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WFI-201 Course

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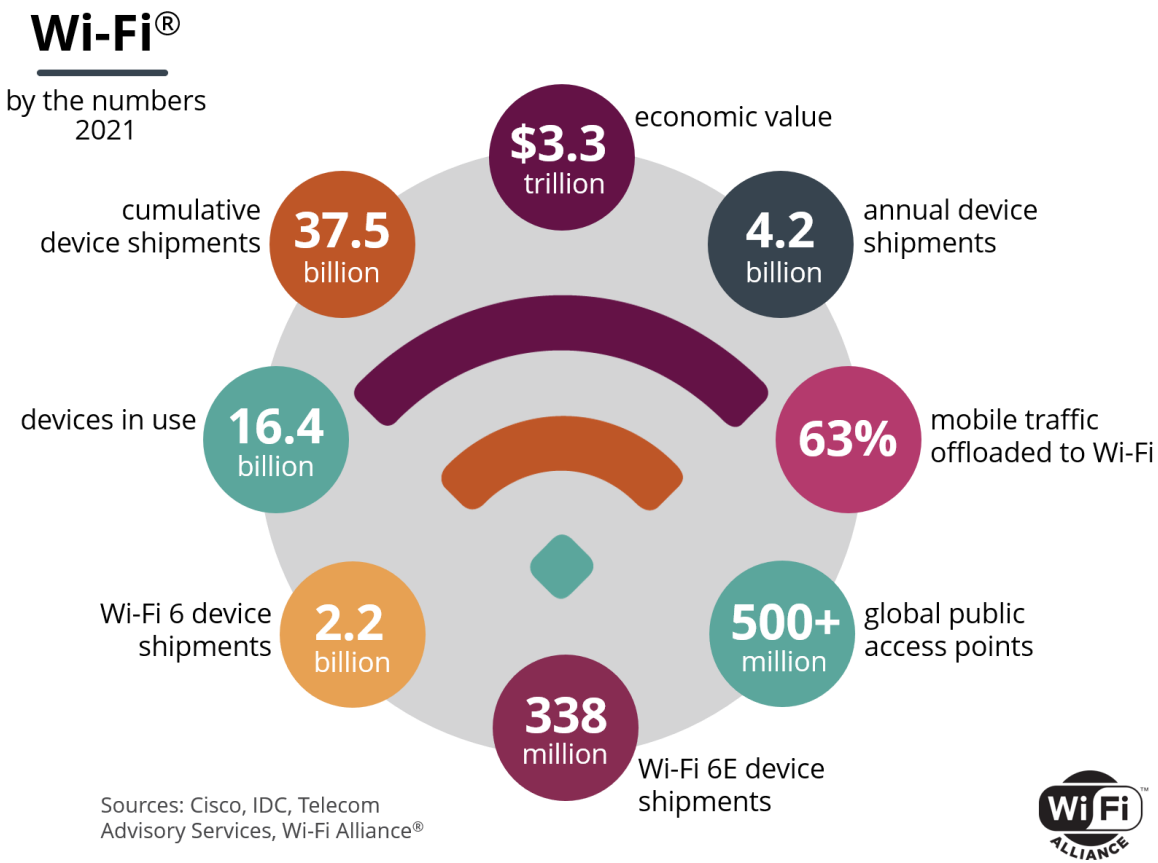
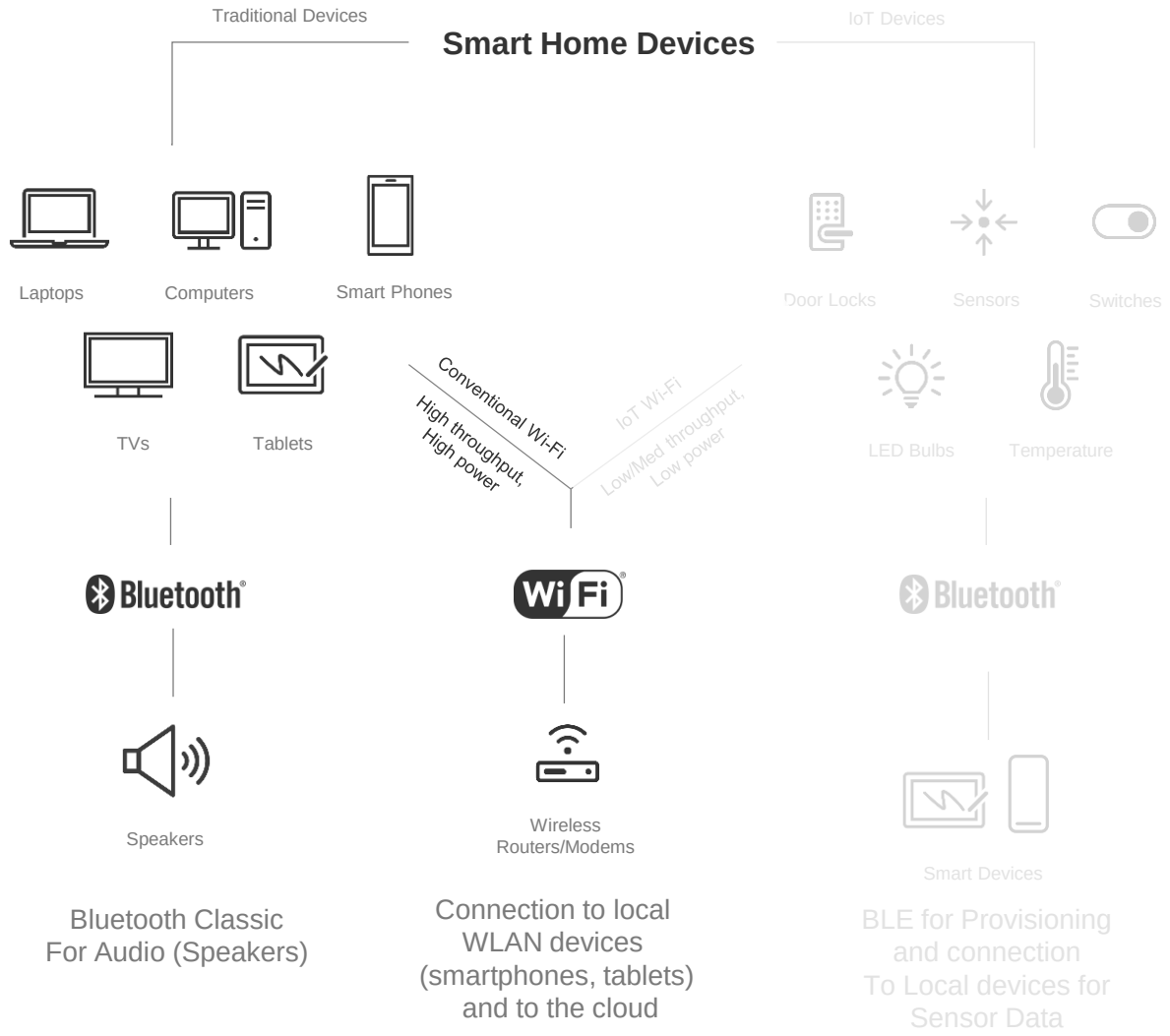
Why Wi-Fi



