LR102

Technical Comparison of Wi-SUN, Z-Wave LR, & Amazon Sidewalk for Smart City and IoT Applications

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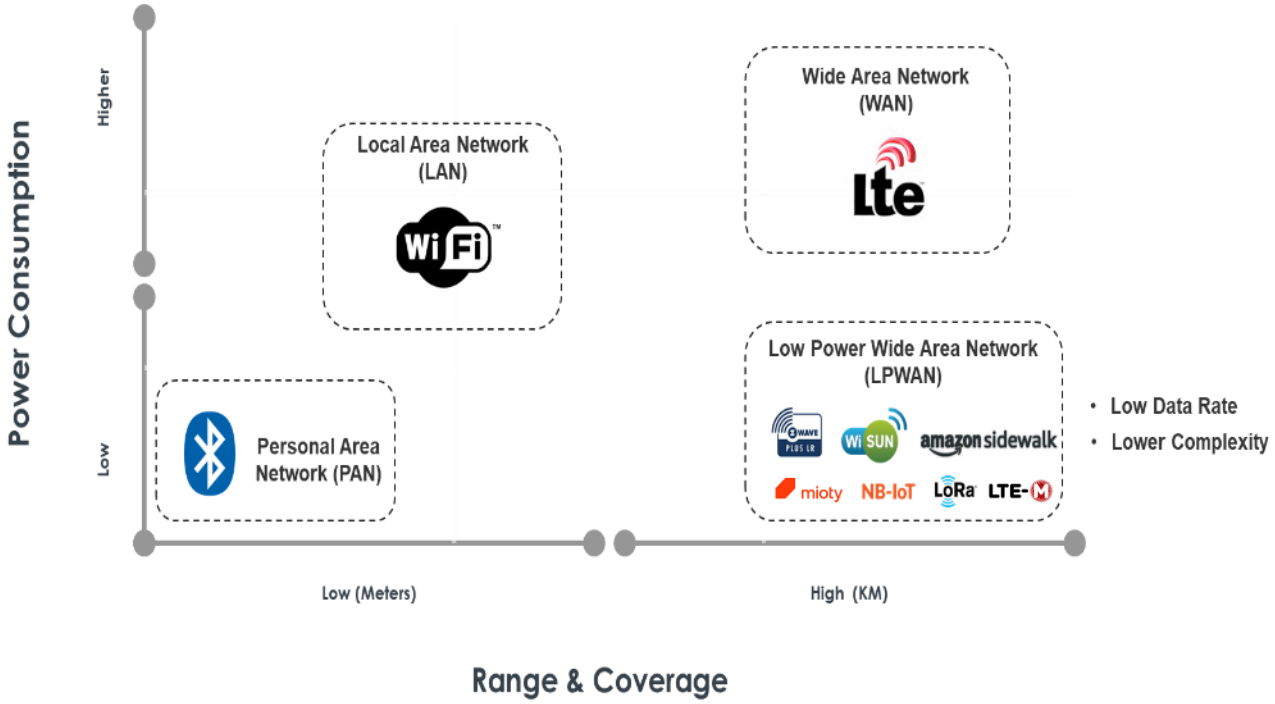
Agenda

- Target Markets
- Design Objectives
- Technology Overview
- Key Technical Attributes
- Silicon Labs Portfolio
- Antenna Design for IoT

Quick Primer on LPWAN



- Agriculture & Environment
- Building & Infrastructure
- Healthcare
- Home & Consumer
- Industrial & Manufacturing
- Retail & Commerce
- Smart Cities & Others
- Transportation, Supply Chain & Logistics
- Utilities

Each LPWAN technology focus on a target use case by addressing its unique requirements

Three IoT solutions tailored for three distinct markets

	Wi-SUN	Z-WAVE PLUS LR	amazon sidewalk
Primary MKT	Smart Metering	Smart Home & Beyond	Generic LPWAN
	Smart City, Smart Energy, Smart Agriculture	MDUs, Hospitality	Trackers, Telemetry, Appliances, Security Cameras
Primary Objective	Scalability & Flexible Data Rate [1,000,000s of Nodes]	Longer Range [Over a mile Line of Sight]	Coverage & "Free Network Access" [Nation Wide]
Additional Objective	Re-use existing & proven standards	Ease of Use [SmartStart]	Community Network
	Flexibility [Data rate, Modulation]	Low Power [Up to 10 Years]	Cost-Effectiveness
	Interoperability [Certification]	Interoperability [Certification]	Seamless Integration [AWS], Alexa
	Security [PKI, Certificates]	Security [S2V2]	Security & Privacy [Certificate]
	Reliability & Robustness [MESH]	Reliability & Robustness [sub-GHz]	Reliability & Robustness [Redundancy]

