

LPW-103

# Z-Wave Long Range: Bringing Beyond-the-Home Connectivity



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# Agenda

- 01 Z-Wave Long Range Introduction
- 02 Silicon Labs Z-Wave 800 Platform
- 03 Z-Wave Long Range Demo

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# Z-Wave Long Range Introduction

# Z-Wave Markets: Applications and Use Cases

## SMART HOME



## MULTI DWELLING UNITS



## HOSPITALITY



Yard Lighting



Front Gate



Water Leak



Tenant Safety



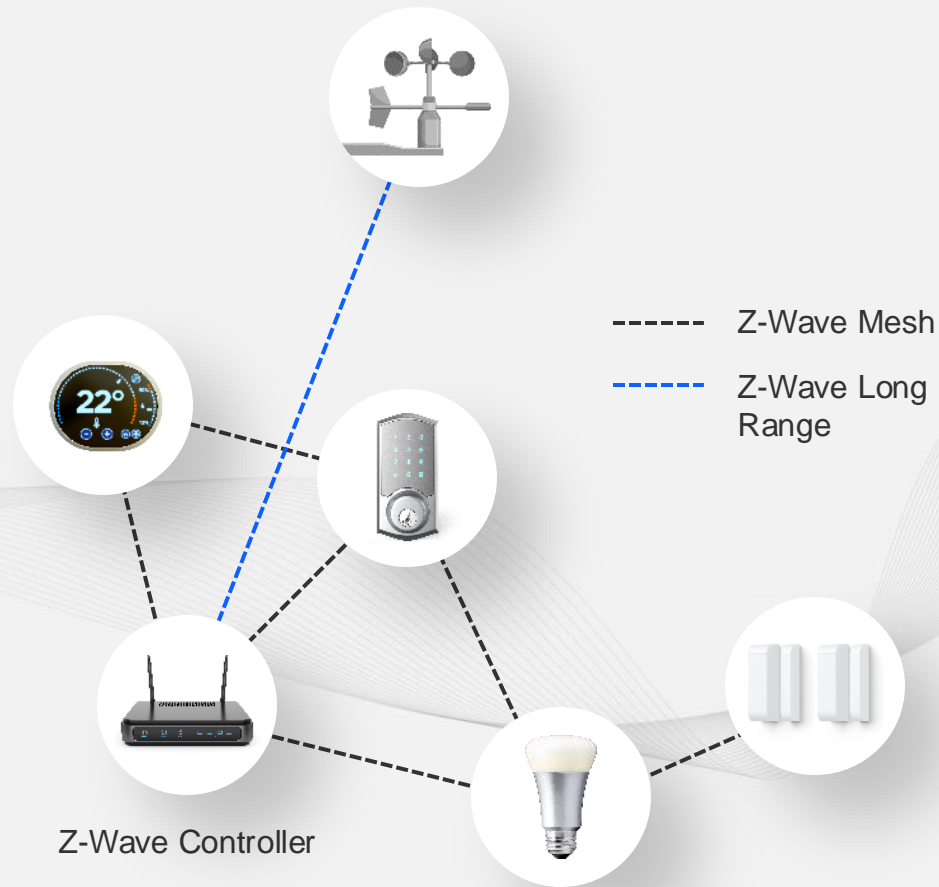
Guest Comfort



Energy Mgmt.

Over A Mile Range, 4000 Nodes Network Capacity, and 10-Year Battery Life Enable New Use Cases & Reduce Cost

