SILICON LABS
CONNECTED INTELLIGENCE

2026 tech talks
WEBINAR SERIES

Connected, Responsive, and Efficient

Getting the most out of you low-power Wi-Fi products

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Wi-Fi CERTIFIED

Wi-Fi

SPEAKERS

MATT MAUPIN

SENIOR MANAGER – PRODUCT MARKETING

SILICON LABS

VASEEM KAZIA

STAFF PRODUCT MANAGER – WI-FI

SILICON LABS

Agenda

Introduction: Why Low-Power Wi-Fi

Wi-Fi Specification and Low Power Improvements

Designing for Low Power

Conclusions & Key Takeaways

Q&A

Introduction: Why Low-Power Wi-Fi

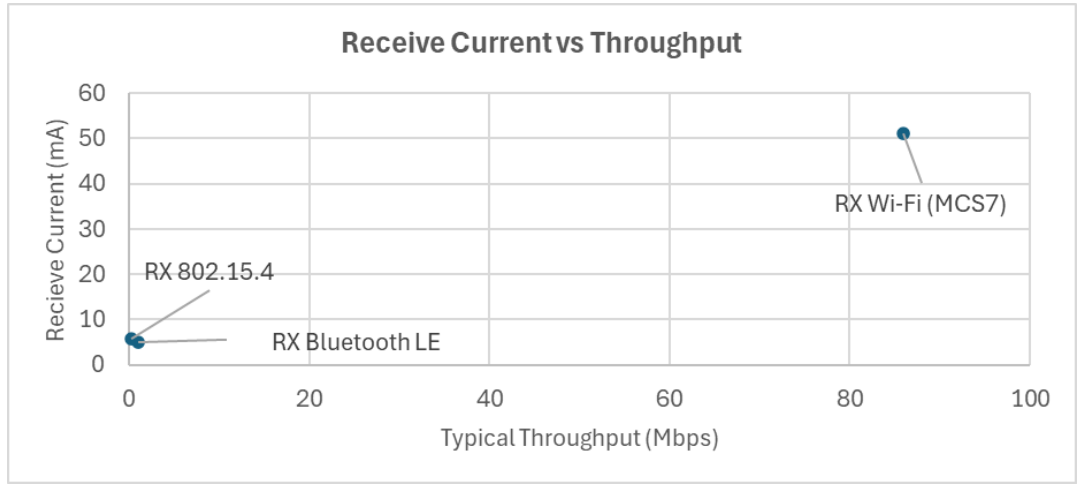


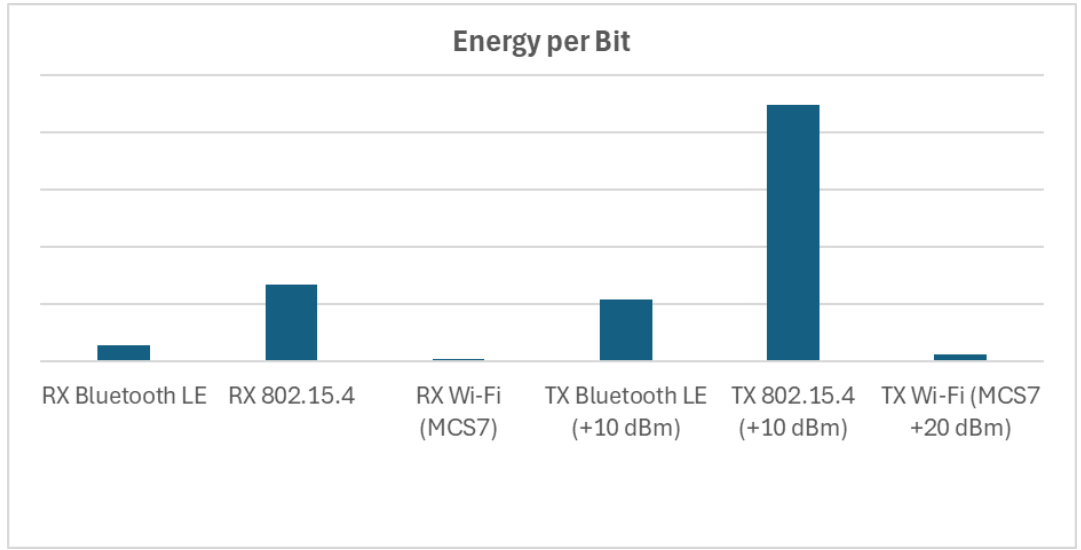



The Shift to Wi-Fi for Low Power Applications

- **Wi-Fi devices need low power options**
  - Low power Wi-Fi is still orders of magnitude more
    - More then 5x the active and sleep currents of 802.15.4 & BLE

