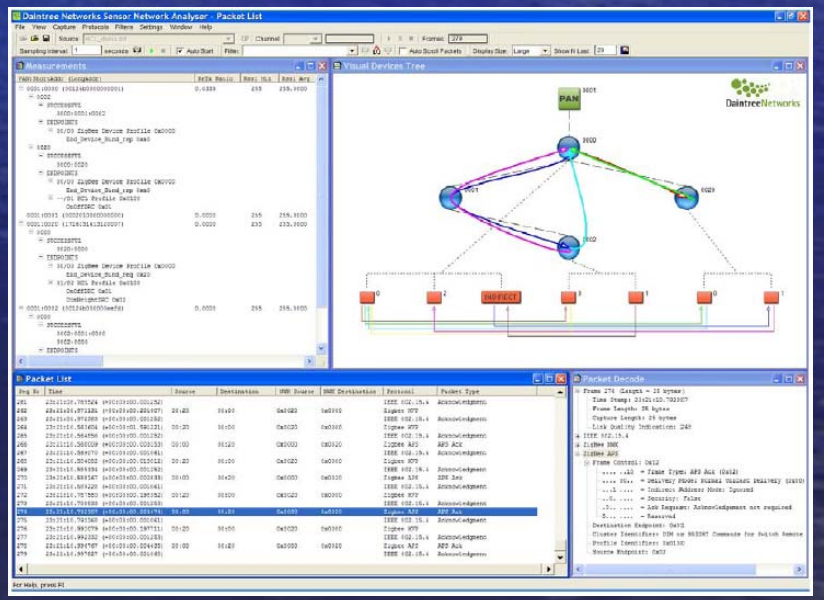
Daintree Sensor Network Analyzer

Daintree Networks
Wireless Communication Solutions

- Capture network data
- View based on field
- Customizable for application
- Visual view into the network



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ZigBee Interoperable Application

Buy products from multiple vendors…
that simply work

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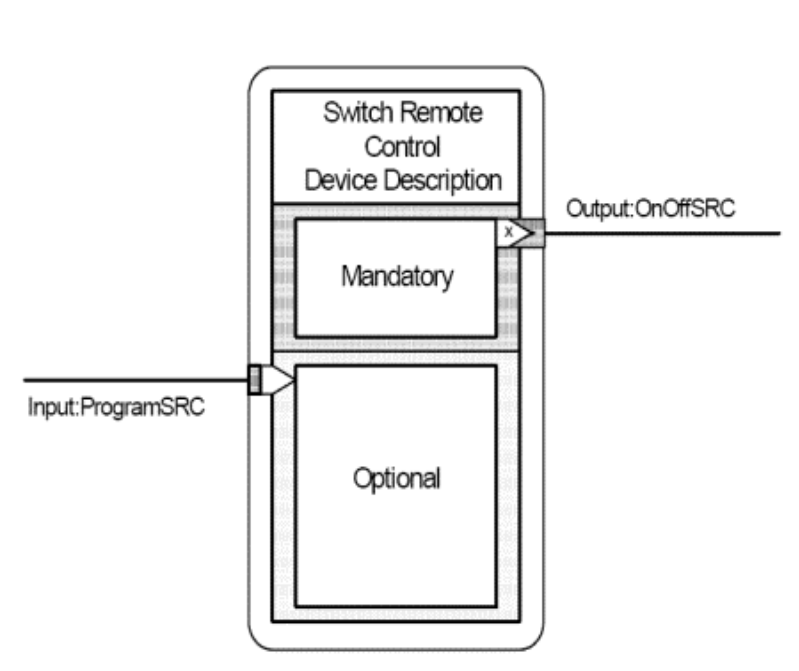
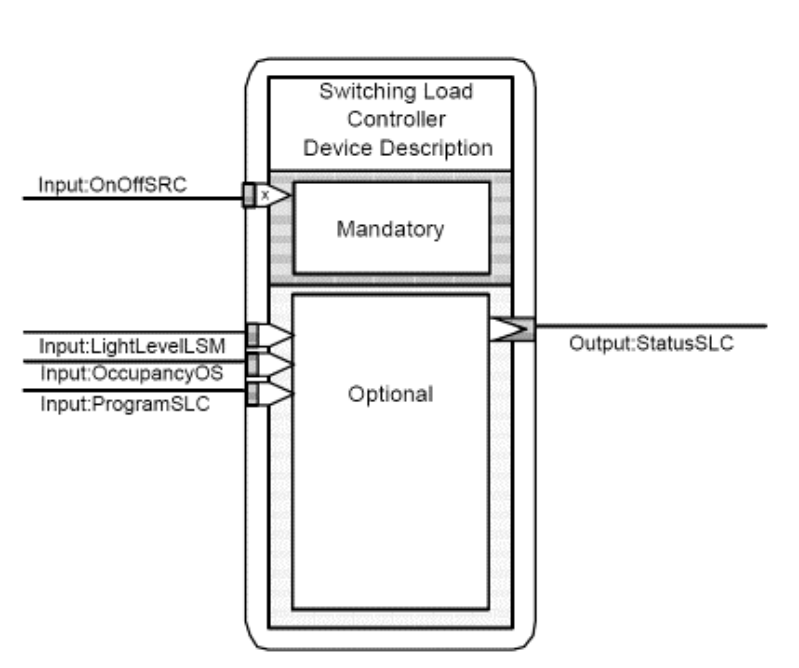
Home Lighting Control