# Z-Wave – Wireless Highlights



## Mesh Network Topology

**100 kbps**  
data rate  
+0/14 dBm TX power

**400 m**  
range (4 hops)  
Coverage for the smart home and end of yard

**200+ nodes**  
scalable  
8-bit address space

## Star Network Topology (LR)

**100 kbps**  
data rate  
Up to +30 dBm TX power

**~1.5 Mile**  
range  
Coverage for the whole home, yard, and beyond without a repeater

**4000 nodes**  
highly scalable  
12-bit address space

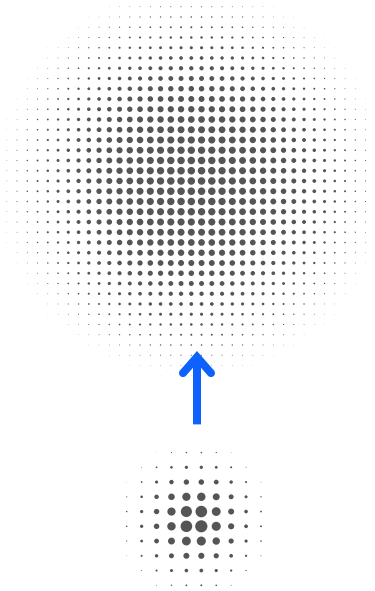
# Z-Wave Long Range – Key Benefits

## COVERAGE



Up to 1.5 miles

## SCALABILITY



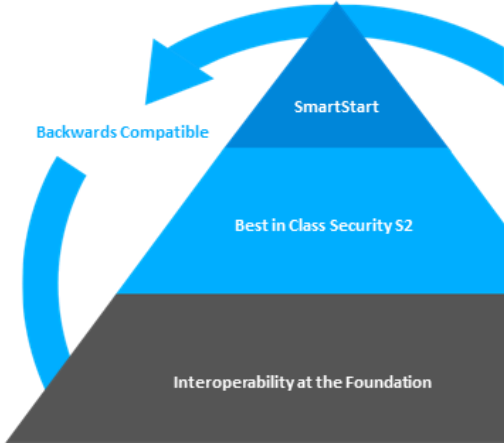
Up to 4,000 nodes

## LOW POWER



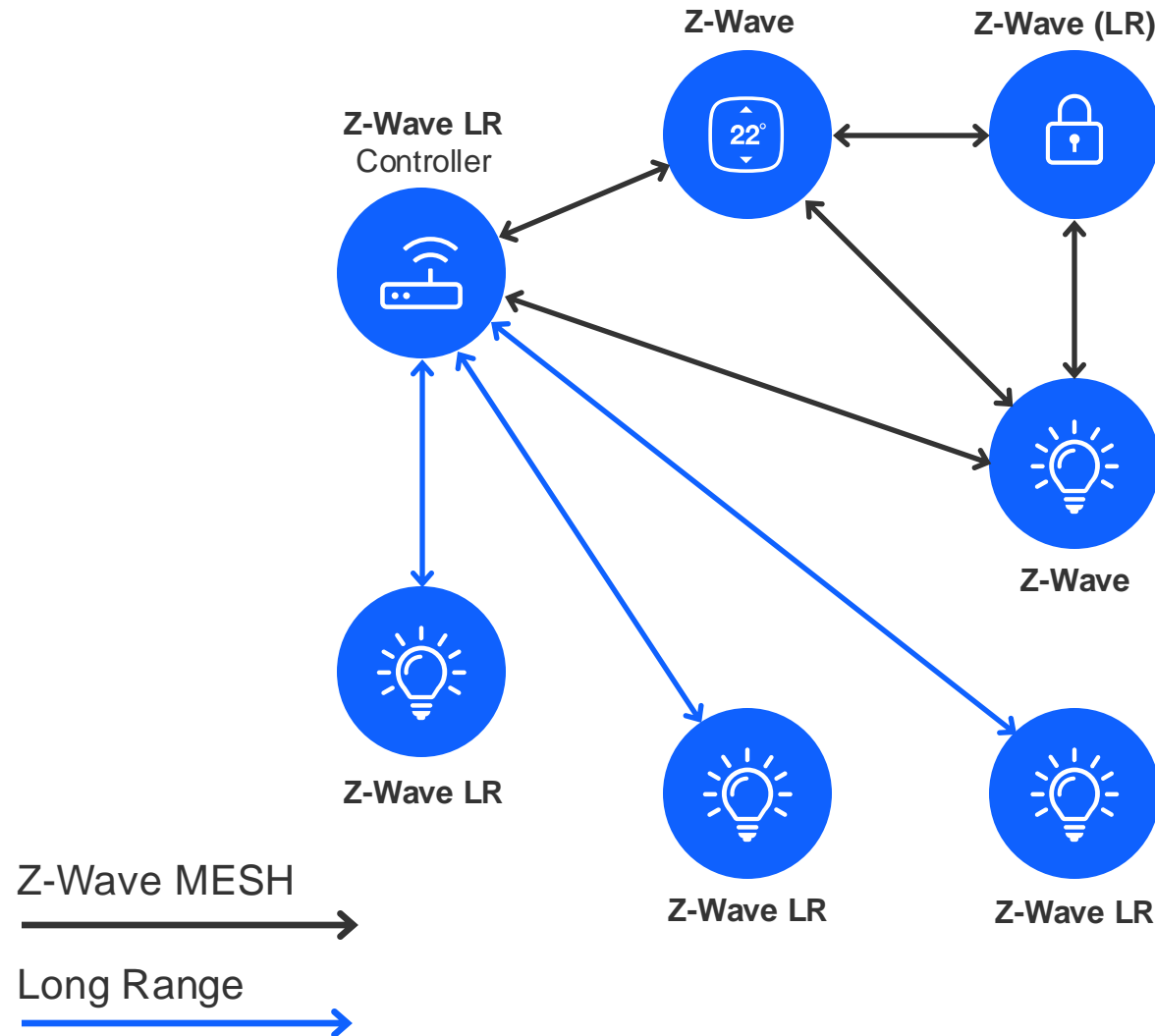
10 Years

## BACKWARD COMPATIBLE



Secure & Interoperable