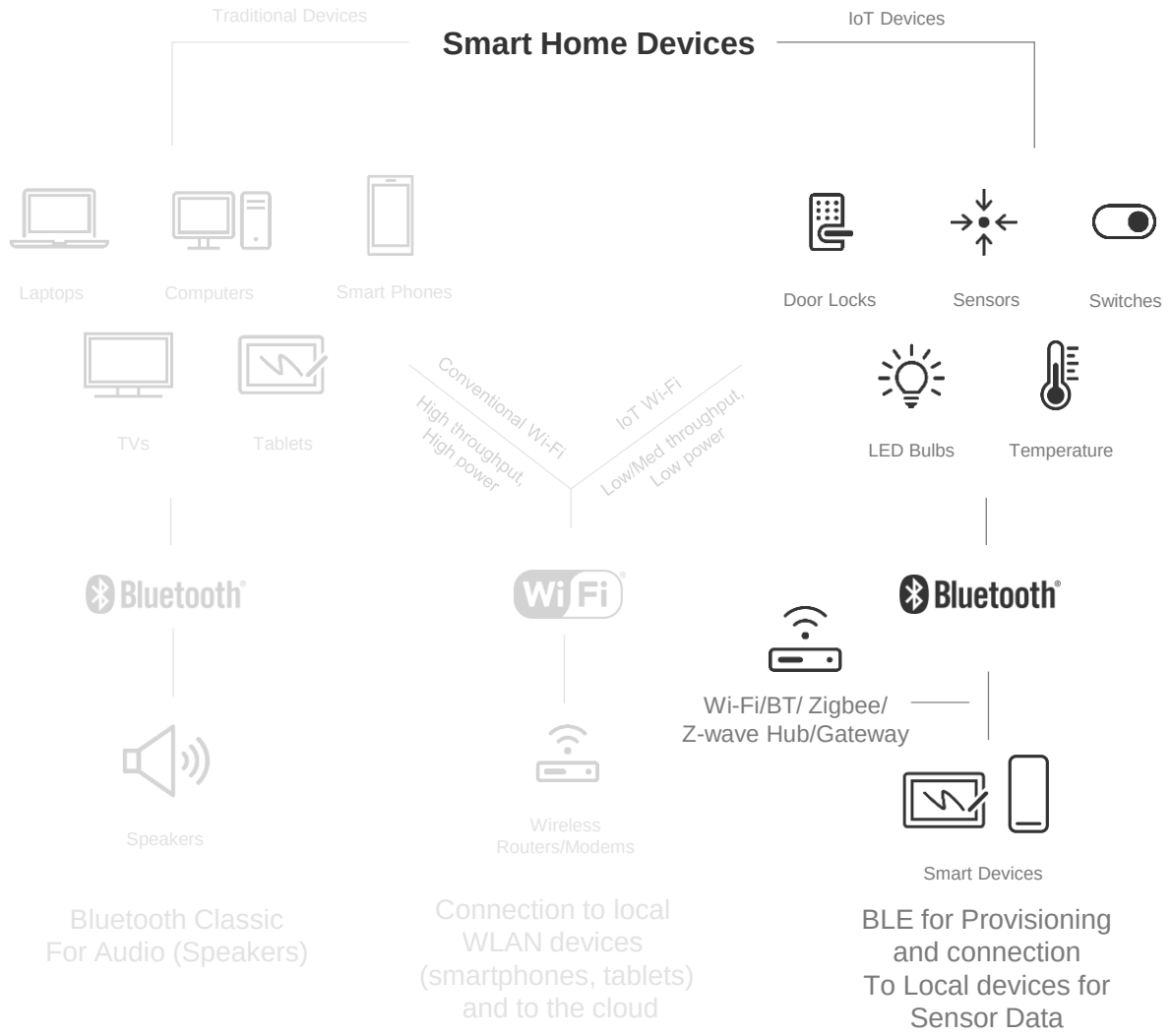
Users depend upon Wi-Fi so much that they can no longer imagine a day without it.