OSI Layer Mapping & Scope of each protocol

Flexible Application Layer
Network Level Interoperability

Well defined Application Layer
Application-Level Interoperability

Secure Data Pipe to Cloud

Scope of Wi-SUN Specification

Scope of Z-Wave Specification

Scope of Sidewalk Specification

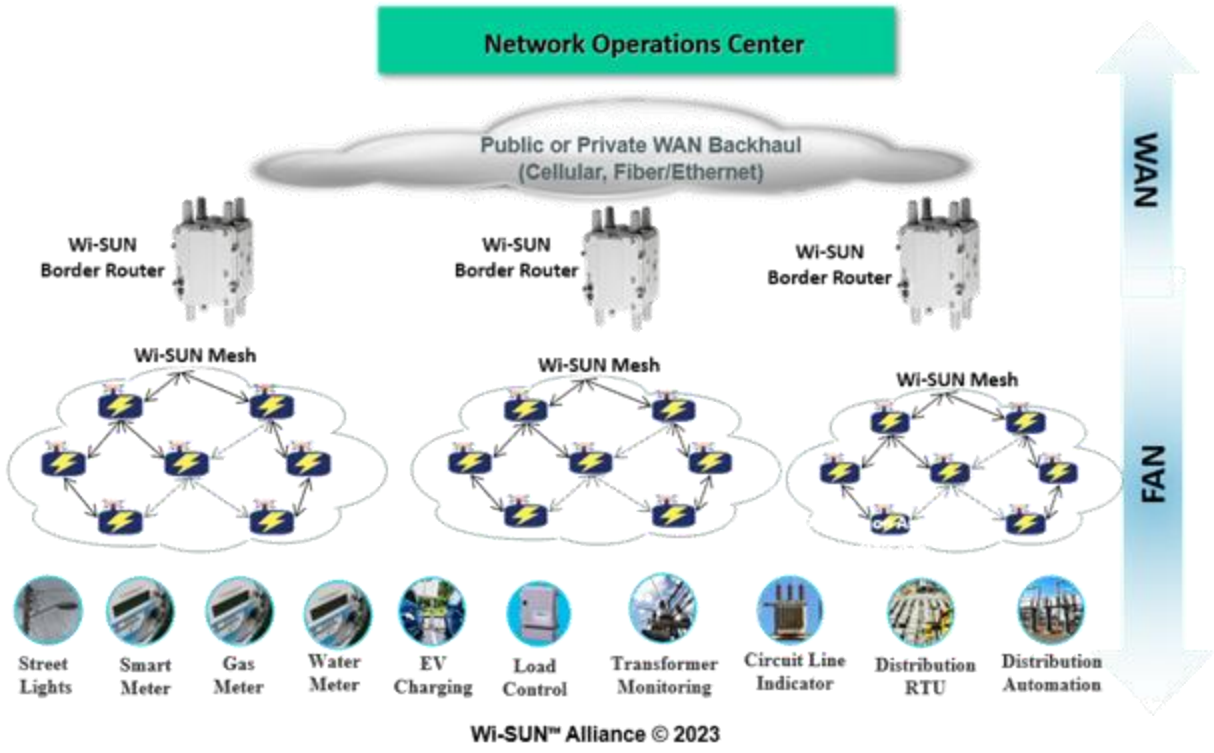
Sub-GHz & 2.4 GHz | MESH & STAR

Sub-GHz | STAR

Sub-GHz & 2.4 GHz | STAR

Wi-SUN

Brief Introduction to Wi-SUN



300+
Members

100m+
Devices Worldwide

46
Countries Represented

Wi-SUN [Wireless Smart Ubiquitous Network]

- Standards based (IEEE and IETF)
- Wireless IPv6 mesh network. Self forming/self healing
- For large geography Industrial IoT field applications
- Designed with enterprise class security

Field Area Network [FAN] Standards Evolution

- FAN Spec describes how to implement a device for FAN communication
- The FAN Certification Program ensures interoperability

FAN1.0 [Production] – 105 Certified Products

- For Line Powered Devices [Electric Meters, Street Lights etc..]
- FSK only modulation , Multiple Data Rates

FAN1.1 [Latest Specification]

- Added OFDM modulation, Data rate up to 2.4 Mbps
- Added support for Battery Powered Devices [Water & Gas Meters, Sensors]

FAN1.2 [Concept]

- Certificate enrolment, Time Reference Distribution, Network Management

Wi-SUN FAN1.1 High Level Features

High Performance [HP]

Low Energy [LE]

Mode Switching

FAN1.1 High Performance [HP]