# Z-Wave Long Range is Backwards Compatible



- Coexistence between Z-Wave and Z-Wave LR nodes
- Controller's choice for Z-Wave or Z-Wave LR at inclusion
- Controller can communicate in both channels
- The controller is the relay between classic and LR Z-Wave

# Certification Guarantees All Products Work Together



## Z-Wave Plus V2 ensures:

- Interoperability between products & vendors
- Backwards compatibility
- Uniform SmartStart setup, software upgrades, & S2 security

## End node & controller certification delivers:

- Specifications for products and services
- High-quality test tools

## Interoperability benefits:

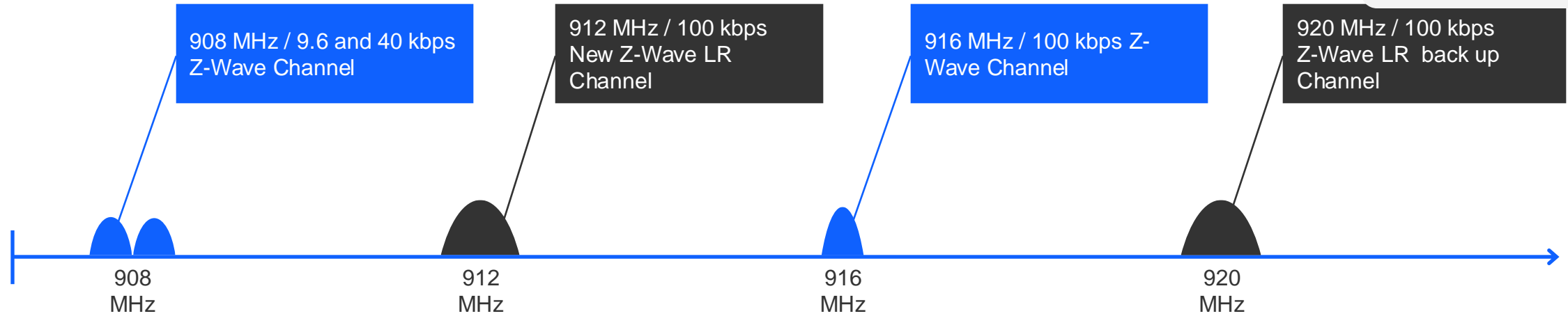
- Ensures all products speak the same language
- Control all Z-Wave products with a single app
- Provides thousands of configuration options
- Certifications owned by Z-Wave Alliance