Wi-Fi in Smart Home



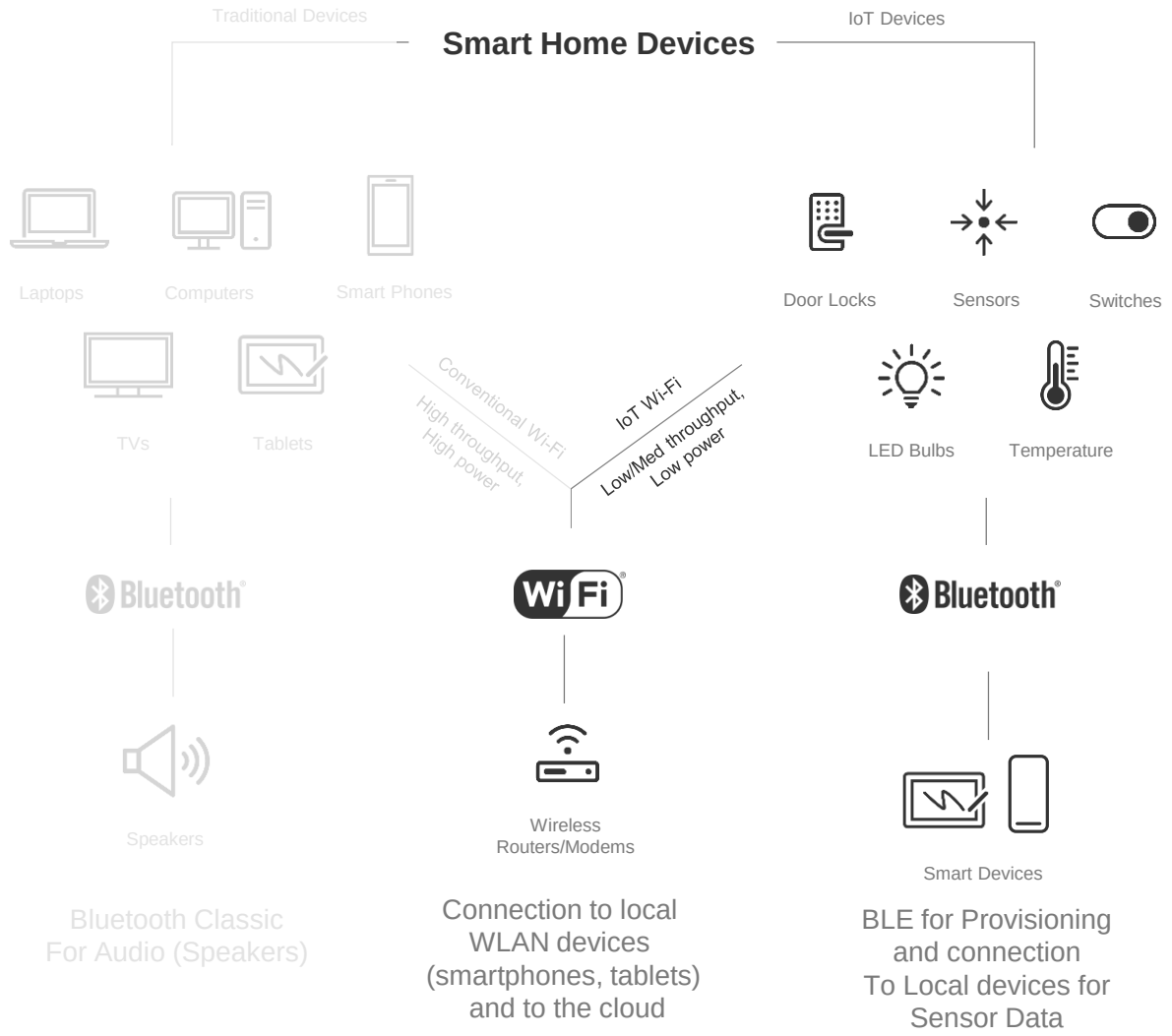
- **Wi-Fi is ubiquitous at homes**
- **Traditional devices at home such as laptops, tablets, smart phones use Wi-Fi for its ability to support variable communication rates**
  - High throughput for streaming video/movies/audio
  - Medium throughput for basic email, web browsing or messaging
  - Generally use higher power to support high/Medium throughput
- **Bluetooth Classic is used for audio streaming to speakers, headsets etc**
- **Use existing home Wi-Fi router/modem**
- **Not suited for IoT Devices due to power and high resource usage (CPU, memory, etc)**

Other Wireless Protocols in Smart Home



- **Multiple protocols exist in current IoT devices**
  - BLE, Zigbee, Z-wave
- **Ultra low power and enable local communication to peer or smart phones (using BLE)**
- **Support Low throughput devices**
- **Require BT/Zigbee/Zwave Gateway for communication to outside world (cloud)**
  - Gateway does IP translation and provides connection to home Wi-Fi routers
  - Added cost of gateway and needs to be provisioned to connect to home router
- **Ok to use for IoT devices, but added cost of gateway for IP networking/cloud connectivity**

Low Power IoT Wi-Fi in Smart Home



- **IoT Wi-Fi allows variable communication for local and cloud control of smart home devices**
  - Low to medium throughput devices
  - Support for large no of devices
- **Ultra Low current consumption and longer range for smart home devices**
  - Longer battery life for devices such as sensors and smart locks
  - Bridges the power gap between Wi-Fi and other protocols
- **No Added Cost of Hub/Gateway required**
  - Connects to existing home Wi-Fi routers
- **Ease of install and use through BLE provisioning to existing home Wi-Fi network**
- **Compatible with future Wi-Fi standards that further enhance lower power, denser device deployments (Wi-Fi 6)**
- **Well Suited for IoT devices due to low power, enable use of limited device resources (MCU, memory, etc), range, security and cost**

Low Power Smart Home Wi-Fi IoT Device - Smart Locks Requirements

TECHNICAL REQUIREMENTS

Ultra low power for long Battery Life

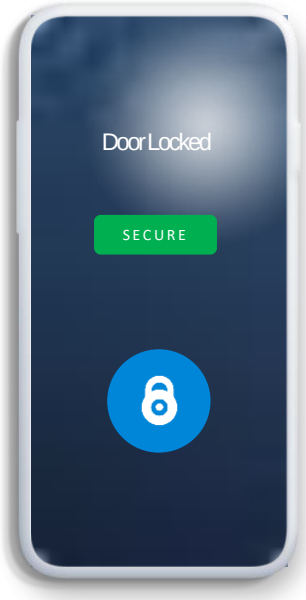
- Achieved through ultra low standby associated, active and sleep currents

Systems Solution

- Integration to drive design simplicity

Wi-Fi+BLE Pre-Certified Modules

- Reduced time to market



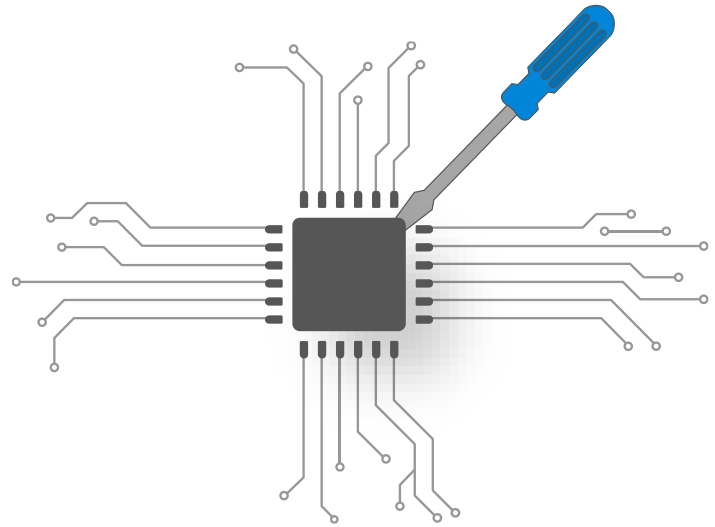
EASE OF USE

Smart Home Ecosystem Integration

- Wi-Fi+BLE and IP embedded networking stack
- Local and Cloud Connectivity for control of the lock from anywhere

