IoT Networking

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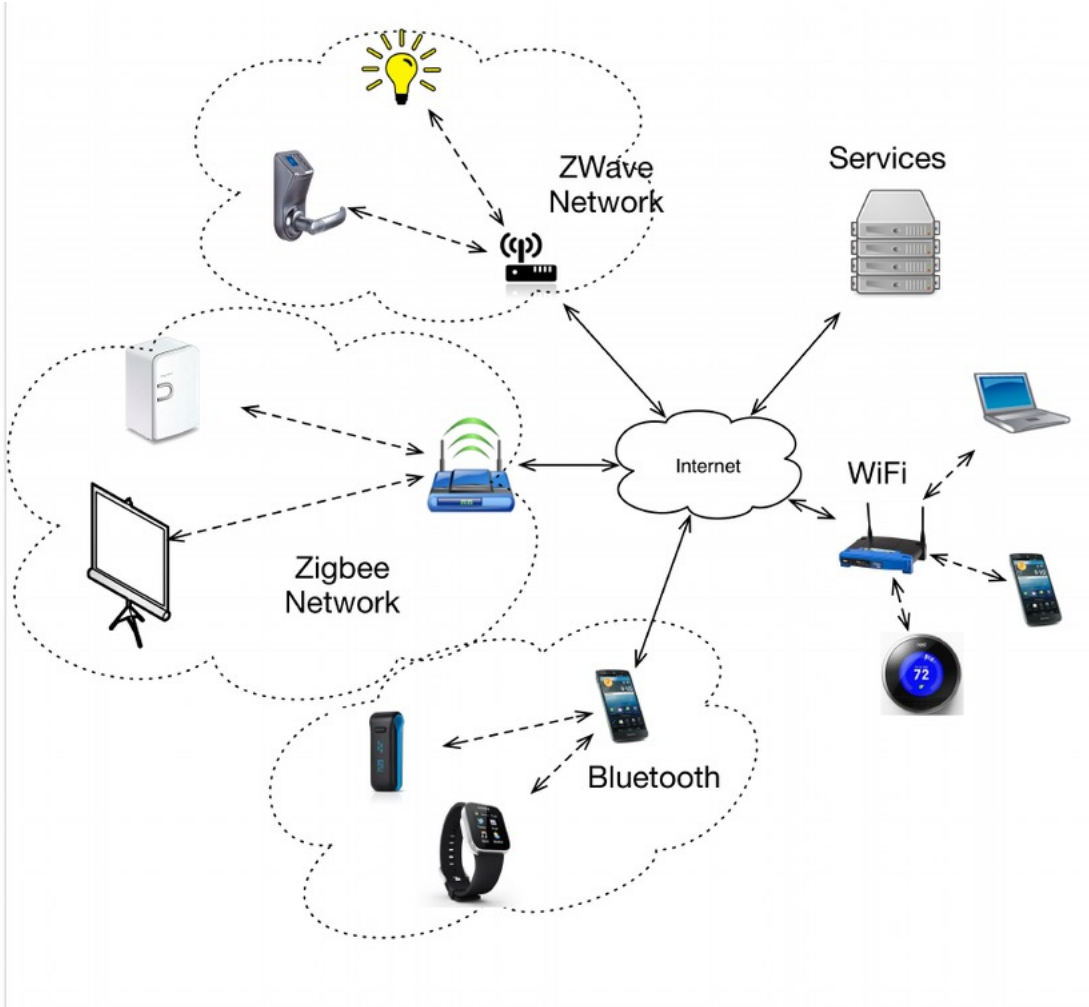