- **However, Wi-Fi offers unique benefits**
  - Ubiquity
    - >90% of homes in developed countries have Wi-Fi
  - Native cloud connectivity
    - Wi-Fi is in the gateway, no separate hub required
  - Provides orders of magnitude higher throughput
    - Video streaming, large data transfer and real time applications
    - Wi-Fi has lower energy per bit
      - Efficient for larger data transfers
      - Inefficient for small payloads
      - Large overhead (preambles, headers)





Applications for Low Power Wi-Fi

- **Many applications require low power Wi-Fi**
  - Low power is more then just running on batteries

- **Low power needs to address battery-powered and power-constrained mains powered devices**
  - Battery powered devices for primary cell and rechargeable applications
    - CR2450 (3V) coin cell 500mAh
    - 4xAA (6V) batteries 2500mAh
    - Rechargeable battery (3.6V) – 200mAh to 5000mAh (depends on size – wearable to larger handheld device)
  - Power-constrained wired applications require lower current draw and average power consumption
    - No neutral wire for smart switches
    - No C wire for T-Stats
    - Low current budget or vampire current

Low Power Device Behavior and Modes

- **Duty cycled and event driven**
  - Sensors: periodic or event-based reporting
    - Window sensor that reports a status or an event (window opens)
  - Actuators: respond to command
    - Door lock that need to respond in a timely fashion (unlock door)
  - Duty Cycled: connects as needed
    - Wearable device that connects to mobile to send data
- **Wi-Fi Modes**
  - Associated
    - Always-on
  - Standby Associated
    - Legacy Power-Save Mode (PSM)
    - WMM Power Save
    - DTIM Interval
  - Disassociation
    - Disconnected from network

Smart Locks

- Battery: Typically, primary cell (4xAA)
- Actuator: Polls every 3 to 5 seconds for message
- Throughput: Low, higher for firmware updates

Wireless Sensors

- Battery: Small form factor primary cell (CR123A)
- Reports: Infrequent heartbeat and on event
- Throughput: Low. May not support firmware updates

Smart Thermostats

- Battery: Primary or rechargeable for backup power
- Actuator: Polls and reports data
- Throughput: Low, higher for firmware updates

Wearable Devices

- Battery: Rechargeable lasting days or weeks
- Duty cycle: Mode depending on use case
- Throughput: Low to high, dependent on mode

Medical Devices

- Battery: Lithium primary cell or rechargeable
- Reports: Polling varies based on device
- Throughput: Low.

Wi-Fi Power States

Application Type	Example	Key Requirement	Dominant Power Factor	Optimal Strategy
Always-On	Security Camera Lighting Wearables	Low Latency	Transmit (TX) Power	Optimize for efficient data transmission
Periodically Connected (Actuators)	Door Lock Thermostat Shades/Blinds	Balanced Power/Latency	Receive & Sleep Current	Use DTIM intervals and WMM Power Save
Event-Driven (Sensors)	Order Button Door/Window Sensor Smoke/Co Detectors	Ultra-Low Standby Power	Deep Sleep Current	Dissociate from the network when inactive

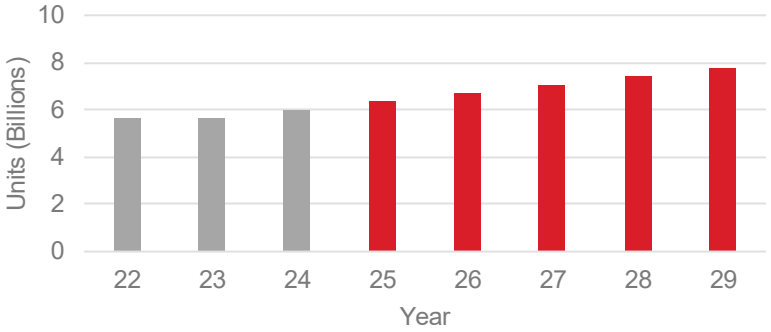
Wi-Fi Specification and Low Power Improvements