Install and Wi-Fi Commissioning using BLE

- Ease of Wi-Fi provisioning using BLE and smart phone



SW AND SECURITY

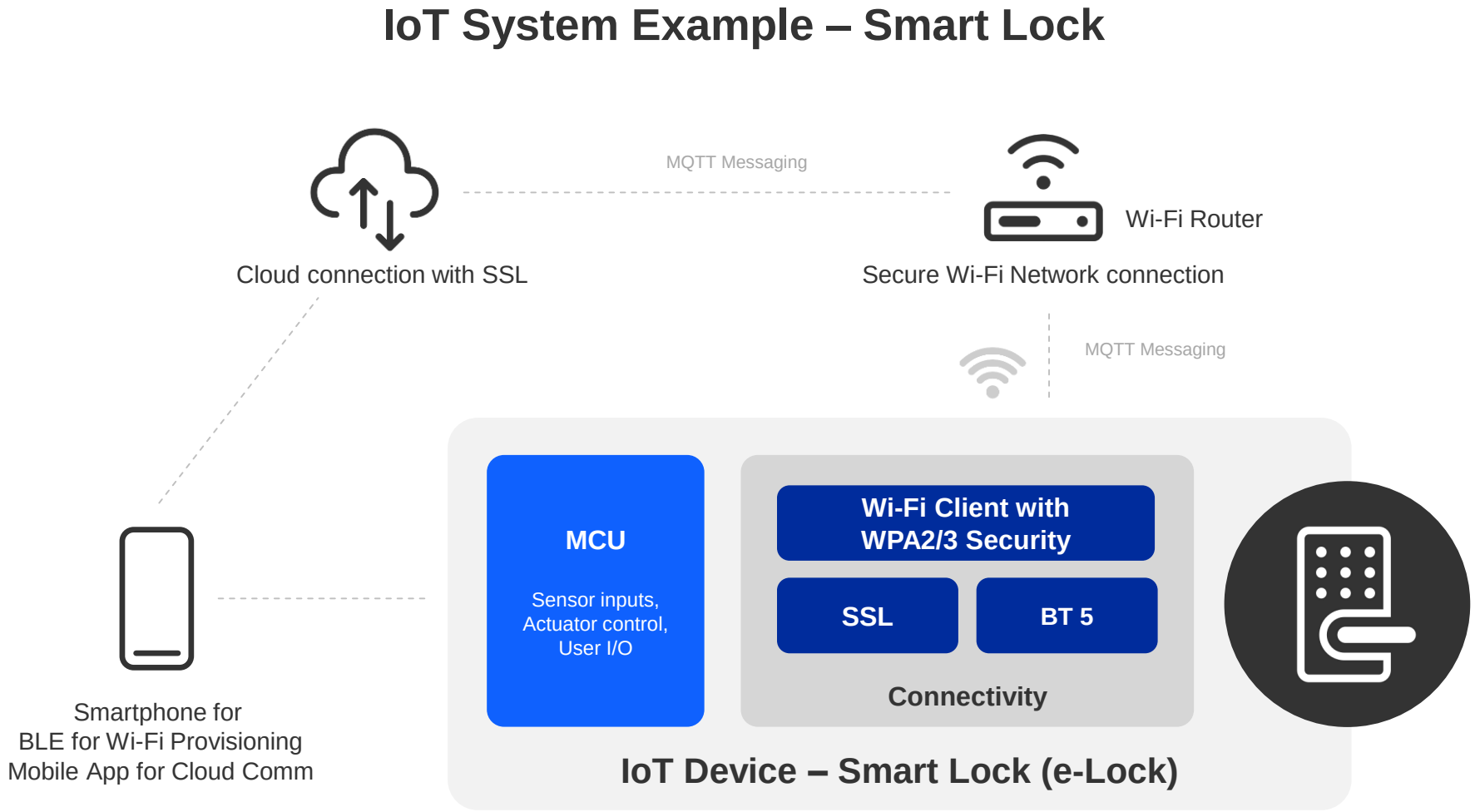
Intuitive SW Tools

- Making design and programming easy to use

Wireless and system Security

- WPA2/3, AES Encryption, Secure Boot, Key Storage, etc.

Demo of Low Power IoT Wi-Fi



Use Case Example: How RS9116 Enables Smart Lock Application

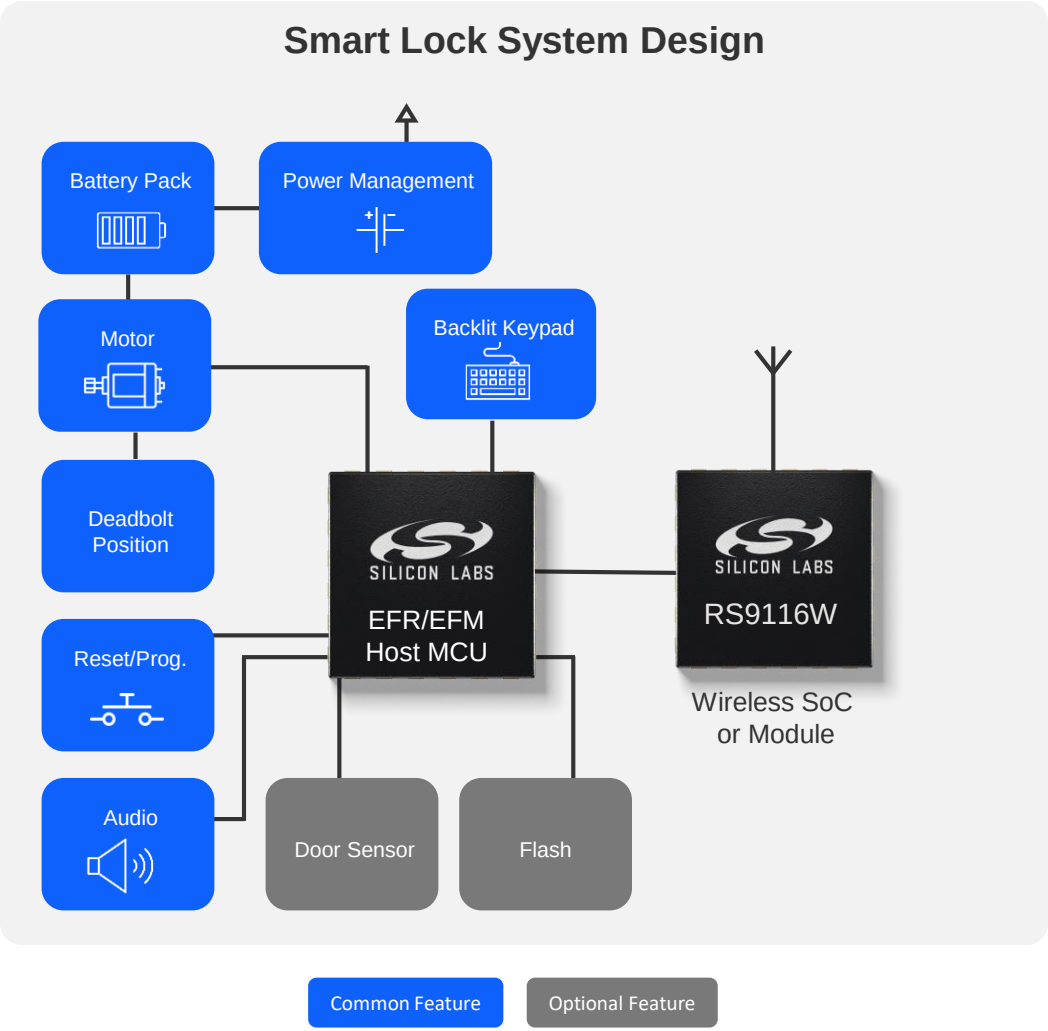
Smart Lock

	Wi-Fi Power Consumption	Estimated Battery Life (yrs)
RS9116	~ 55 uA	> 3 years
Off the shelf	~ 250 uA	< 1 year