## Certification performed by independent test house:

- Z-Wave Plus V2 certification for end devices and controllers



# Z-Wave LR PHY and Channel Details (FCC Regions)



	PHY Details	Comment
<b>Modulation</b>	DSSS-OQPSK	Higher output power and better interference immunity
<b>Frequency</b>	912 MHz or 920 MHz	Channel agility, better network, and better blocker performance
<b>Maximum Data Rate</b>	100 kbps	
<b>Maximum Output Power</b>	+20 dBm	For Z-Wave 800, specification allows up to +30 dBm (FCC limit)
<b>DSSS-OQPSK Sensitivity @100 kbps</b>	-110 dBm	
<b>Total Link Budget</b>	130 dB	1.5 miles of range

# Comparing Z-Wave MESH and Z-Wave Long Range

	Z-Wave MESH	Z-Wave Long Range
<b>PHY Modulation</b>	FSK/GFSK	<b>DSSS OQPSK</b>
<b>PHY Speed</b>	9.6/40/100 kbps	100 kbps
<b>PHY Frequency</b>	908.42/916 MHz	<b>NA 912/920 MHz   EU 800 MHz</b>
<b>PHY max output power*</b>	-1 dBm <sup>(FCC)</sup> , +14 dBm <sup>(ETSI)</sup>	<b>FCC +30 dBm   EU +14 dBm</b>
<b>PHY output power control</b>	No	<b>Yes</b>
<b>NWK</b>	Mesh	<b>Star</b>
<b>Sensitivity at 100kbps</b>	-108.6 dBm	-109.8 dBm
<b>MAC LBT</b>	Yes	Same as Z-Wave
<b>MAC random back off</b>	Yes	Same as Z-Wave
<b>MAC frames</b>	Single, multi, broadcast, beams (1000ms)	Single, multi, broadcast, beams (100ms fragmented)
<b>Mac address space</b>	32-bit Home Id, 8-bit Node ID	32-bit Home Id, <b>12-bit Node ID</b>
<b>Routing</b>	Supported	<b>Not supported</b>
<b>Inclusion</b>	NWI and Inclusion controller support	<b>Direct inclusion only</b>
<b>SmartStart</b>	QR code	Same as Z-Wave
<b>Security</b>	S0, S2 non-Auth, S2 auth, S2 Access	<b>S2 auth, S2 Access</b>
<b>Application framework</b>	Supported	Same as Z-Wave
<b>Sample Apps</b>	Supported	Same as Z-Wave
<b>IMA</b>	Supported	Same as Z-Wave
<b>Network Size</b>	256 nodes	4000 nodes

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# Z-Wave 800 Solutions

# Z-Wave 800: Simple, Secure, & Interoperable



## Broad Ecosystem

Hundreds of Z-Wave Alliance members



## Sub-GHz

Penetrates walls, long range, less interference

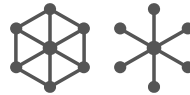


SMART HOME



## All Interoperable

Thousands of certified products & 100% interoperable



## Mesh & Star

Large network coverage  
Robust



MULTI DWELLING UNITS



## Easy to Install

SmartStart error free installation



## Secure

S2 security framework  
Secure Vault™



HOSPITALITY



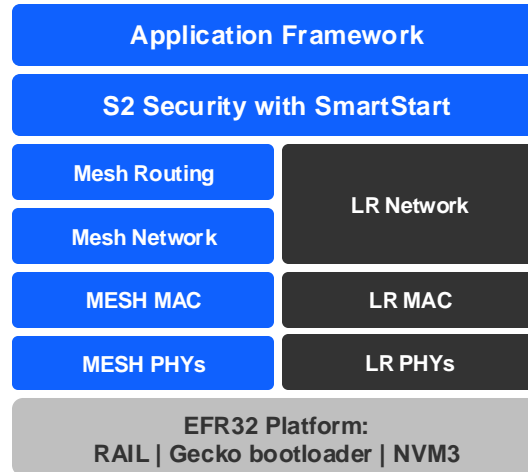
## Low Power

Up to 10 years on a coin cell

# The Silicon Labs Z-Wave 800 IoT Solution



## Z-Wave Certified Application



## Hardware

- SoCs & SiP Modules
- Supports all Z-Wave frequencies
- Mesh & Long Range
- Z-Wave & Proprietary support