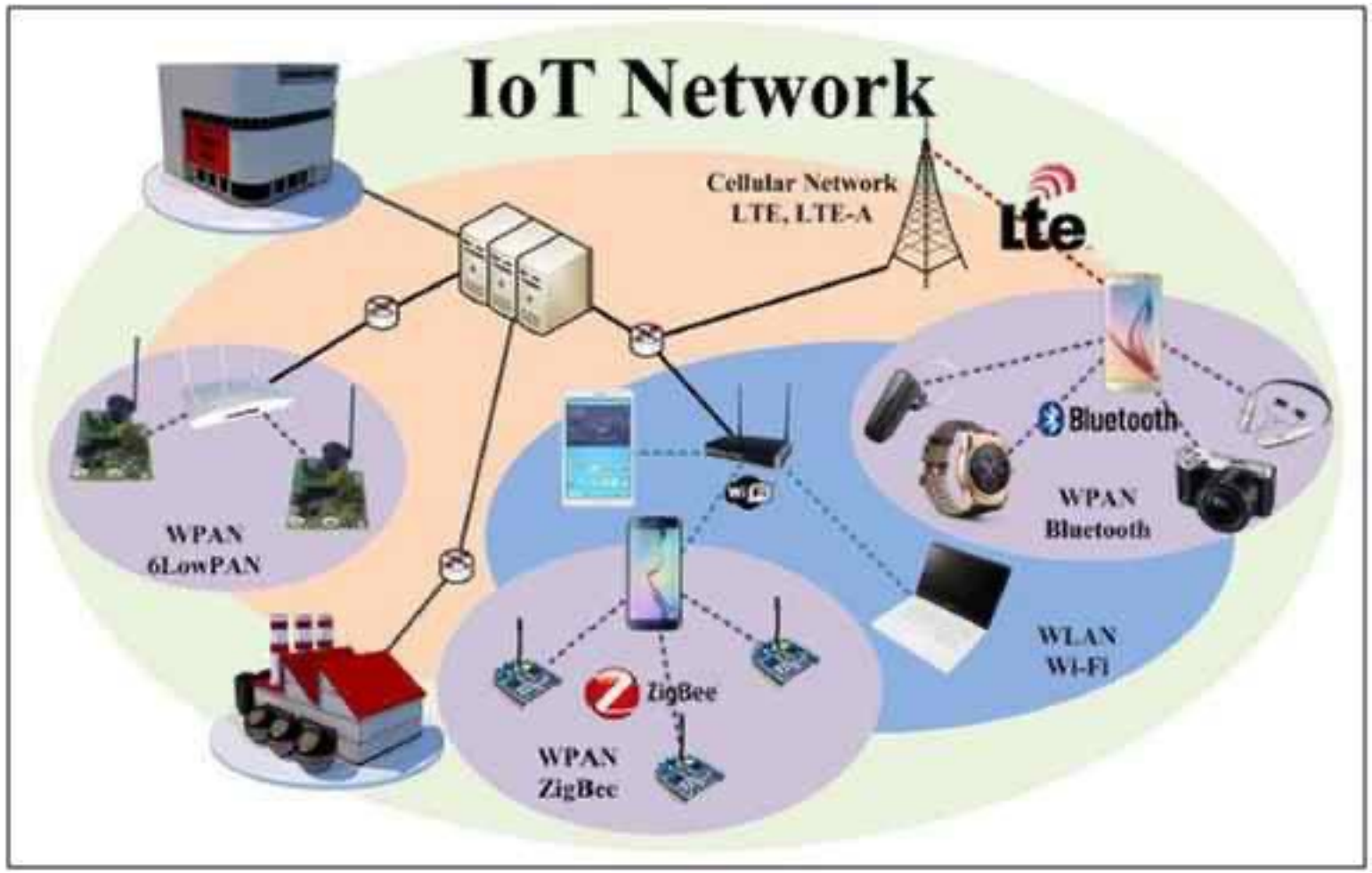
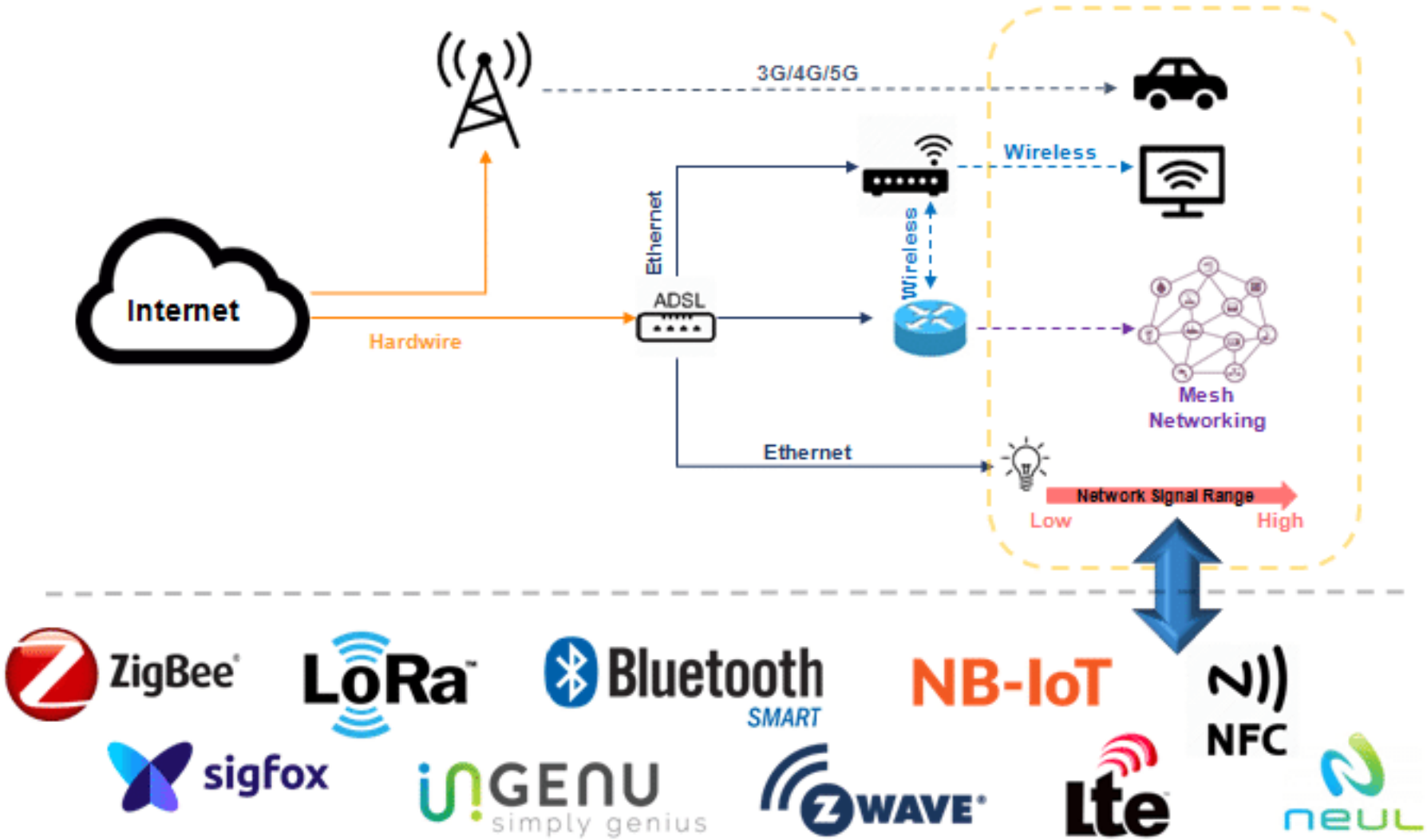

