6.3 Core Technology Architectures

Modern Bluetooth is not a single technology but a combination of three distinct architectures designed for different use cases. A device can implement one or more of these.

Bluetooth Classic (BR/EDR)

This is the original Bluetooth protocol, designed for continuous, point-to-point data streaming.

- **Primary Use Case:** Audio streaming and data transfer where throughput is more important than power consumption.
- **Topology:** It forms a **piconet**, where a single **master** device can connect to up to seven active **slave** devices. The communication is connection-oriented.
- **Strengths:** High data throughput (up to 3 Mbps) ideal for high-quality audio or file transfers.
- **Weaknesses:** Higher power consumption, making it unsuitable for battery-powered IoT devices.
- **Example Applications:** Wireless headphones, speakers, in-car audio systems, legacy file transfers.

Bluetooth Low Energy (BLE)

BLE was introduced in Bluetooth 4.0 and is the dominant technology for the Internet of Things.

- **Primary Use Case:** Short bursts of data from low-power, battery-operated devices.
- **Topology:** A **central** device (like a smartphone) can connect to many **peripheral** devices (like sensors). It operates by **advertising** its presence and can form fast, temporary connections to transfer data.
- **Strengths:** Extremely low power consumption, allowing for multi-year battery life. Very fast connection setup time.
- **Weaknesses:** Lower data throughput than Classic, not designed for continuous streaming.
- **Example Applications:** Fitness trackers, smartwatches, environmental sensors, proximity beacons, smart home devices.

Bluetooth Mesh

Bluetooth Mesh is not a separate radio technology; it's a networking protocol that operates on top of the BLE radio.

- **Primary Use Case:** Large-scale device networks requiring reliable, building-wide coverage.
- **Topology:** A true **mesh network**. Devices (or **nodes**) can relay messages for other nodes, extending the range of the network far beyond the reach of a single device. This creates a many-to-many communication system.
- **Strengths:** Enormous scalability (up to 32,000 nodes), high reliability (no single point of failure), and extended range.
- **Weaknesses:** Higher latency than a direct BLE connection and is not suitable for high-throughput or streaming applications.
- **Example Applications:** Smart lighting systems in commercial buildings, industrial sensor networks for predictive maintenance, asset tracking across a large facility.

Key Differences: A Summary

Feature	Bluetooth Classic (BR/EDR)	Bluetooth Low Energy (BLE)	Bluetooth Mesh
Primary Use Case	Audio Streaming, File Transfer	IoT Sensors, Wearables, Beacons	Large-Scale Control Networks
Throughput	Medium-High (~2.1 Mbps)	Low-Medium (~1-2 Mbps)	Low
Power Consumption	Medium	Very Low	Low (node-dependent)
Topology	Piconet (Master-Slave)	Star (Central-Peripheral)	Mesh (Node-to-Node)
Connection Time	Slower (~100ms)	Very Fast (<3ms)	N/A (Always on or advertising)
Number of Devices	1 Master to 7 Slaves	1 Central to Many Peripherals	Thousands of Nodes in a Network
Example	Wireless Headphones	Heart Rate Monitor	Smart Building Lighting

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