Wi-Fi: 25+ Years of Evolution, Ubiquity and Everyday Impact

Annual Wi-Fi Devices Shipped

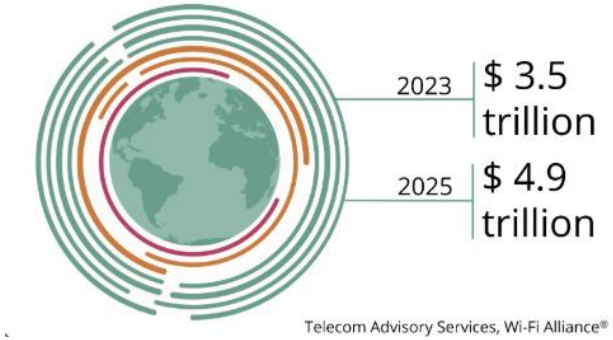


Source: ABI Research 1Q25 Wi-Fi Market Tracker

21B+ Devices in use

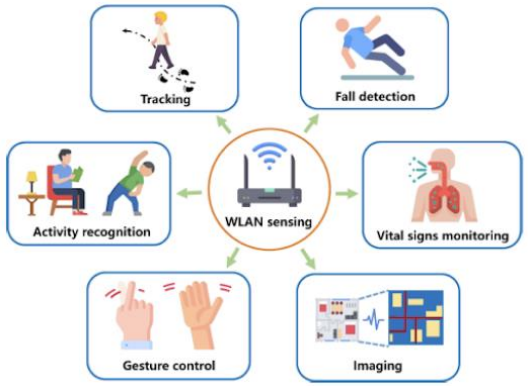
5.3 % CAGR ('25-'29)

Global Value of Wi-Fi

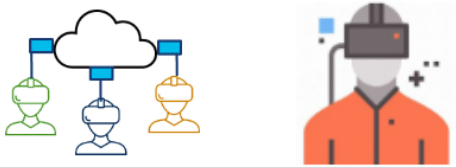


Telecom Advisory Services, Wi-Fi Alliance®

Multiple Applications beyond basic connectivity



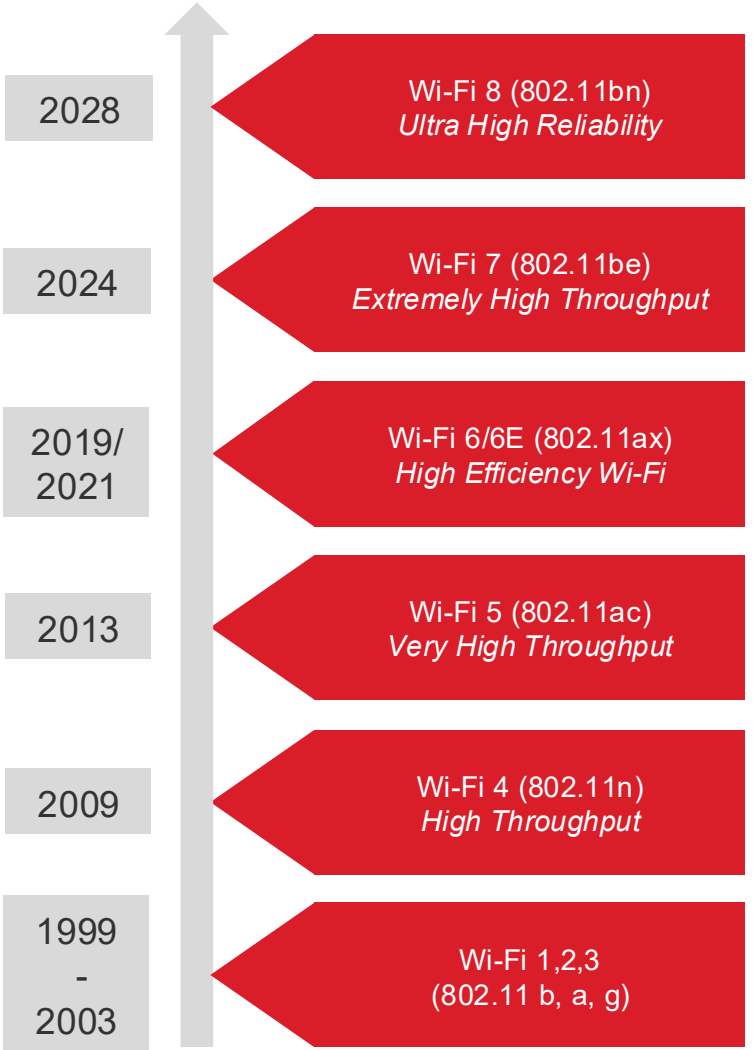
Wi-Fi Sensing applications



Multi-use XR, Immersive gaming

Automotive Infotainment

Evolving with user needs



Wi-Fi Standard Evolution

Reliability
Efficiency
Density
Capacity
Speed
Applications

Wi-Fi 4
(802.11n)

600 Mbps

2009

- ***Cost effectiveness & reliability for IoT***
- Basic HD streaming
- Multi devices per home
- SOHO setups
- Dual-Band
- MIMO
- Aggregation
- 64-QAM

Wi-Fi 5
(802.11ac)

6.9 Gbps

2013

- ***High throughput for video IoT***
- HD & 4K streaming
- Online gaming
- Large file transfer
- DL MU-MIMO
- 80/160MHz BW
- 256-QAM