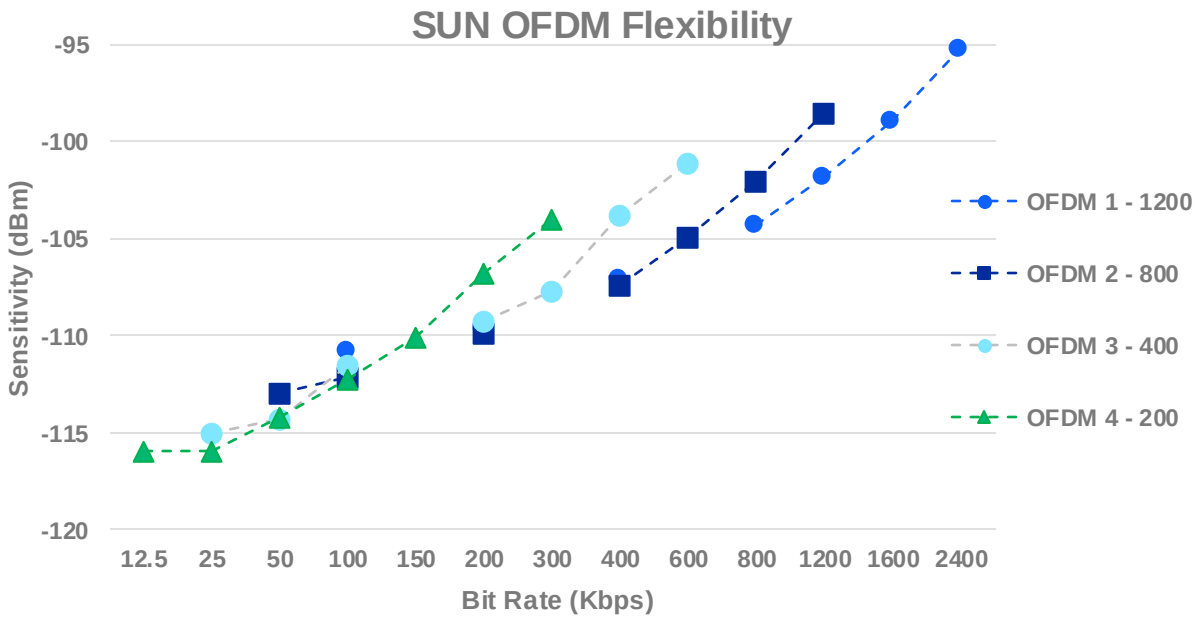
- High throughput OFDM PHYs, Up to 2.4 Mbps
- Recommended SoC : FG25

- FAN1.1 Low Energy [LE]
  - For battery operated devices
  - Recommended SoC : FG28

- Modulation and Data Rate Switching
  - Dynamic negotiation of modulation & data rate based on application requirement & channel condition

High Performance through OFDM Modulation, Multiple Data Rates & Channel BW

OFDM option	Bandwidth (kHz)	Main regions	Bit rates (kbps)	Sensitivity (dBm)
1	1200	NA, BZ	100 to 2400 (3600*)	-111 to -95
2	800	NA, BZ, JP	50 to 1200 (1800*)	-113 to -98
3	400	NA, BZ, JP	25 to 600 (900*)	-115 to -101
4	200	NA, BZ, JP, EU	12.5 to 300 (450*)	-116 to -104



Example of Tx duration for a 1500-Byte PHY Payload

bandwidth (KHz)	modulation	bit rate (kbps)	Tx duration (ms)
200	FSK 1b	50	241.9
	FSK 2a	100	121.0
	OFDM 4 MCS3	100	121.6
	OFDM 4 MCS6	300	41.5
	OFDM 4 MCS7	450	28.2
400	FSK 3	150	80.9
	FSK 4a	200	60.6
	OFDM 3 MCS3	200	61.6
	OFDM 3 MCS6	600	21.5
	OFDM 3 MCS7	900	14.9
600	FSK 5	300	40.7
800	OFDM 2 MCS3	400	31.6
	OFDM 2 MCS6	1200	11.5
	OFDM 2 MCS7	1800	8.2
1200	OFDM 1 MCS3	800	16.2
	OFDM 1 MCS6	2400	6.1
	OFDM 1 MCS7	3600	4.4

OFDM
FSK
DSSS-OQPSK
Mode-Switch
Concurrent Detection

Low Power Features in FAN1.1 LFN

LFN do not participate in the MESH

FFN participate in the MESH on behalf of LFN
This allows LFN to limit its TX & RX to save battery life

LFN “sleeps” most of the time

LFNs turn their receiver on only for a brief to check for data from FFN

LFN keys are long lived

Security process, key acquisition and maintenance are expensive and having long lived keys allow LFN to save power

LFN Battery Life specification in FAN1.1 spec.

- LFN battery life of 20 years (suggested battery of 3 volts with 2 AHr capacity).
- The MAC MUST support a < 2-minute response time for LFNs

- EFR32FG28 offer best in class FAN1.1 low power performance

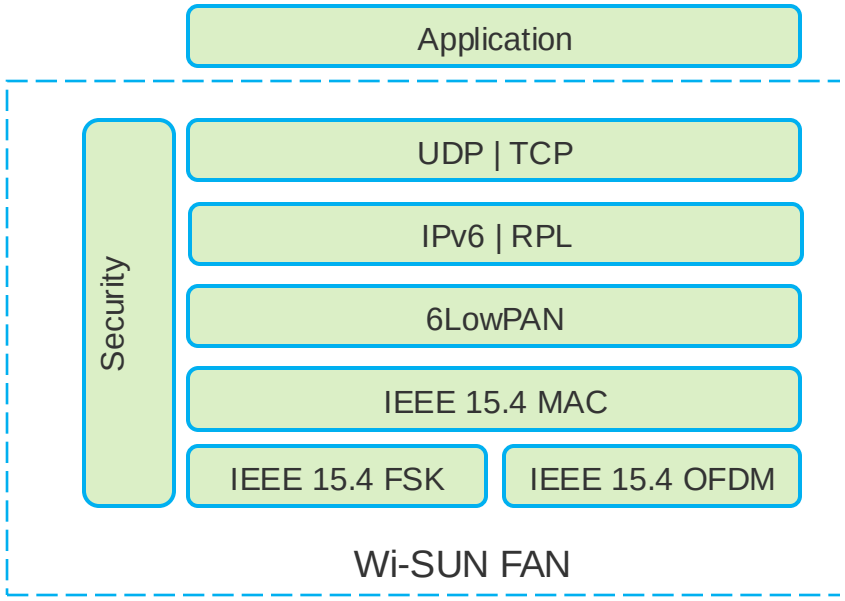
Sleep Current (EM2, 16 kB ret)	1.6 µA
TX Current @ +14 dBm (915 MHz)	25 mA
TX Current @ +20 dBm (915 MHz)	89 mA
RX Current (915 MHz GFSK)	4.3 mA (50 kbps)