## Stack

- Based on open specification
- Complete solution - PHY to App
- Controller reference design
- Secure Vault™ integration

## Certification


- Ensures interoperability & backwards compatibility
- Z-Wave LR certification is part of Z-Wave Plus V2
- Certification is mandatory for all products

## DEVELOPMENT TOOLS

- Packet sniffer & analyzer
- Energy Profiler
- Network controller
- Installation & maintenance tool

# ZG23 and ZGM230S



Proprietary 



5x5 QFN40 (23 GPIO)  
6x6 QFN48 (31 GPIO)  
6.5x6.5 SiP (34 GPIO)

## DIFFERENTIATED FEATURES

### RX Sensitivity

- Integrated LNA with RX Sensitivity as low as -109.8 dBm
- **Secure Vault™ Mid and High**
- Allows for migration path as security needs change

### +20 dBm Output Power

- Provides 1+ mile range with Z-wave LR

### 16-bit ADC

- Up to 14-bit ENOB for better analog resolution

### Preamble Sense

- Ultra-low-power receive mode

### Segment LCD

- 4x20 segment LCD

### Compact Size

- Supports up to 34 GPIO

## DEVICE SPECIFICATIONS

### HIGH-PERFORMANCE DUAL-BAND RADIO

- Up to +20 dBm TX (SoC)
- Up to +14 dBm TX (SiP)
- -109.8 dBm RX @ 100 kbps O-QPSK
- -110 dBm RX @ 40 kbps FKS

### EFFICIENT ARM® CORTEX®-M33

- 78 MHz (FPU and DSP)
- 512kB of flash
- 64kB of RAM

### LOW POWER

- 9.8 mA TX @ 0 dBm
- 25.0mA TX @ +14 dBm
- 4.0 mA RX (GFSK)
- 26  $\mu$ A/MHz
- 1.2  $\mu$ A EM2 with 16 kB RAM

# Introducing ZG28



amazon sidewalk



8 × 8 × 0.85 QFN68 (49 GPIO)  
6×6 × 0.85 QFN48 (31 GPIO)

## DIFFERENTIATED FEATURES

### Dual-Band<sup>1</sup>

- Supports Sub-GHz + 2.4 GHz Bluetooth LE

### +20 dBm Output Power

- Provides 1+ mile range with Z-wave LR

### 16-bit ADC

- Up to 14-bit ENOB for better analog resolution

### AI/ML Hardware Accelerator

- Reduces current consumption for AI/ML at the edge

### Segment LCD

- 8x24 or 4x28 segments

### High GPIO Count

- Supports up to 49 GPIO

### Preamble Sense<sup>2</sup>

- Ultra-low-power receive mode
- **Pin-compatible with ZG23**
- **6x6 Pin-compatible for drop-in replacement**

<sup>1</sup>Future support for Z-Wave+BLE SMP

<sup>2</sup>Not supported on Z-Wave

## DEVICE SPECIFICATIONS

### HIGH-PERFORMANCE DUAL-BAND RADIO

- Up to +20 dBm TX (Sub-GHz)
- Up to +10 dBm TX (2.4GHz BLE)
- 5.2 mA RX (2.4 GHz, 1Mbps BLE)
- -109.8 dBm (912MHz, 100kbps O-QPSK)

### EFFICIENT ARM® CORTEX®-M33

- 78 MHz (FPU and DSP)
- 1024kB of flash
- 256kB of RAM

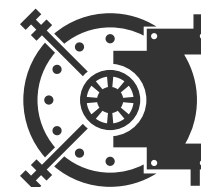
### LOW POWER

- 25.7 mA TX @ +14 dBm
- 23.2 mA TX @ +10 dBm, 2.4 GHz
- 5.2 mA RX (1 Mbps BLE)
- 33 µA/MHz in active mode
- 1.3 µA EM2 16 kB RAM retained
- **Secure**
- Secure Vault™ Mid and High
- Supports Z-Wave S2
- **Feature Rich peripherals**
- USART, EUSART, 16 BIT- ADC, VDAC, I2C, Temp Sensor, LCD