Wi-Fi 6/6E
(802.11ax)

9.6 Gbps

2018 / 2020

- ***Low-Power (TWT), Spectral-efficiency & increased density for IoT***
- High density environment
- IoT and smart homes
- Enhanced gaming
- Immersive VR/AR
- OFDMA
- TWT
- BSS-coloring
- 6GHz band
- 1024-QAM

Wi-Fi 7
(802.11be)

46 Gbps

2024

- ***Increased reliability & reduced latency with MLO for IoT***
- Seamless 4K/8K streaming
- RT Advanced VR/AR
- High-capacity Wi-Fi
- MLO (Multi-Link)
- RTWT
- Multi-RU
- 320MHz
- 4096-QAM

Wi-Fi 8
(802.11bn)

46Gbps*

2028

** one AP*

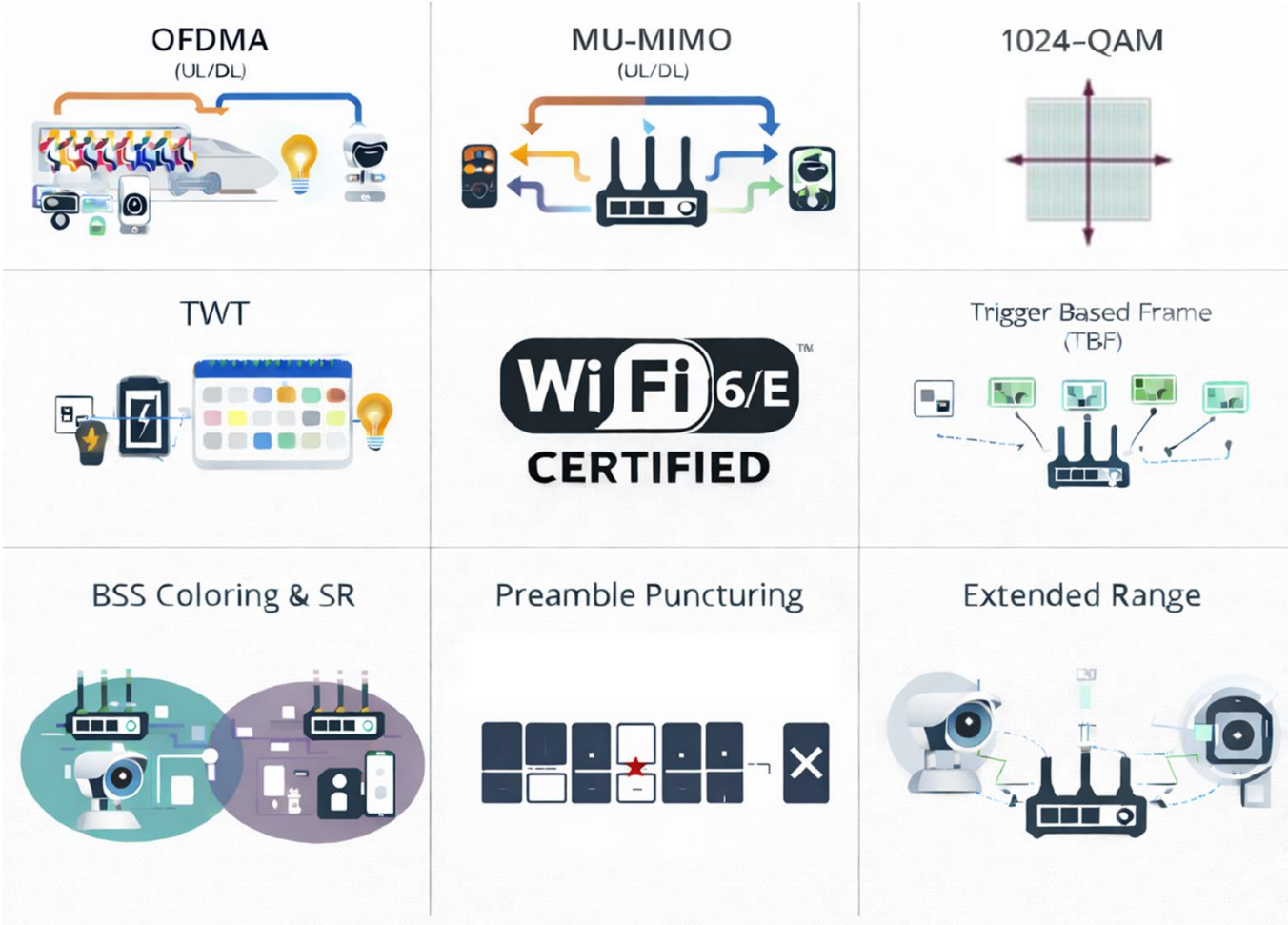
- ***Ultra-high reliability & lower power for IoT***
- Advanced AI/ML driven network optimization
- NG IoT (e-Health, Digital twin, etc)
- Highly-reliable Wi-Fi
- Multi-AP Coordination
- Co-RTWT
- Finer MCS, dRU, UEQM, NPCA, ELR
- DSO, HIP-EDCA, Enhanced IDC