LFN will stay in EM2 (1.6 µA) state while sleeping

Note - LFN is the technical/spec terminology and LE is the marketing / branding

Wi-SUN FAN1.1 Stack

- IPv6 Protocol
  - 6LowPAN Adaptation
  - RPL Routing
  - Unicast & Multicast
  - DHCPv6
- Security
  - PKI & Certificate based
  - EAP-TLS/PKI Authentication
  - 802.11i Key Management
  - AEC-CCM 128b Encryption



- MAC
  - Discovery & Join
  - Unicast, Multicast & Broadcast
  - Frequency Hopping
- PHY
  - Sub-GHz & 2.4 GHz
    - Sub-GHz is popular
  - Global Coverage
    - NA, JP, BZ, IN, EU, SG
  - Multiple Modulations
    - FSK & OFDM
  - Multiple Data Rates
    - 50 Kbps – 2.4 Mbps

Silicon Labs' Wi-SUN Product Portfolio

Increasing Memory & Features

OFDM & FSK

- Wi-SUN
- Proprietary
- SecureVault
- +20 dBm
- For BR & Routers

Dual-Band, AI/ML, Low Power, Longer Range, Secure & Multi-Protocol

- Wi-SUN
- Z-Wave MESH & LR
- Proprietary
- Amazon Sidewalk
- BLE
- SecureVault
- +20 dBm
- For BR, Routers & LFN