ZWave
Network
Services
Internet
WiFi
Zigbee
Network
Bluetooth


IoT Network
Cellular Network
LTE, LTE-A
lte
Bluetooth
WPAN
Bluetooth
WPAN
6LowPAN
WLAN
Wi-Fi
ZigBee
WPAN
ZigBee


3G/4G/5G
Wireless
Ethernet
Wireless
Internet
ADSL
Hardwire
Mesh
Networking
Ethernet
Network Signal Range
Low
High
ZigBee
LoRa
Bluetooth
SMART
NB-IoT
NFC
sigfox
INGENU
simply genius
Z-WAVE
Lte
neul

Technology	Pros	Cons	Use Cases
Wi-Fi	High bandwidth, Widely available	High power consumption, Limited range	Smart homes, Indoor positioning systems, High data rate applications
Bluetooth	Low energy consumption, Good for short range	Limited range, Limited data rate	Wearable devices, Healthcare monitoring, Smart home devices
Zigbee	Low power consumption, Large network (mesh capabilities)	Lower data rate compared to Wi-Fi, Can be complex to implement	Home automation, Industrial control, Smart energy
LoRaWAN	Long range, Low power consumption	Lower data rate, Network coverage can be an issue	Rural IoT applications, Smart cities, Agricultural monitoring
NB-IoT	Very low power consumption, Excellent penetration and coverage	Lower data rate, Dependent on cellular network infrastructure	Smart meters, Environmental monitoring, Asset tracking

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Networking Option	Pros	Cons	Specific Use Cases
Wi-Fi	* High bandwidth * Common infrastructure * Good range (indoors)	* Power-hungry * Interference susceptibility * Limited device density per access point	* Home automation * Smart appliances * Indoor asset tracking
Bluetooth (BLE)	* Low-power consumption * Good for short-range* Ubiquitous in smartphones	* Very limited range * Data throughput limitations	* Wearables (fitness trackers, smartwatches) * Beacons * Medical devices
Cellular (4G/LTE, 5G)	* Wide coverage area * Reliable * High bandwidth	* Higher cost * Power consumption * Requires cellular subscription	* Connected vehicles * Remote asset tracking * Smart city infrastructure
LPWAN (LoRaWAN, Sigfox, NB-IoT)	* Extremely long range (kilometers) * Very low power (years of battery life) * Designed for low data-rate sensors	* Low bandwidth * Limited uplink capacity (device to network) * May require specialized infrastructure	* Smart agriculture * Environmental monitoring * Utility metering * Smart city sensors
Zigbee	* Low power consumption * Mesh networking (extends range) * Self-healing network	* Lower bandwidth than Wi-Fi * Potential device compatibility issues * Can be complex to set up	* Home automation * Smart lighting * Industrial monitoring
Z-Wave	* Designed for home automation * Low interference (different frequency than Wi-Fi) * Mesh networking capabilities	* Limited device ecosystem * Slower than Zigbee	* Smart home devices * Lighting control * Security systems

Important Considerations when Choosing:

1. Range: How far does the data need to travel?
2. Bandwidth: How much data needs to be transmitted, and how fast?
3. Power Consumption: Are your devices battery-powered?
4. Cost: What are the infrastructure, subscription, and device costs?
5. Environment: Will the network be indoors, outdoors, or in an industrial setting?

Wi-Fi

Pros:

1. High bandwidth, allowing for the transfer of large amounts of data.
2. Widely available and familiar to many users.
3. Supports a wide range of IoT devices.

Cons:

1. High power consumption, not suitable for battery-operated devices.
2. Limited range, typically around 100 meters in open space.

Use Cases:

1. Smart homes (e.g., smart TVs, smart speakers).
2. Office environments for connected office equipment.
3. Areas with existing Wi-Fi infrastructure and power sources.

Bluetooth and Bluetooth Low Energy (BLE)

Pros:

1. Low power consumption, especially with BLE, suitable for battery-operated devices.
2. Short-range communication, reducing interference issues.

Cons:

1. Limited range, generally up to 100 meters for Bluetooth and even less for BLE.
2. Lower data transfer rate compared to Wi-Fi.

- **Use Cases:**

1. Wearable devices (e.g., fitness trackers, smartwatches).
2. Healthcare monitoring devices.
3. Proximity-based applications (e.g., indoor navigation).

Zigbee and Z-Wave

Pros:

1. Low power consumption, designed for battery-operated devices.
2. Mesh network capabilities, extending the range by allowing devices to communicate through other devices.