# Secure Vault™ Support in Z-Wave 800: Protecting the IoT Device

Base	Mid	High	Feature
✓	✓	✓	True Random Number Generator
✓	✓	✓	Crypto Engine
✓	✓	✓	Secure Application Boot
—	<b>HSE</b>	<b>HSE</b>	Secure Engine
—	✓	✓	Secure Boot with RTSL
—	✓	✓	Secure Debug with Lock/Unlock
—	✓	✓	DPA Countermeasures
—	—	✓	Anti-Tamper
—	—	✓	Secure Attestation
—	—	✓	Secure Key Management
—	—	✓	Advanced Crypto

**Z-Wave 800  
Supports  
Secure Vault**

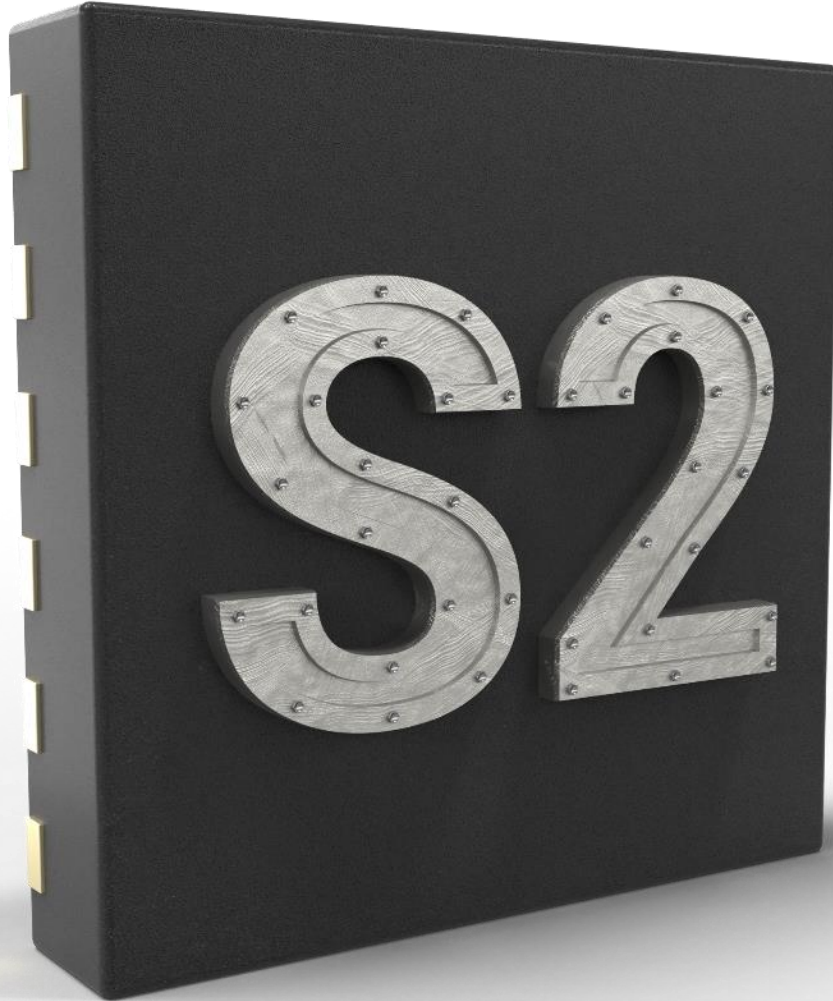


**Industry Leading  
IoT Security**





# Securing the Network: Z-Wave S2 Framework



- **Protection against**
  - Hacks and man-in-the-middle-attacks
  - Inclusion of rogue nodes
  - Deciphering of keys
  - Sniff & replay and delay attacks
- **Supports**
  - Out-of-band inclusion
  - Elliptic Curve Diffie-Hellman key exchange
  - Strong AES 128 encryption
  - Unique/nonce transmissions
  - Isolated access control levels
  - Secure multicast groups
- **Energy-efficient security and low latency with single frame**
  - 50% less energy than challenge-response