Latency
Power
(J/bit)

Adoption Accelerating

Key Wi-Fi 6 Features

- **OFDMA**
  - Allows multiple devices to transmit simultaneously
  - Reduces latency and increases efficiency
- **MU-MIMO**
  - Wi-Fi 6 Enables MU-MIMO on both downlink and uplink
  - Enables AP to send data to multiple clients at once and enables multiple clients to transmit simultaneously to AP
- **1024-QAM**
  - Increases modulation density from 256-QAM to 1024-QAM for 25% higher raw data rates
- **TWT**
  - Reduces power consumption for IoT and battery-powered devices
- **Trigger Based Frame**
  - Cuts contention overhead, minimizes collision-driven retransmissions, lowers active radio time, and reduces latency (more predictable as well)
- **BSS Coloring**
  - Improves spatial re-use in dense deployment by enabling devices to ignore transmissions from overlapping networks
- **Preamble Puncturing**
  - Allows 20MHz only device to operate at full bandwidth simultaneously with other high bandwidth devices
- **Extended Range**
  - HE ER SU PPDU, 4x guard interval and 4x LTF, 2MHz RU with PSD boost (Uplink)

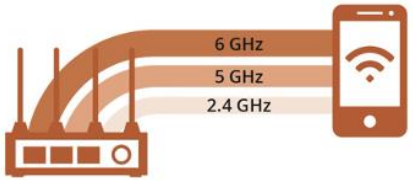


Key Wi-Fi 7 & Wi-Fi 8 Features

Wi-Fi 7 & 7 R2 Features

Multi-Link Operation (MLO)

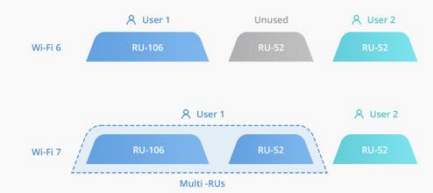
Enables
- Multi-Band aggregation
- Lower Latency via link selection
- Roaming reliability



Solves
- Resiliency problem by providing fallback connection
- Roaming issues between different bands with seamless handover
- Power reduction on multi-band STA with seamless switch

Multi-RU

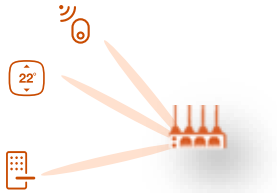
Enables
- Reduced wastage of spectrum
- Devices to use multiple sizes RUs



Solves
- Wi-Fi performance Issues in dense environments
- Jitter/Latency issues for real-time applications

20 MHz-only STA (R2)

Enables
- Low Power IoT STA with Wi-Fi 7
- Certification of low cost IoT devices and AP capability

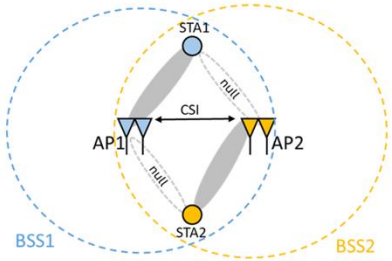


Solves
- Market adoption of Wi-Fi 7 in the IoT world

Wi-Fi 8 Features

Multi-AP Coordination (MAPC)

Enables
- APs to work together intelligently
- Improves signal quality with Coordinated BF



Solves
- MDU & Enterprise Wi-Fi deployment issues
- Enhances efficiency of Wi-Fi Mesh networks

Enhanced Power Save

Enables
- 20MHz Low Power operation for main-stream clients
- Selective Bandwidth Operation depending on the need

Solves
- Power issues on high-end clients such as Phones/Tablet
- Improvements for European Power regulations on Access Points

Enhanced Long Range (ELR)

Enables
- Improved link robustness at long range
- New PPDU format for reliable uplink communication
- Operation across supported bands with low data rates (1.67 / 3.33 Mbps)

Solves
- Coverage gaps in extended range deployments
- Reliability issues at cell edge and weak signal conditions