Cons:

1. Lower data rates compared to Wi-Fi and Bluetooth.
2. Requires a coordinator/hub for the network.

Use Cases:

1. Home automation (e.g., lighting, security systems).
2. Agricultural sensors.
3. Energy management systems.

Cellular (LTE, 4G, 5G)

Pros:

1. Wide coverage, leveraging existing cellular networks.
2. High data rates, especially with 4G and 5G technologies.
3. Supports mobility, ideal for moving devices.

Cons:

1. Higher power consumption than technologies like BLE and Zigbee.
2. Operational costs may be higher due to data plans and subscriptions.

- **Use Cases:**

1. Fleet management and vehicle telematics.
2. Remote monitoring (e.g., pipeline, infrastructure).
3. Smart cities applications.

LoRaWAN

Pros:

1. Long-range communication, up to 15 km in rural areas.
2. Low power consumption, suitable for battery-operated devices.
3. Good penetration in urban areas.

Cons:

1. Lower data rates.
2. Requires gateway installations for network connectivity.

Use Cases:

1. Agricultural IoT applications (e.g., soil moisture monitoring).
2. Smart metering (water, gas, electricity).
3. Smart parking solutions.

NB-IoT

Pros:

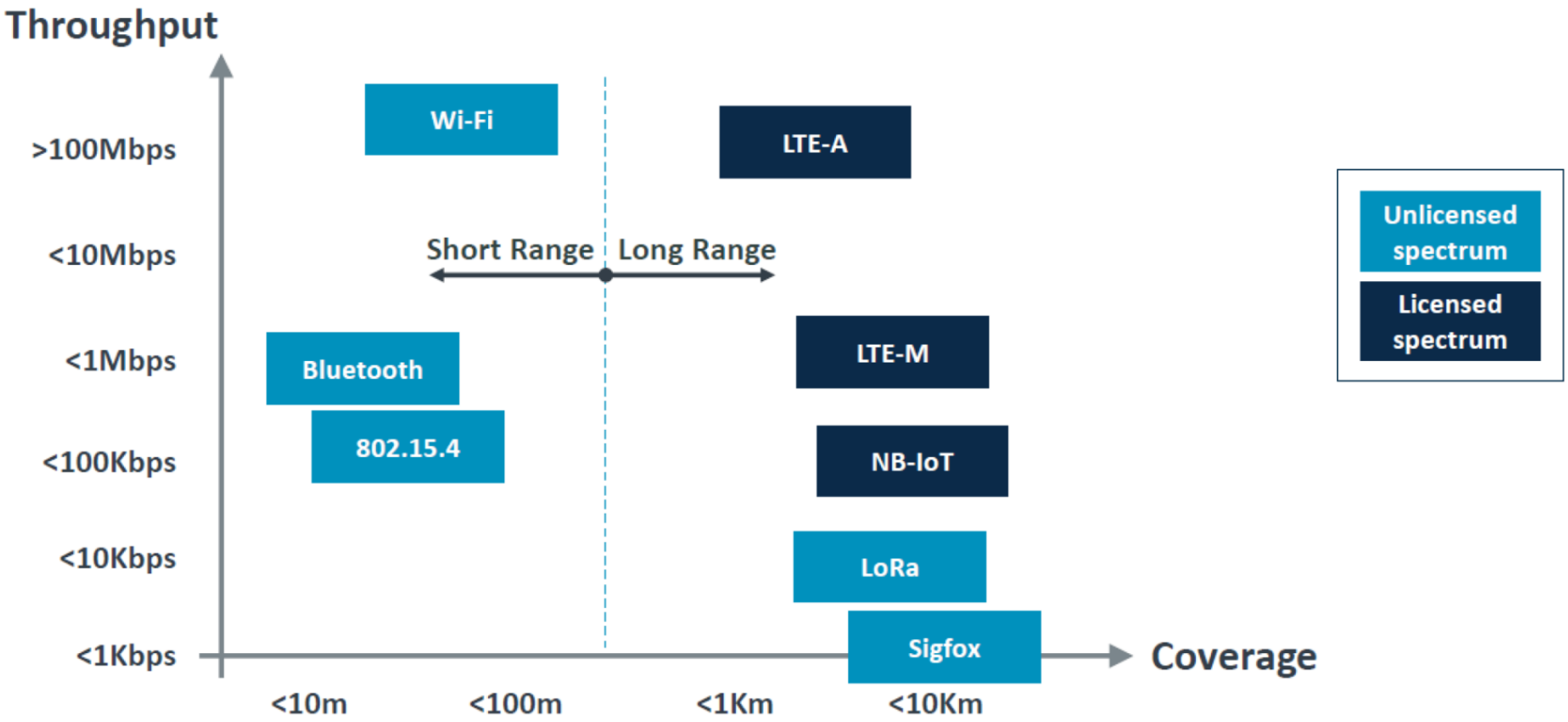
1. Very low power consumption, extending battery life significantly.
2. Excellent penetration and coverage, even indoors or underground.
3. Utilizes existing cellular network infrastructure.