- Smart Lock with battery (4) providing 1500mAh @ 6V
- Wi-Fi, Secure (SSL), robust, always-on TCP Cloud connectivity (1 second latency)

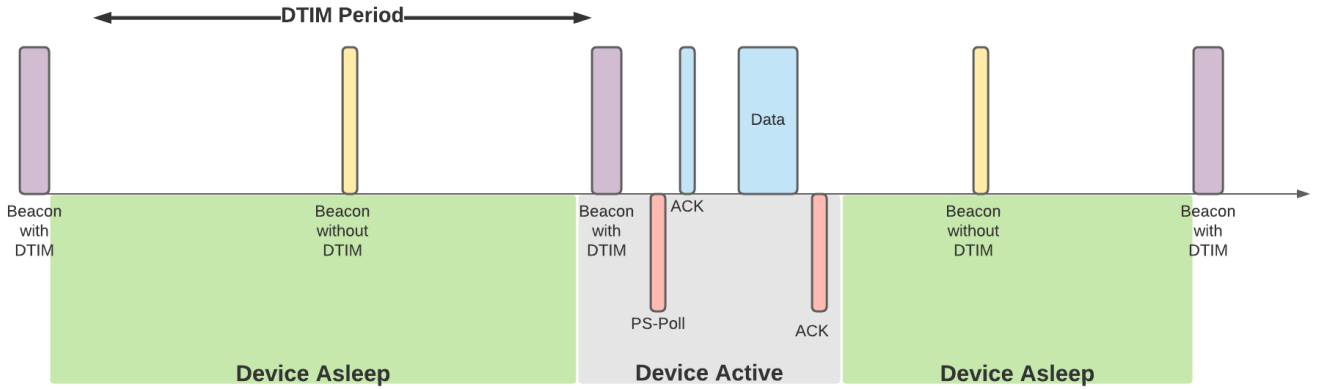
- Best in class current consumption (~55uA for DTIM 10) for always on Wi-Fi connectivity improves battery life
- Wi-Fi + BLE 5 support in a single SoC/module reduces, cost, size and integration effort
- Integrated coexistence manager ensures seamless Wi-Fi + BLE operation
- Embedded Wi-Fi, BT and TCP/IP Networking stack for cloud connectivity
- 15-20Mbps application throughput in embedded mode (Note: depends on the environment, application and processor)
- Highest BLE output power with integrated PA (18 dBm) providing longer range
- Extensive security support (SSL, WPA/WPA2 and enterprise security) to ensure end user security

RS9116W+EFR/EFM Offers Systems Solution & Optimizes Battery Life



- **RS9116W + EFR/EFM Systems Solution**
  - RS9116W Provides multiprotocol Wi-Fi + BLE capability
  - RS9116W Integrated Networking Stack reduces load on MCU
  - RS9116W Embedded HTTP(s), MQTT Simplifies Cloud Connectivity
  - MCU (ex: EFR) with integrated peripherals focuses on application, thus reducing overall system complexity
- **Increased Battery Life with Wi-Fi**
  - RS9116W optimized ultra low current in always on standby associated significantly increases battery life
  - MCUs with very low power consumption running application
- **Pre-Certified Wi-Fi Modules**
  - RS9116W offers pre-certified modules removing certification burden and reducing time to market
  - Ultra small form factor modules for space constrained devices

How the Wi-Fi Standard Allows Devices to Save Power



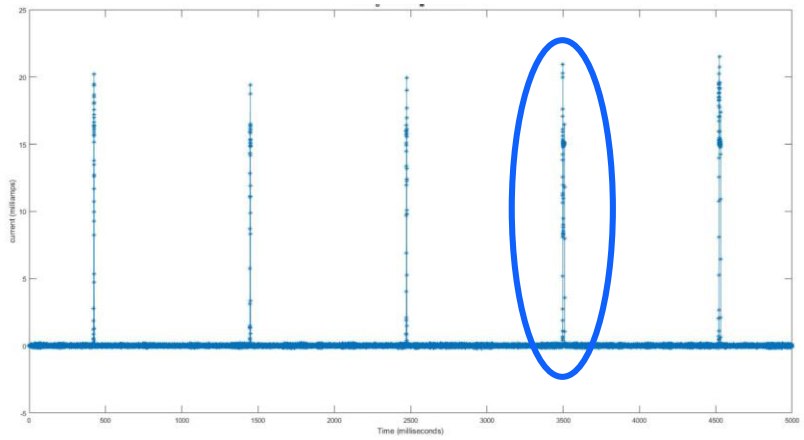
- Wi-Fi Client (Stations) can go to ‘sleep’ when they have nothing to send
- They wake up at ‘Listen Interval or DTIM’ intervals to check whether any data is pending for them
- They send ‘PS-POLL/NULL’ to the AP to retrieve their data
- They go to sleep again after retrieving all available data – enables power savings between data transfers

How power is further optimized at each device wake-up

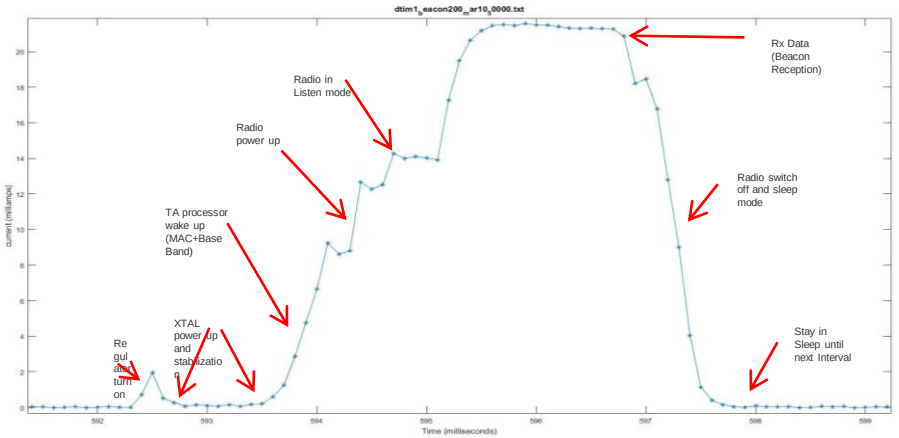
- Quick receive or transmit and transition to sleep
- Only turn on full Wi-Fi radio when necessary to receive/transmit data
- Fast wake-up of Wireless sub-system – state is retained