Wi-Fi Evolution to Low Power for IoT

- Legacy Wi-Fi (802.11b/g/n) and Low Power
  - Legacy Power Save Mode (PSM): The original power-saving mechanism
    - Allowed a device to doze but required it to wake up frequently (every DTIM, ~100-300ms) to listen for beacons
  - The Problem: The "doze" state wasn't very deep
    - Frequent wake-ups kept average power consumption too high for multi-year battery life
- Wi-Fi 6 (802.11ax): A Paradigm Shift for IoT
  - Wi-Fi 6 wasn't just about speed; it was fundamentally about efficiency
  - It introduced several features specifically designed to support dense deployments of low-power IoT devices
    - Target Wake Time (TWT)
    - BSS Coloring
    - OFDMA & RU
- Wi-Fi 7 (802.11be): The Future of Low-Power Efficiency
  - Builds upon the foundation of Wi-Fi 6/6E
  - Headline features focus on Extreme High Throughput (EHT)
    - However, several are highly relevant to low-power operation by further increasing efficiency
  - Key Features for IoT:
    - Multi-Link Operation (MLO)
    - Punctured Transmission
    - OFDMA & MRU
    - RTWT

Infrastructure Rollout: A Reality Check

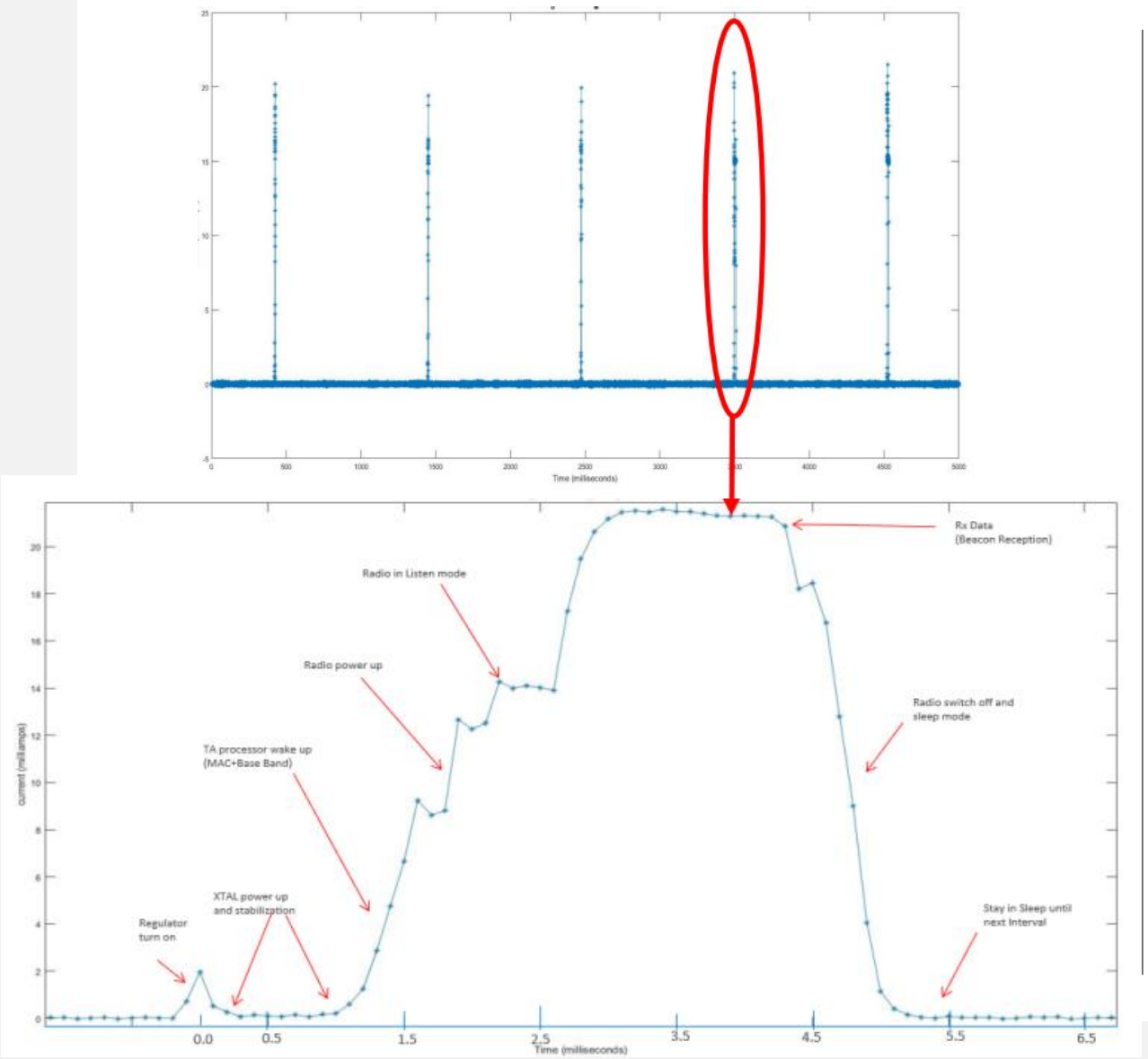
- Device support is only half the story. The AP must support these features too!
- Luckily, Infrastructure APs typically pioneer new Wi-Fi standards and features, leading the adoption curve well ahead
- Wi-Fi 6/6E: Rollout is now very widespread and dominating in consumer and enterprise APs
  - Wi-Fi 6E: Adoption is accelerating, a key enabler for clean-slate IoT deployments
- Wi-Fi 7: becoming mainstream market, surpassing 90% in 2028 according to Dell O'ro projection
- Wi-Fi 8: Draft-compliant consumer products launched since CES 2026