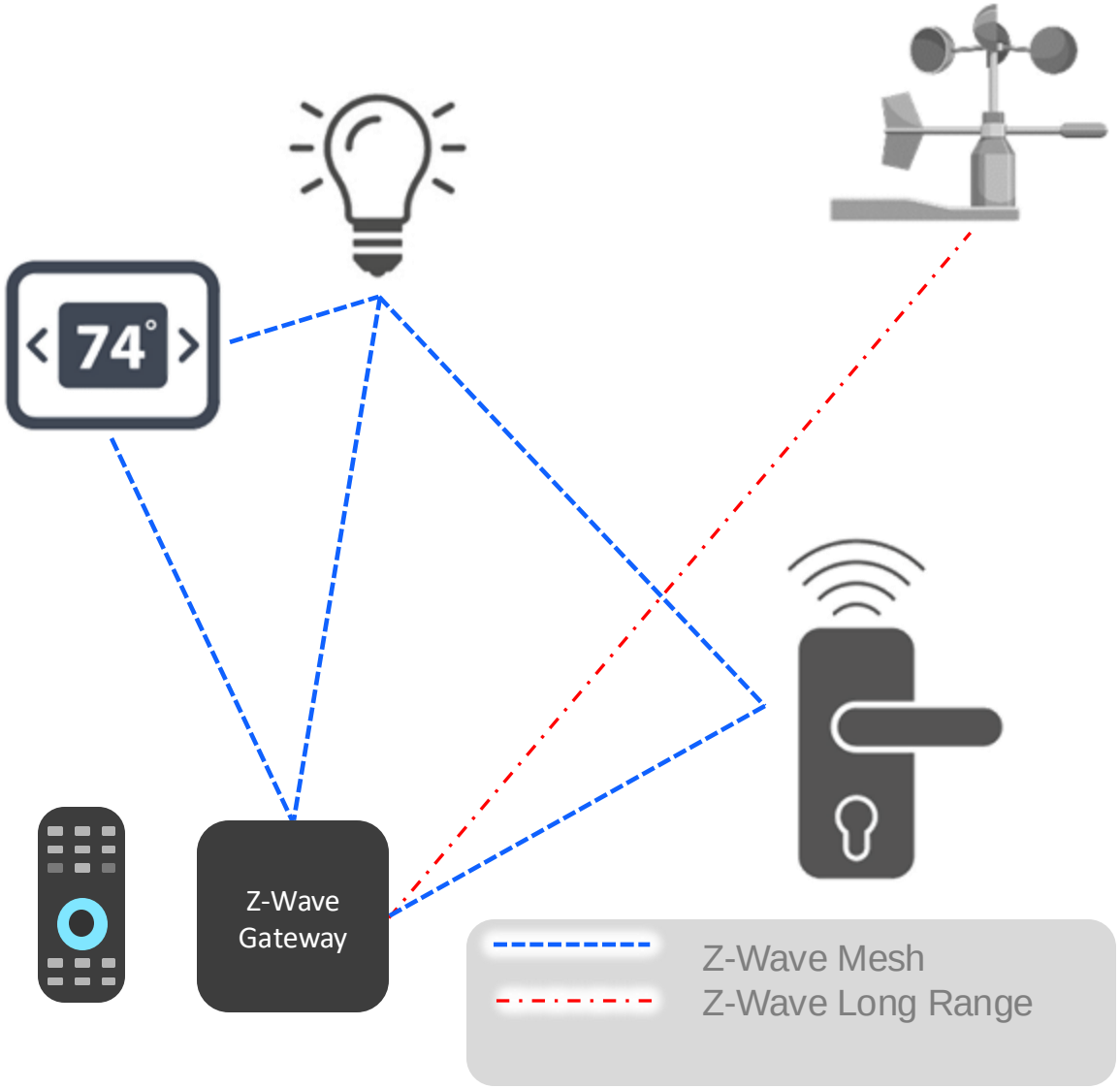
Complete Solution

- Supports All Devices Types
  - Router, Border Router & LFN
- Supports All Modulations
  - OFDM, FSK & DSSS OQPSK
- Supports All Regions
  - US, JP, BZ, IN, EU, SG
- PHY & Profile Certification
  - FG25 is also a FAN1.1 PHY CTBU
- Wi-SUN FAN1.1 Stack
  - Out of the box support for Cisco FND

2023 2024 2025 2026 2027 2028

Z-Wave Long Range

Brief Introduction to Z-Wave Long Range



New Long-Range channel in Z-Wave

- DSSS-OQPSK PHY ; 100 kbps data rate
- Up to +30 dBm TX power [FCC 15.247]

Highly scalable up to 4000 nodes

- 12-bit address space

Optimized for longer battery life

- Dynamic power control to optimize battery life
- Multi year battery life on a coin cell

STAR Topology

- Lower latency due to direct link to GW

Backward compatibility

- Z-Wave MESH & Z-Wave LR can co-exists

Technology behind the range and long battery life of Z-Wave Long Range

Range

- New DSSS-OQPSK Modulation
  - Uses BW>500kHz allows transmission to +30dBm/1w max per FCC 15.247
  - Better sensitivity compared FSK, again improving the range

Low Power

- Dynamic Transmit Power
  - Higher TX power needed for Range [+14 dBm, +20 dBm] can reduce battery life
  - To address this Z-Wave LR uses Dynamic TX power and optimize TX power

Specification

Range & Low Power - A combination of the specification & implementation

800 Series

Range

- +20 dBm TX power with integrated PA
- -109.8 dBm sensitivity with integrated LNA
- ~130 dB Link budget offering over 1.5 miles outdoor LoS Range

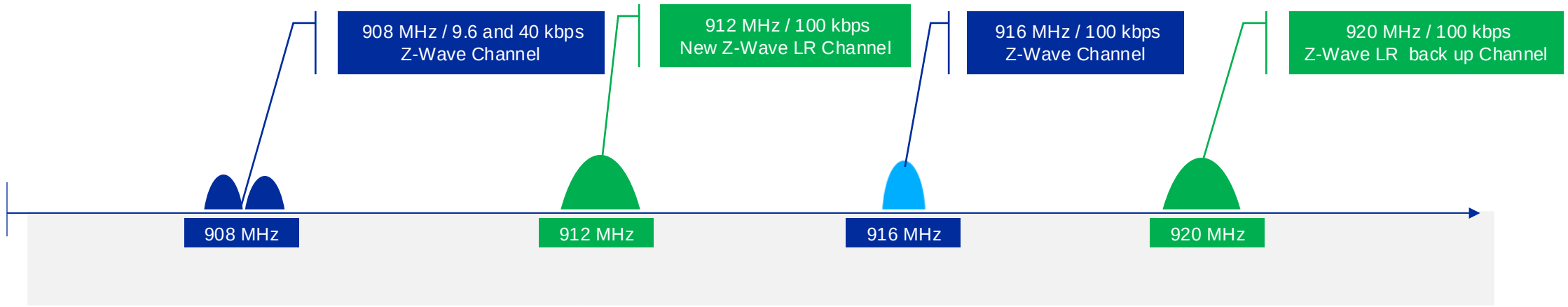
ZG23

Low Power

- 0.15 uA Sleep Current [EM3 with 16 KB RAM retention]
- 4.5 mA Receive Current [@ at 3.3 V with DCDC]
- 25 mA TX Current [@ +14 dBm]