Description	Comments
Sleep Time Between Wakeup	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

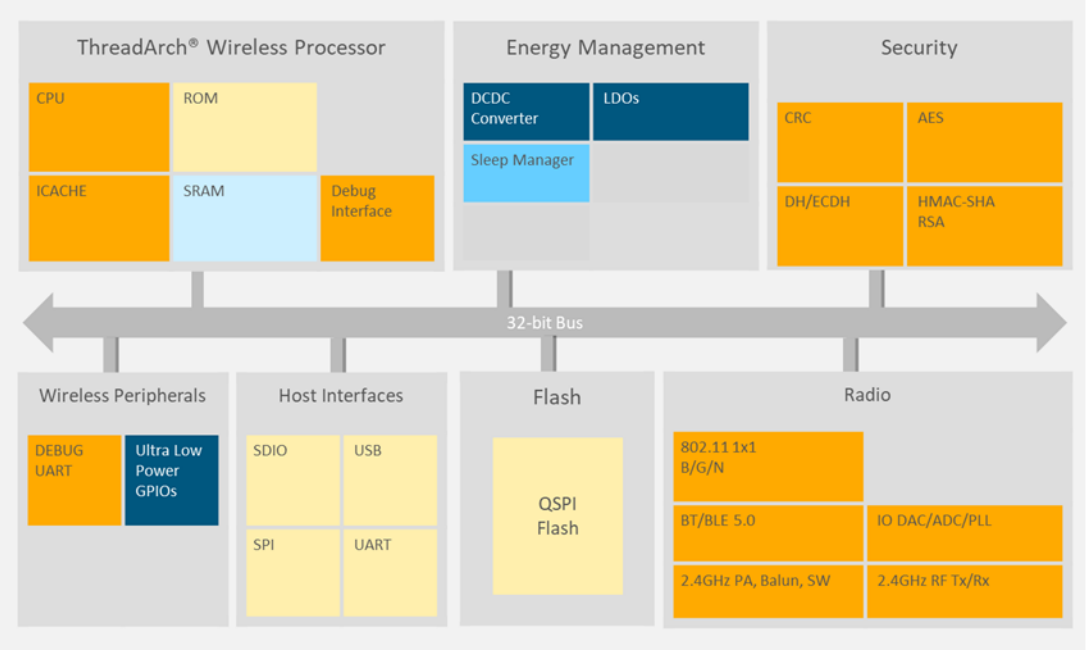
Wake up every 1 sec



Optimized current consumption during wakeup

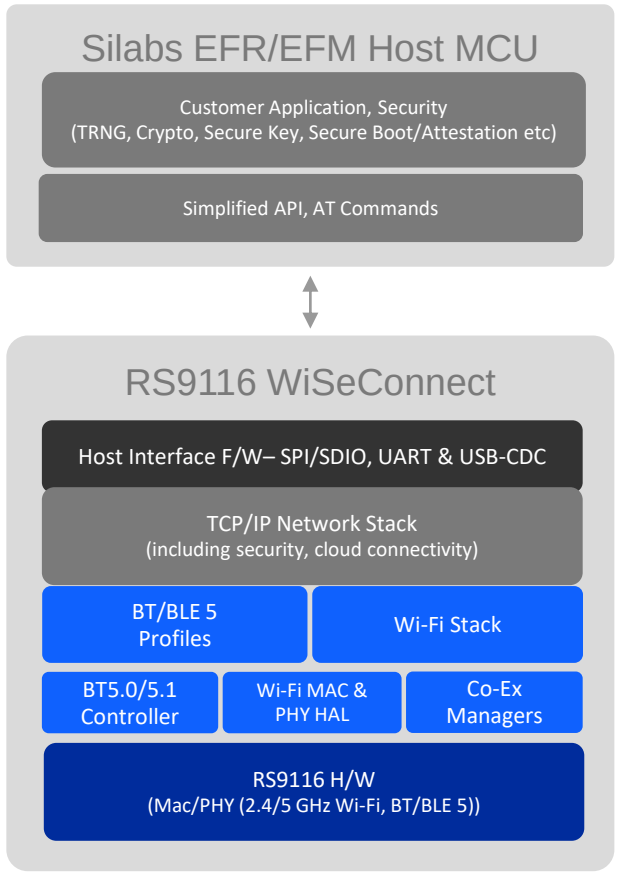


RS9116 Power Save Techniques in the Device



- Big Little Radio Design (listen/Beacon)
- Dynamic voltage scaling
- Clock Scaling
- Using low leakage cells
- Power islands
- Using DC-DC convertors

RS9116 Embedded Stacks and EFR/EFM MCUs

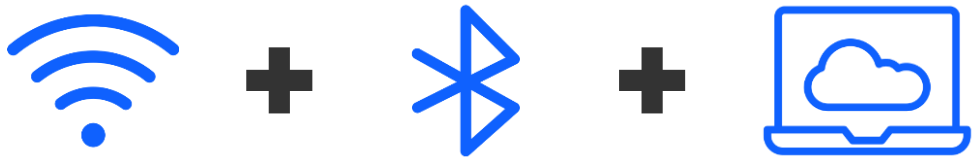


- **Embedded stacks and profiles**
  - Wi-Fi stack, BT/BLE stack and profiles
    - TCP/IP (IP v4) Networking stack with SSL 3.0/TLS 1.2, HTTP/HTTPS, Websockets, DHCP, DNS, MQTT Client;
  - Simplifies network and cloud connectivity
  - Significantly reduced Host load, letting MCU focus on application code

- **Multiple Operating Modes and ultra low power modes**
  - Wi-Fi Station, Wi-Fi Access Point, BT/BLE 5, Concurrent modes
    - Provisioning using Wi-Fi AP or BLE modes
    - Over the Air Firmware Update
  - Significantly reduces system power, thus increasing battery life
- **Security and Wireless Connectivity**
  - Embedded wireless stacks provide secure personal and enterprise connectivity
  - EFR/EFM MCU provides system level security with secure vault capabilities