Designing for Low Power





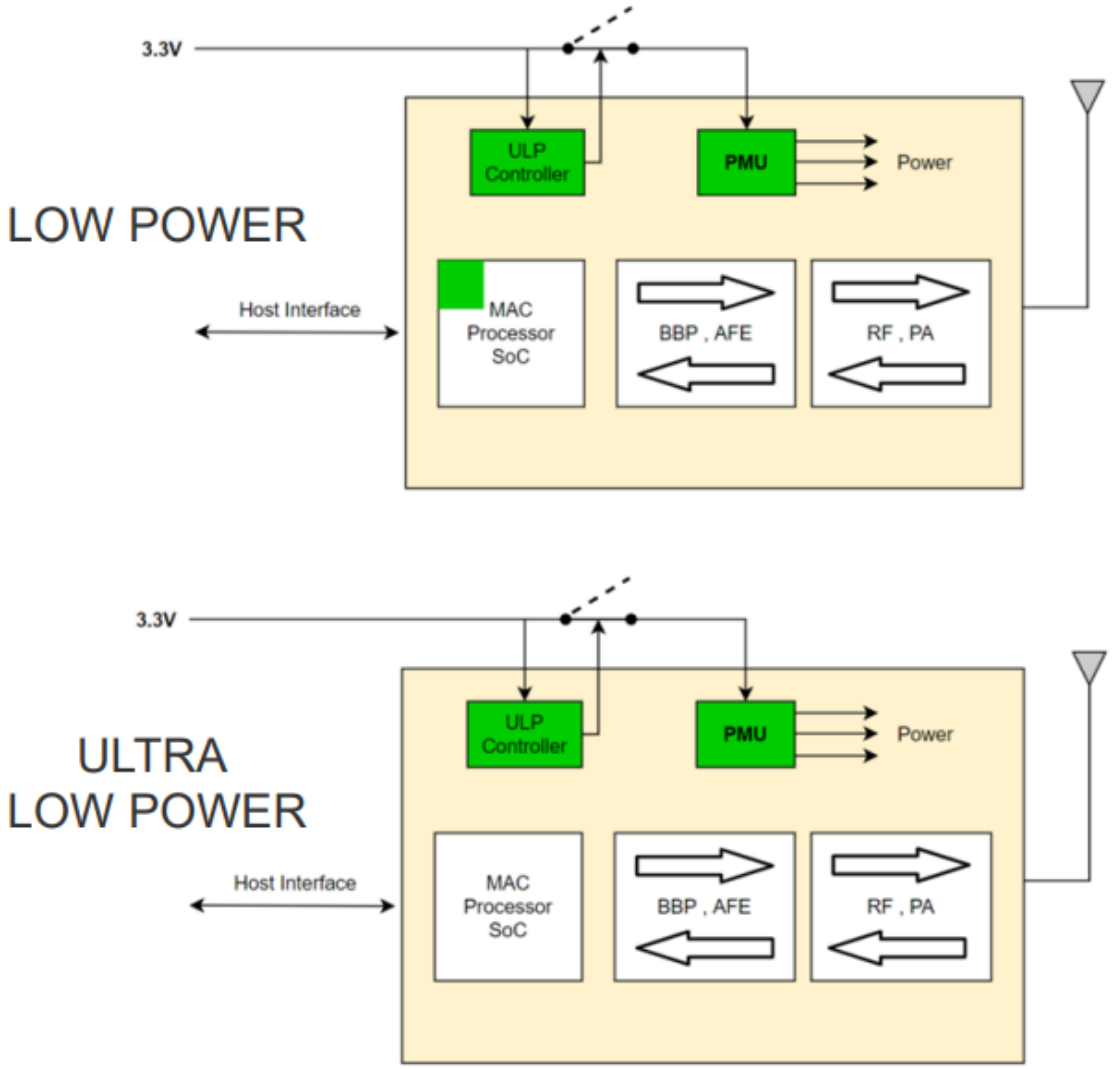

Additional Power Saving Enabled by Silicon Labs Wi-Fi Devices



- **Multiple Low Power Modes and embedded stack enable ultra low system power consumption**
- **Wi-Fi Standby associated with automatic periodic wake-up**
  - DTIM, listen interval or TWT based
  - Device remains associated to AP
- **Low power optimized at each device wake-up**