Light Switch



Light



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APSDE-DATA.request

APSDE-DATA.request	(	
	DstAddrMode,	Not present, 16-bit or 64-bit
	DstAddress,	According to DstAddrMode
	DstEndpoint,	Target endpoint: 0x00-0xff
	ProfileId,	Profile to use (broadcast transmissions only)
	ClusterId,	Binding object to use (indirect transmissions only)
	SrcEndpoint,	Source endpoint: 0x00-0xfe
	asduLength,	The length of asdu and <= *apscMaxPayloadSize*
	asdu,	The application data
	TxOptions,	Security, NWK key, acknowledgement select
	DiscoverRoute,	Route discovery override
	RadiusCounter	Broadcast radius (broadcast transmissions only)
	)	

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afFillAndSendMessage

```
afStatus_t afFillAndSendMessage (
    afAddrType_t *dstAddr, byte srcEndPoint, byte clusterID,
    byte TransCount,
    byte FrameType,
    byte *TransSeqNumber,
    byte CommandType,
    byte AttribDataType,
    uint16 AttribId,
    byte ErrorCode,
    byte DataLength, byte *Data,
    byte txOptions, byte DiscoverRoute, byte RadiusCounter );
```

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Switch Load Control Source Code

```
/*********************************************************************
 * @fn      SLC03394_RcvSET_OnOffSRC
 *
*/
byte SLC03394_RcvSET_OnOffSRC( byte endPoint, uint16 AttribId, byte State)
{
      byte leds;
      if (State == OnOffSRC_ON)
            SLC03394_State = OnOffSRC_ON;
      else if (State == OnOffSRC_OFF)
            SLC03394_State = OnOffSRC_OFF;
      else if (State == OnOffSRC_TOGGLE)
       {
            // Make sure SLC03394_State matches LEDs
            leds = SetLed( LED_NONE, LED_ON );
            SLC03394_State = ( leds & LED4 ) ? OnOffSRC_ON : OnOffSRC_OFF;
            // Toggle, if current state is ON --> OFF, OFF --> ON
            if (SLC03394_State == OnOffSRC_ON)
                SLC03394_State = OnOffSRC_OFF;
            else
                SLC03394_State = OnOffSRC_ON;
      }
      osal_set_event( SLC03394_taskID, SLC03394_STATE_CHANGED_EVT );
      return ( ERRORCODE_SUCCESS );
}
```

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Switch Remote Control Source Code

```
/*********************************************************************
 * @fn      SRC03391_Set_OnOffSRC
 *
 * @brief   Sends a SET command for OnOffSRC Cluster.
 *
 * @param   dstAddr - NULL or DSTINDIRECT, if indirect
 * @param   epDesc - pointer to the originating endpoint descriptor
 * @param   State - OnOffSRC_Off or OnOffSRC_On.
 *
 * @return  0 - Sent it on its way, !0 if error
 */
byte SRC03391_Set_OnOffSRC( afAddrType_t *dstAddr, endPointDesc_t *epDesc,
                            byte State )
{
      byte status;
      status = afFillAndSendMessage( dstAddr, epDesc->endPoint,
            CLUSTERID_OnOffSRC, 1, FRAMETYPE_KVP,
            &SRC03391_TransSeqNumber,
            CMDTYPE_SET, DATATYPE_UINT8, OnOffSRC_OnOff,
            ERRORCODE_SUCCESS,
            sizeof(State), &State,
            AF_MSG_ACK_REQUEST, true, AF_DEFAULT_RADIUS );
      return ( status );
}
```

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Summary

- ZigBee designed for highly-reliable, low-cost, low-power, low-data rate, highly-secure wireless applications
- ZigBee built on global, robust IEEE 802.15.4 radio standard
- Large ZigBee ecosystem available today equates to fast time to market

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