# Getting Started with ZG23 and ZG28 SoCs and Modules

## Dev Board

- 1x Development board
  - On-board debugger
  - Signal breakouts
  - On-board sensors
  - 20-bit ADC
  - AI/ML hardware accelerator

## Explorer kit

- 1x Explorer board
  - mikroBus socket
  - Qwiic connector



Part Number	Description
xG24-DK2601B	EFR32xG24 2.4 GHz +10 dev board
xG24-EK2703A	EFR32xG24 2.4 GHz +10 explorer board

## Pro Kits

- 2x pro kit main boards
- 1x ZGM230S SiP radio board
- 1x ZG23 SoC radio board (+14 dBm)
- 2x Button and LEDs expansion board
- 1x UZB-7 USB stick
- 2x USB A to USB mini-B cable
- 1x BRD4002A Wireless Starter Kit Mainboard
- 1x FG28-RB440xB 915MHz Radio Board
- 1x 915 MHz antenna
- 1x Flat cable
- 1x 2xAA battery holder



Part Number	Description
ZWAVE-PK800A	Z-Wave 800 Series Pro Kit
xG28-PK6024A	xG28 868-915 MHz +14 dBm, +10 dBm 2.4 GHz BLE Pro Kit
xG28-PK6025A	xG28 868-915 MHz +20 dBm, +10 dBm 2.4 GHz BLE Pro Kit

## Radio Board Kits

- 1x radio board (superset SoC OPN)
- 1x radio board (superset SoC OPN)
- 1x radio board (superset module OPN)
- 1x xG28-RB440xC 915MHz Radio Board
- 1x SMA antenna connector



Part Number	Description
xG23-RB4204D	xG23 868-915 MHz +14 dBm Radio Board
xG23-RB4210A	xG23 868-915 MHz +20 dBm Radio Board
ZGM230-RB4205B	ZGM230S Z-Wave SiP Module Radio Board (+14 dBm)
xG28-RB4400C	xG28 868-915 MHz +14 dBm + 10 dBm 2.4 GHz BLE Radio Board Kit
xG28-RB4401C	xG28 868-915 MHz +20 dBm + 10 dBm 2.4 GHz BLE Radio Board Kit

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# Z-Wave Long Range Testing

# Z-Wave LR vs. LoRaWAN

## Pros of Z-Wave LR:

### ■ Current Draw: 1:3 ratio

- ZWLR: 40mA vs LoRaWAN:130mA  
20dBm Tx power

#### ○ Reduces:

- BOM COST
- BATTERY
- REQUIREMENTS
- POWER SUPPLIED
- SIZE OF DESIGN

- No costly cloud-based LoRa Network Servers via telcos
- Low-cost Controllers 1:4 ratio
- Defined command classes vs DIY data models
- Low peripheral component cost  
component cost 1:4 ratio

1. Data from: <https://multitech.com/wp-content/uploads/S000645-xDOT-Developer-Guide.pdf>

# ZWLR vs LoRaWAN in Residential areas

## ZGM130S +14dBm vs MultiTech MTDOT +19dBm



# Case 1, Residential

## Z-Wave LR:

- 347m, non-line of sight
- 100/100 packets, 0 errors
- 100 or 40 kbps

## LoRa WAN:

- 372m, non-line of sight
  - 7% range gain, even with 5dB advantage
- 10/10 packets, 0 errors
- 980 bits per second (SF10)



## Case 2, Residential + Small/Medium Business (SMB)

Z-Wave LR:

494m non-line of sight

LoRaWAN:

494m, non-line of sight

- 0% range gain when slightly less LoS
- **Consider 5dBm advantage**



# ZWLR +14 and LoRaWAN +20 sometimes attain equal range

Both ZWLR and LoRaWAN met edge of range at ~628m:

- Blocked by houses, a concrete school and SMB





# Conclusions

Z-Wave Long Range offers near LoRaWAN range in Residential and small business areas

## Z-Wave Pros:

- No cloud service fees
- Finished frames arrive at gateway
- Allows for edge processing and reduction of cell fees
- 60% less power consumption
- Well-defined data models
- Coin cell capable
- Interoperability
- Can use already deployed hubs