Cons:

1. Limited bandwidth, suitable for small, infrequent data packets.
2. Dependency on cellular network providers.

Use Cases:

1. Utility metering.
2. Environmental monitoring (e.g., temperature, humidity).
3. Asset tracking in logistics.


Throughput
>100Mbps
<10Mbps
<1Mbps
<100Kbps
<10Kbps
<1Kbps
Wi-Fi
LTE-A
Short Range
Long Range
Bluetooth
802.15.4
LTE-M
NB-IoT
LoRa
Sigfox
Coverage
<10m
<100m
<1Km
<10Km
Unlicensed spectrum
Licensed spectrum

Standard /protocol	Body/ stan-dard	Topo-logy	Band-width	Power	Spectrum	Range	Max. Data rate	Channel Band-width	Unique Feature	Typical applica-tion
Wi-Fi	IEEE 802.11 a/b/g/n	Star	Up to 54 Mbps	Low	2.4 - 5 GHz	50 m	135 Mbps	22 MHz	Fast and secure	For public spaces
Zig Bee	IEEE 802.15.4	Mesh, Star, Tree	250 Kpbs	Very Low	2.4 GHz	10 to 300 m	0.25 Mbps	0.3/2 MHz	hand-shaked protocol	For personal area network
6LoWPAN	IEEE 802.15.4	Mesh, Star	250 Kbps	Very Low	2.4 GHz	800 m (Sub-GHz)	0.25 Mbps	868 to 868.6 MHz (EU)	compatible to both Zig-bee &WiFi	For Open space like cafeteria etc.
LORA	LoRa Alliance	Star	18bps - 37.5 kbps	Low	433 - 915 (ISM)	16 Km	27 kbps	EU: 8x125 kHz	For long range with low power	For harsh environ-ments
Sigfox	Sigfox	Star On star	100 bps	Low	868/ 902 (ISM)	40 Km	100 bps	Ultra narrow band	Very reduced power	For long range with low power
Z-Wave	Z-Wave Alliance	Mesh	900 MHz	Very low	2.4 GHz	30 m	0.1 Mbps	868 to 921 MHz	Remote or local control	For Smart home

Standard /protocol	Body/ stan-dard	Topo-logy	Band-width	Power	Spectrum	Range	Max. Data rate	Channel Band-width	Unique Feature	Typical applica-tion
Bluetooth	IEEE 802.15.1	Star	1-2 Mbps	Very Low	2.4 Ghz	greater than 30 m	2.1 Mbps	1 MHz	hop between frequen-cies	For indi-viduals work space
Bluetooth 4.0 LE	IEEE 802.15.4	Star	1 Mbps	Very Low	2.4 Ghz	5-10 m	0.27 Mbps	2400 to 2480 MHz	For personal applica-tion	Electro. gadgets, health etc.
Cellular (2G/3G)	IEEE 802.21	Point to point	Up to 1.4 Mbps	Very High	Varies	16 Km (app.)	Varies	Varies	Long range	For City based ap-plication
Ethernet	IEEE 802.3	Varies	100 to 1000 Mbps	High	None	100 m	Up to 1 Gbps	100 Mbps	-	For big or-ganization

THANK YOU