Description	Comments
Sleep Time Between Wakeups	Micro-amp drain
Fast Boot Up times	WLAN still asleep
Wake up Wireless to listen for Beacons using low power receiver	Reduced radio power consumption
Transmit only if needed	Lower average current

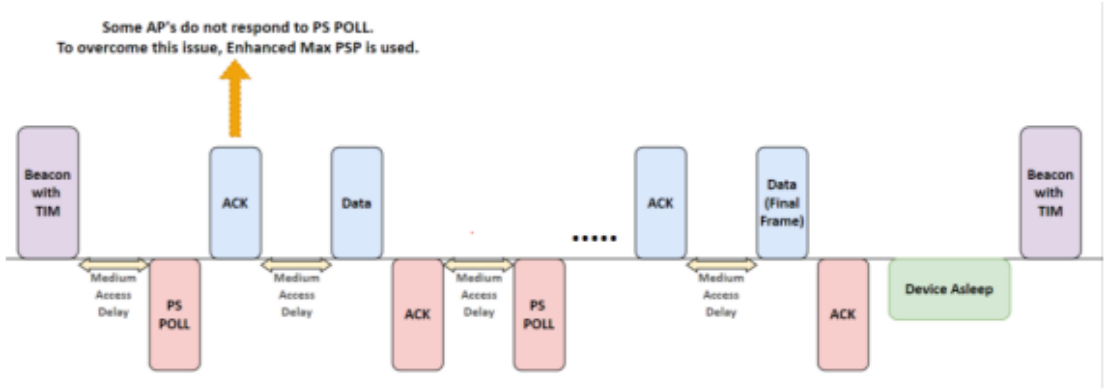
Silicon Labs Wi-Fi – Power Save Sleep Options



- **Supports various power modes to reduce system current consumption**
  - Low Power Mode (Sleep)
  - Ultra Low Power Mode (Deep Sleep)
- **Low Power Mode**
  - Radio and Modem is turned off but rest of SoC is on in low power state
  - System maintains state, Host interface is active and can respond to packets from Host
  - Recommended for line-powered or rechargeable battery designs that want low power consumption
- **Ultra Low Power Mode**
  - Except of ULP sub-system, rest of device is shutdown
  - Two options are available
    - With RAM Retention (system state is saved)
    - Without RAM retention (system state is lost)
  - Host interface is not active, device is woken up using ULP sub-system (ULPGPIOs)
  - Recommended for lowest power consumption and longest life for battery based designs

Silicon Labs Profiles Supported with Wi-Fi Power Save

- **Max PSP**



Application	Requirement	Recommended Settings
Streaming device	Always On, High Throughput	No Power Save is used
Smart Locks or Smart Sensors	Low power consumption, Battery powered Small data transmissions	Max PSP or Enhanced Max PSP Listen Interval based power save (1s listen interval)
Wi-Fi Video Doorbell	Event based power on; Battery Powered; higher throughput during video	Enhanced Max PSP or UAPSD DTIM based power save

- **Based on Application usage, the following power save profiles can be used to optimize battery life**
  - MAX Power Save and Enhanced Max Power Save Profile (PSP)
  - FAST Power Save Profile
  - UAPSD Power Save Profile
- **Max PSP**
  - Recommend using this profile for maximizing power save
  - Data is retrieved using PS-POLL mechanism using either DTIM or Listen Interval
  - If AP response is delayed, device switches to FAST PSP (this is referred to as Enhanced Max PS)
- **FAST PSP**
  - Recommend using this profile if throughput is a priority
  - Offers good trade-off for latency and power consumption
- **UAPSD PSP**
  - Application based priority - Recommended when doing Wi-Fi Multimedia (WMM)
  - Designed for VoIP where real-time Wi-Fi traffic is a requirement
  - Traffic is categorized into voice, video, Best Effort, Background
  - Requires support on AP side (most newer AP's have this support)

Conclusion & Key Takeaways






Conclusion & Key Takeaways

- Wireless technology choice depends on the specific application requirements
- Modern Wi-Fi is a viable option for low-power, battery-operated IoT devices
- Power-saving features like TWT are crucial for extending battery life
- Continued innovation in Wi-Fi will further enhance capabilities for the IoT edge