800 series offer the Lowest Power & Maximum Range Implementation of Z-Wave LR

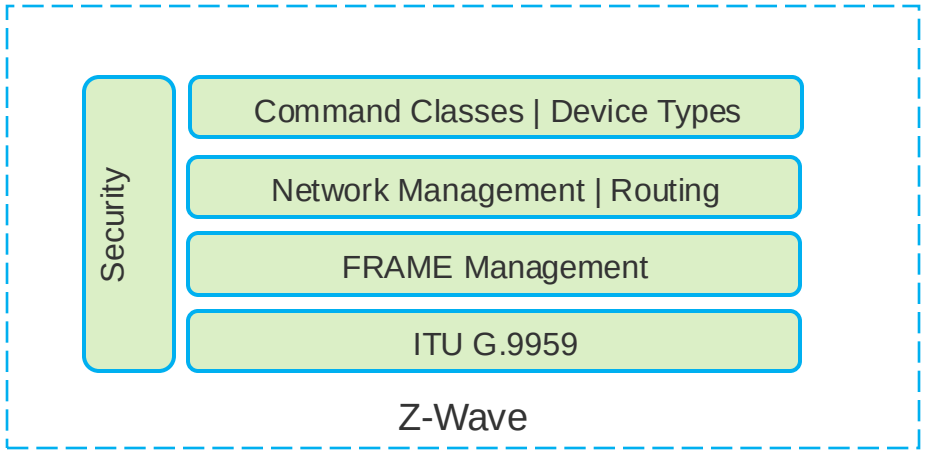
Z-Wave LR PHY and Channel details



PHY Details		Benefit
Modulation	DSSS-OQPSK	• Higher output power for longer range, Up to +30 dBm / 1w per FCC 15.247 • Better sensitivity compared to FSK resulting in more range • Better interference immunity compared to FSK
Frequency [North America]	912 MHz or 920 MHz	• Primary and Secondary channels for channel agility • Better network and blocker performance
Maximum Data Rate	100 kbps	• Comparable timing to Z-Wave MESH allowing for backward compatibility
Maximum output power	+20 dBm	• ZG23/28 offer +20 dBm with integrated PA for lower BoM & superior Range
Link Budget	129.8 dB	• Over a mile line of sight range

Z-Wave Long Range Stack

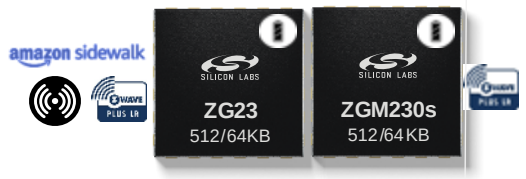
- Application Layer
  - Application CMD classes
  - Transport CMD classes
  - Role Type & Device Type
  - DHCPv6
- Security – S2v2
  - Diffie–Hellman key exchange
  - AES-128 Encryption



- MAC
  - Collision Avoidance
  - Acknowledged Frame Delivery
  - Frame Re-transmission
- PHY
  - Sub-GHz
    - 912 & 920 MHz
    - 800 MHz for EU
  - Global Coverage
    - NA & EU
  - DSSS-OQPSK Modulation
    - 100 Kbps

Silicon Labs' Z-Wave Product Portfolio

Increasing Memory & Features



Lower Power, Longer Range, Secure & Multi-Protocol

- Z-Wave MESH & LR
- Proprietary (SoC-Only)
- Amazon Sidewalk (SoC-Only)
- SecureVault
- +20 dBm (SoC-Only)
- For Gateways & End Nodes

Dual-Band, AI/ML, Low Power, Longer Range, Secure & Multi-Protocol

- Z-Wave MESH & LR
- Proprietary
- Amazon Sidewalk
- Wi-SUN
- BLE
- SecureVault
- +20 dBm
- For Gateways & End Nodes

Complete Solution

- Full Stack
  - Certified Sample Applications
- Z-Wave Alliance Certification
- Controller Reference Design
  - Unify SDK Protocol Controller

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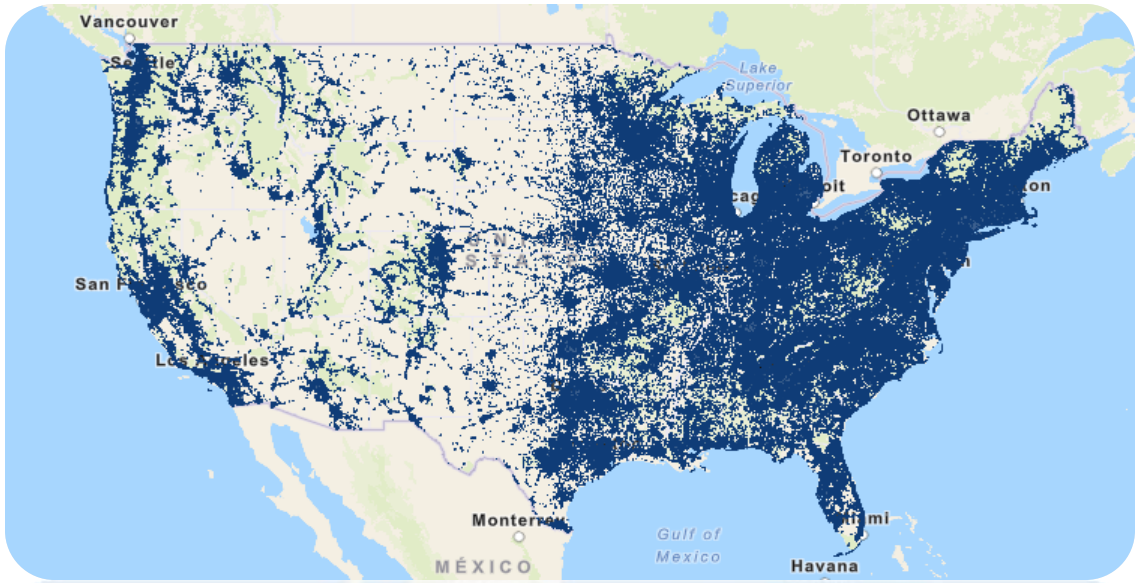
Amazon Sidewalk