Both ZWLR and LoRaWAN met at ~628m



Mark Umina  
Field Applications Engineer, SiLabs

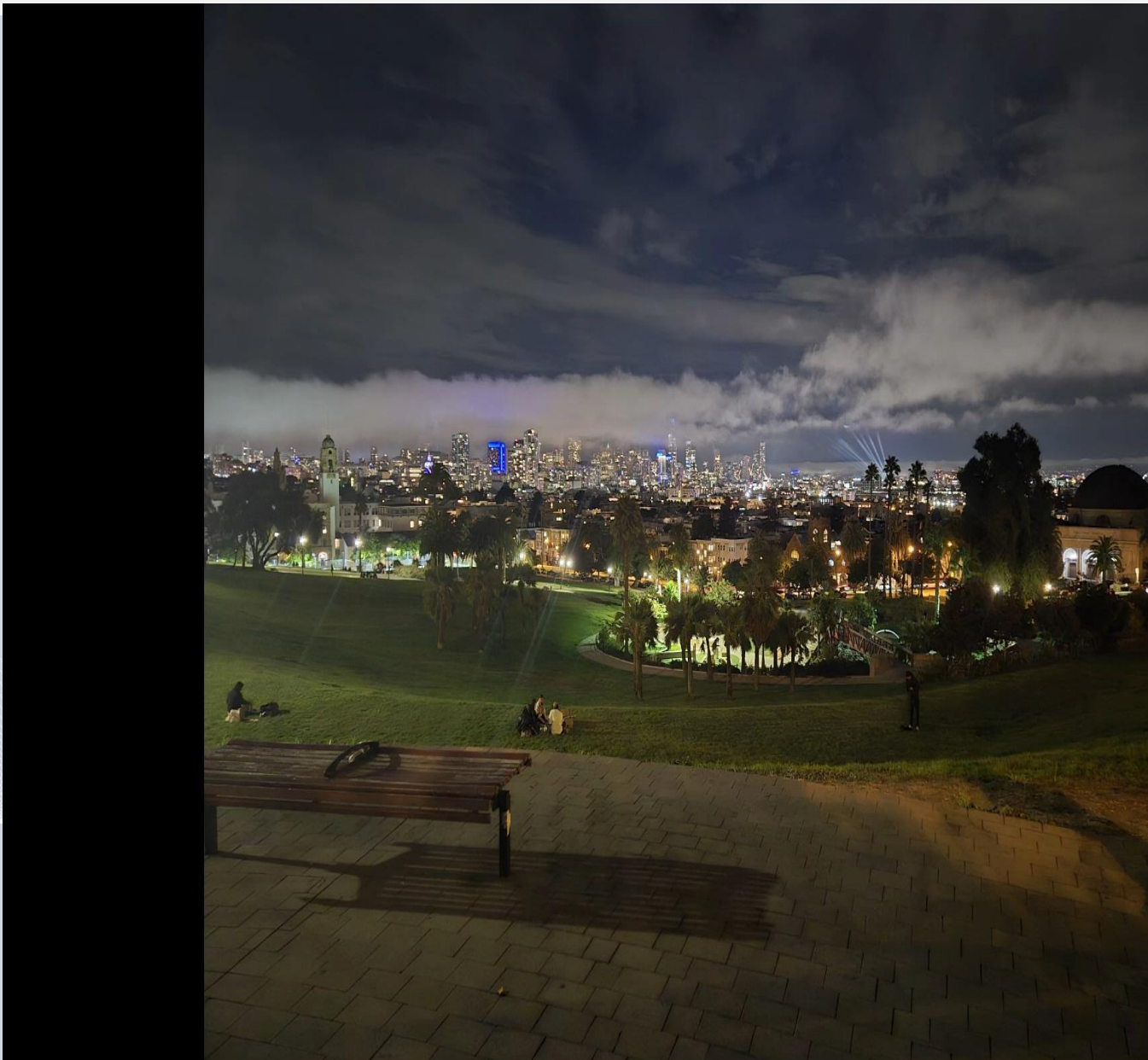
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# Z-Wave Long Range Demo



Demo time:

4:00





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Thank You