SiLabs Low Power IoT Wi-Fi - Benefits

Ultra-Low Power Consumption for Battery Operated Devices



Wi Fi | Bluetooth | Network/Cloud

- **Industry leader in Low power Wi-Fi + BT/BLE 5**
  - 55uA stand-by associated current at DTIM10
  - Certified modules (small form factors)
- **Integrated wireless stacks, networking stacks, cloud connectivity and security**
  - Embedded Wi-Fi, BT/BLE and TCP/IP stacks
- **Integration with Silicon Labs' MCU/Wireless solutions, Simplicity Studio v5**
  - Low power MCUs, Simplified development and Security
- **Start your IoT Wi-Fi design and take advantage of low power Wi-Fi connectivity now**
  - Enables forward compatibility with next gen Wi-Fi standards (Wi-Fi 6)

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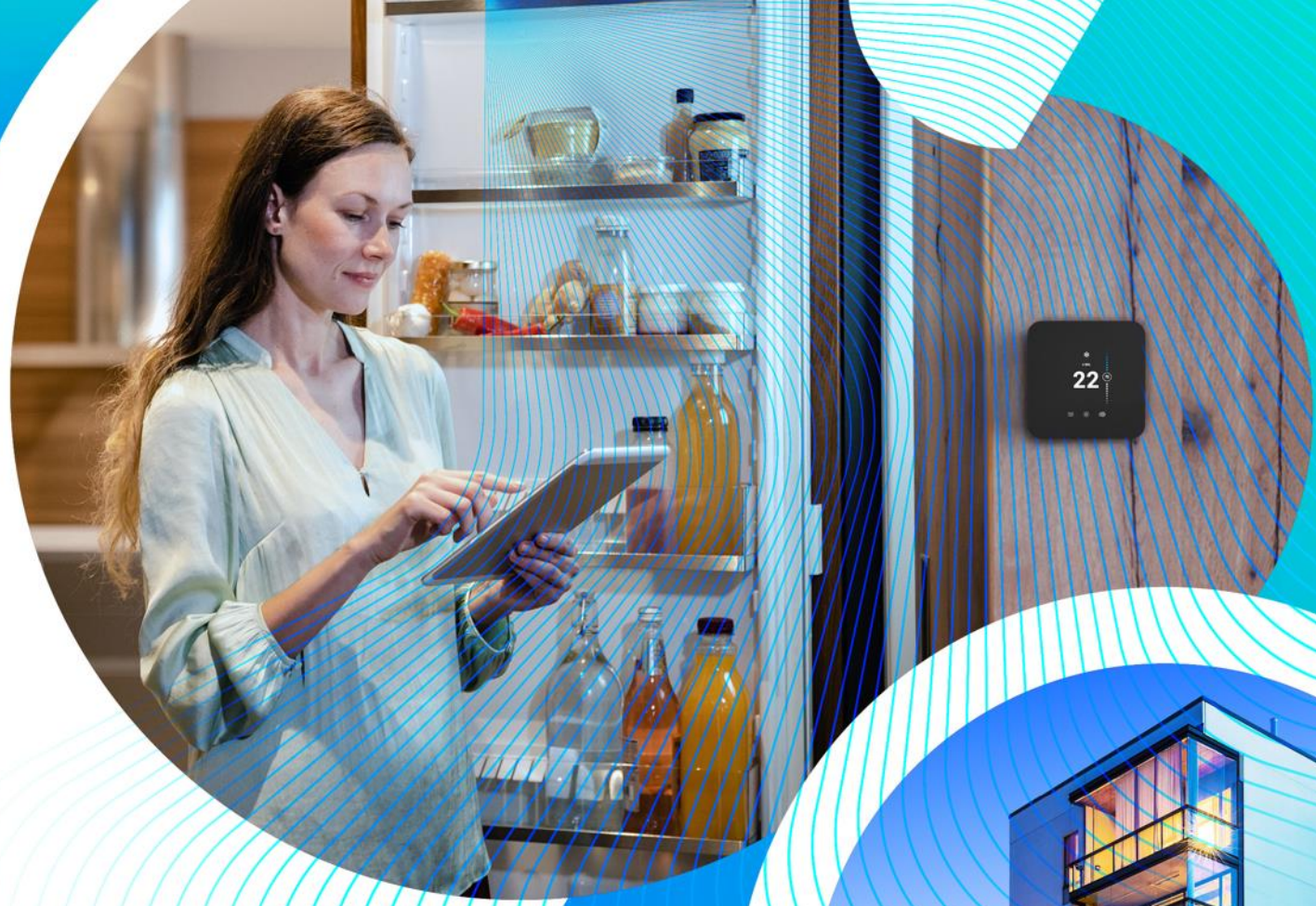
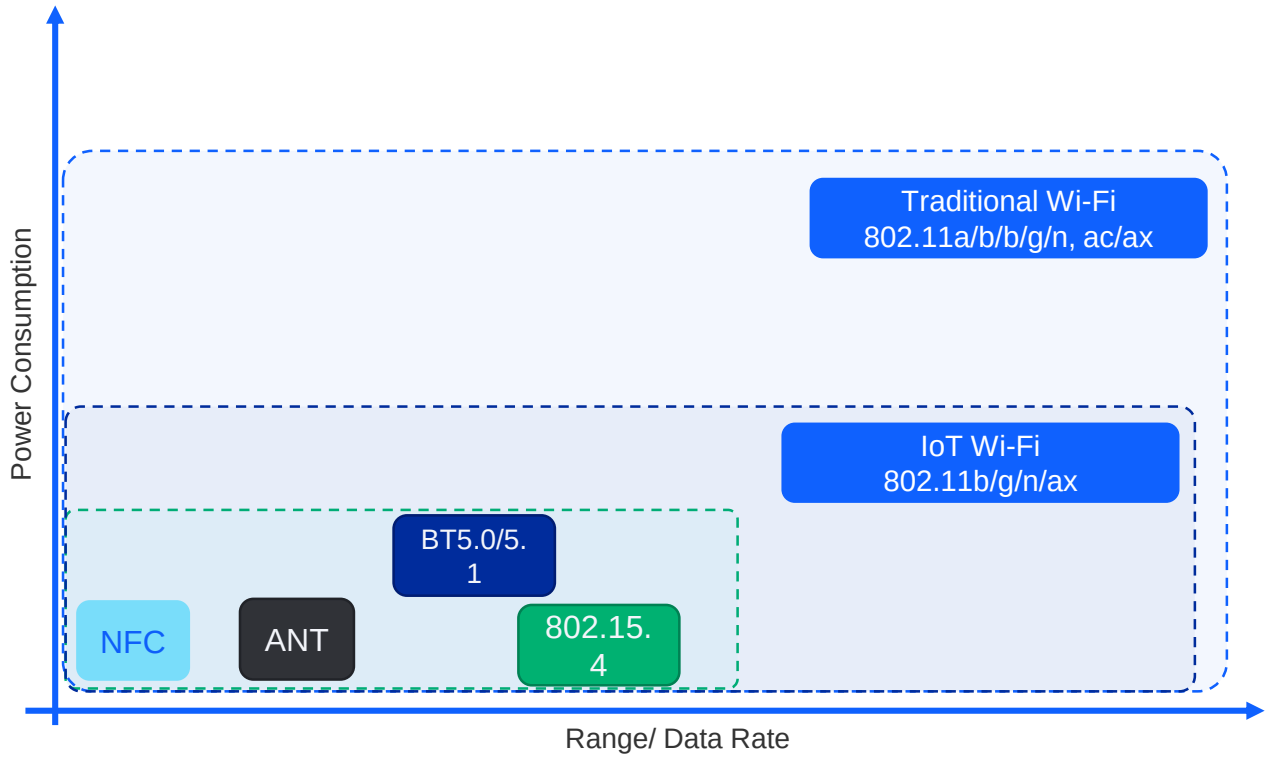
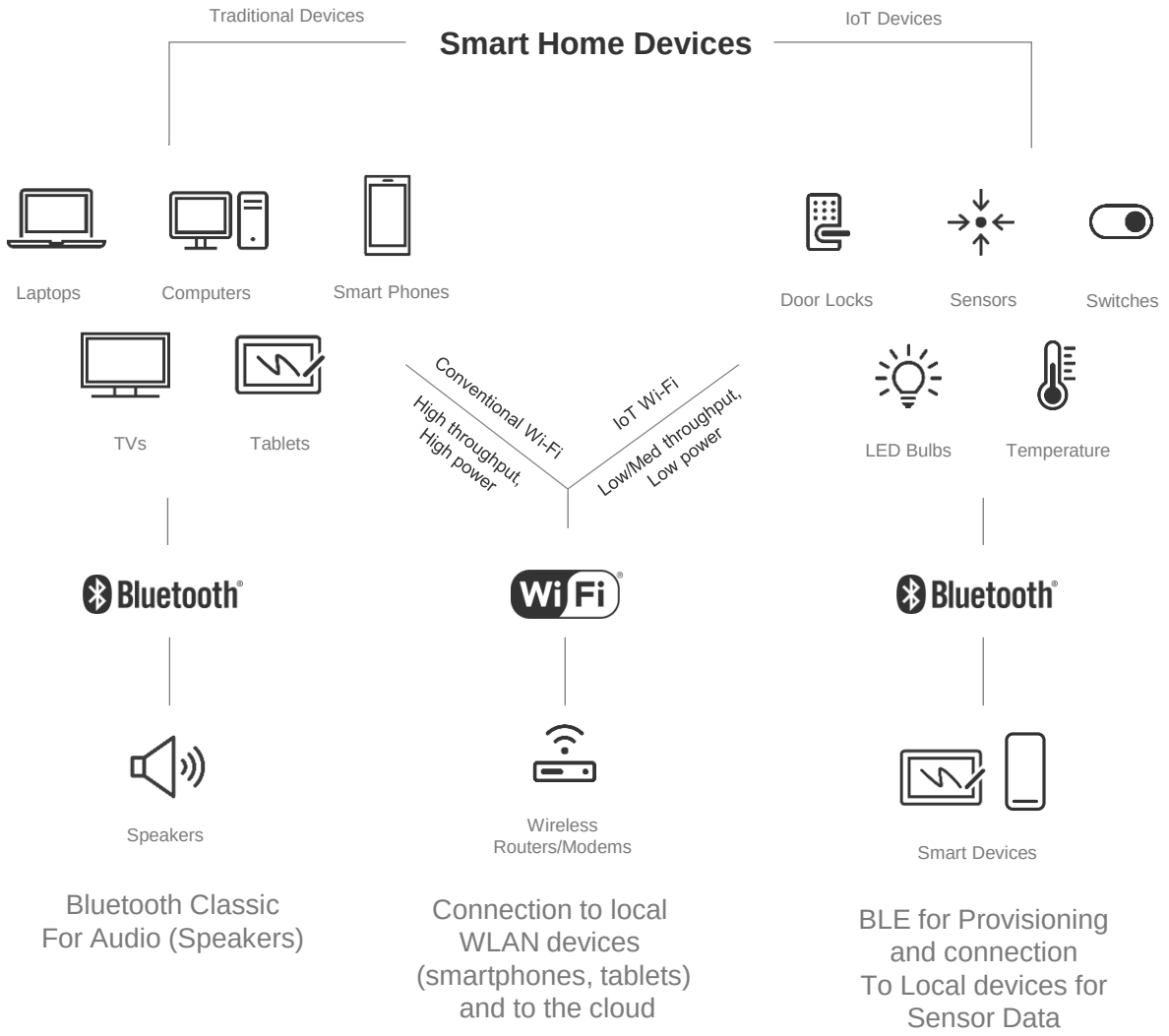


Low Power Wi-Fi in IoT



- **IoT designs unique requirements that are met by Low-Power Wi-Fi**
  - Use existing Wi-Fi infrastructure already available at home
    - No need for additional Hubs or Gateways
    - Security and remote accessibility (cloud)
  - Low power consumption in battery powered applications
    - BLE or Zigbee provide low power, but require hub/gateway or smart phone for Cloud connectivity
    - Low power wi-fi significantly lowers the current bridging the power consumption gap, enabling
      - Longer Battery life - Infrequent battery maintenance (charging or replacing)
  - Longer range for IoT devices, support for larger no of devices
  - Compatible with future Wi-Fi standards that enhance lower power, denser device deployments (Wi-Fi 6)

Wi-Fi in Smart Home



- **Wi-Fi communication for local and cloud control of smart home devices**
  - Traditional and IoT(e.g. smart locks, thermostats)
- **Variable communication requirements:**
  - High power and High throughput for traditional devices
  - Low power and Low to medium throughput for IoT
- **BLE communication to provision smart home device to home Wi-Fi network during installation; also used for proximity detection and sensor connection**
- **Ultra Low current consumption for battery operated smart home devices such as sensors and smart locks**