Brief Introduction to Amazon Sidewalk

NETWORK BUILT BY THE COMMUNITY

Over 90% of US population covered



https://coverage.sidewalk.amazon/

- *Public and crowd-sourced*
- *The Amazon Sidewalk network provides cloud connectivity in the US via Ring and Echo devices*
- *The Amazon Sidewalk AWS integration provides access to 200+ services such as Sage Maker*

Amazon Sidewalk Connectivity

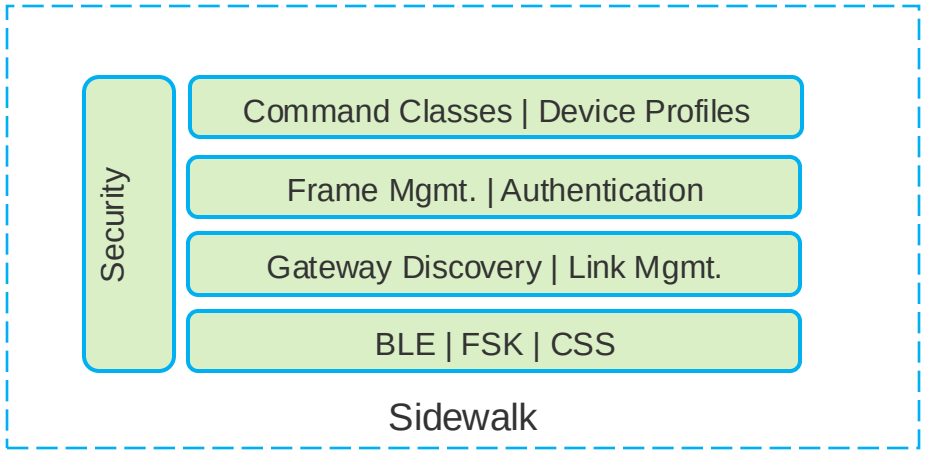
BLE for
battery & throughput

FSK for
whole home & beyond

CSS for
mobility & Wide Area Networking

Amazon Sidewalk Stack

- Application Layer
  - Application CMD classes
  - Management CMD classes
  - Custom CMD classes
  - Metrics CMD classes
  - Security CMD classes
- Security
  - Amazon Sidewalk's Public Key Infrastructure Certificate Authority system
  - Encryption, device registration, authentication and authorization
  - Ed25519 and p256r1 are used for keys and certificate generation.

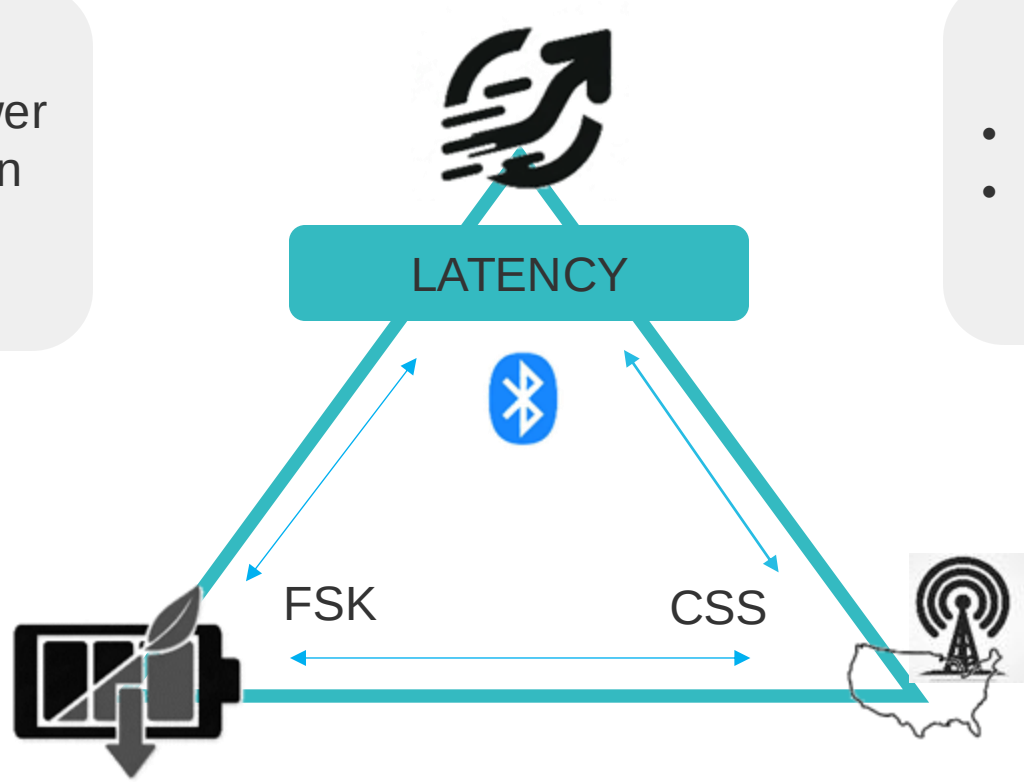


- Link & Network
  - Beacon frames
  - Message frames
  - Control Frames
  - Authentication
- PHYs
  - BLE – 1Mbps
  - FSK – 50 kbps
  - CSS – 2 kbps

Automatic Multi-Link

BENEFITS

Trading off latency and power consumption depending on network availability



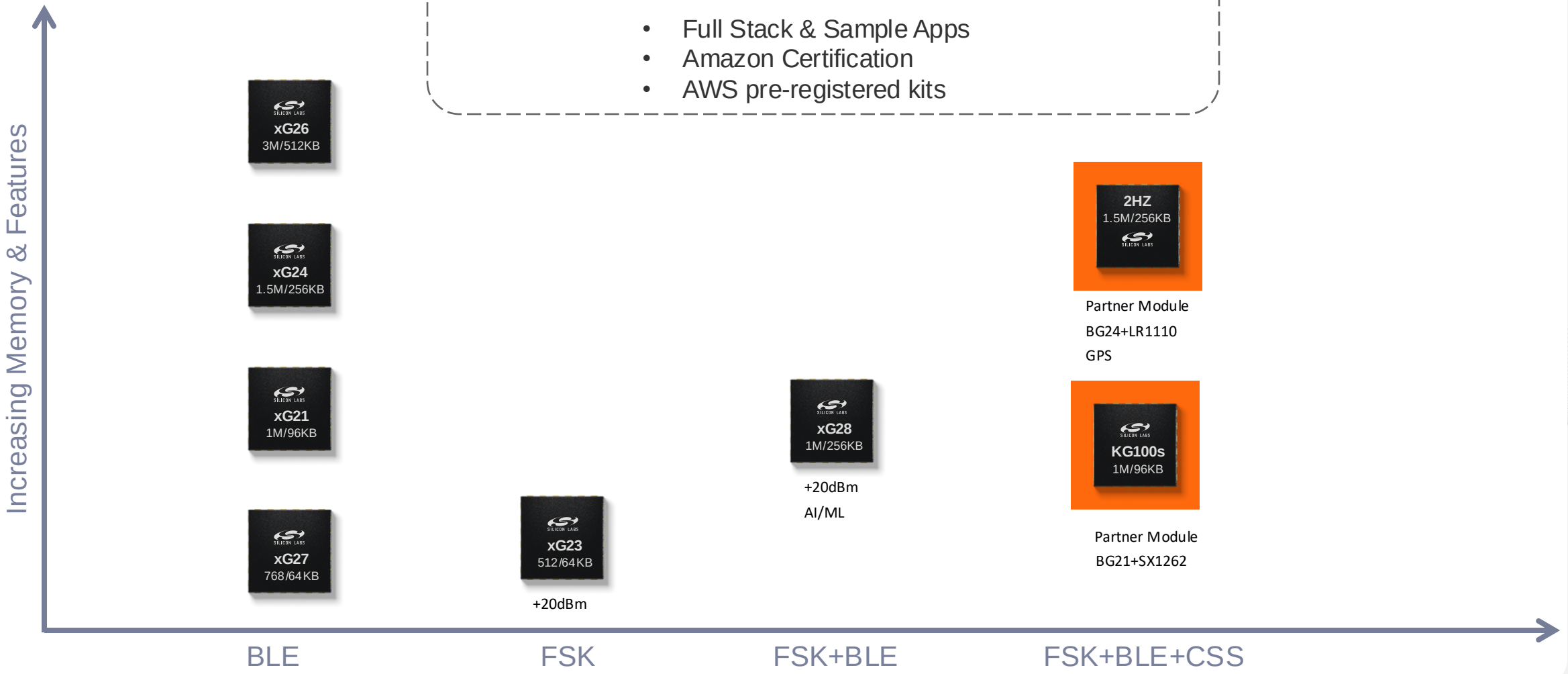
APPLICATIONS

- Trackers
- Mobile Telemetry Sensing

Silicon Labs' Amazon Sidewalk Product Portfolio

Complete Solution with Award-winning UX

- Full Stack & Sample Apps
- Amazon Certification
- AWS pre-registered kits



Summary

Summary & Re-cap

- Multiple market segments and use cases can be addressed with LPWAN technologies
- There is no single technology that address all requirements
- Wi-SUN, Z-Wave LR and Sidewalk focus on specific market segments and use cases.

Agriculture & Environment
Building & Infrastructure
Healthcare
Home & Consumer
Industrial & Manufacturing
Retail & Commerce
Smart Cities & Others
Transportation, Supply Chain & Logistics
Utilities

Summary & Re-cap

	Wi-SUN	Z-Wave Plus LR	amazon sidewalk
Primary MKT	**Smart Metering**	**Smart Home & Beyond**	**Generic LPWAN**
	Smart City, Smart Energy, Smart Agriculture	MDUs, Hospitality	Trackers, Telemetry, Appliances, Security Cameras

SILICON LABS

Complete Solution
SoCs, Full Stack, Sample Applications

Development Tools
Studio, Radio Boards, Certification

These 3 technologies can address almost all use cases in the LPWAN space

xG28 – All in one SoC for your LPWAN needs – Visit www.silabs.com

Q & A