ZIGBEE VS. BLUETOOTH IN IOT APPLICATIONS

Local communications in Internet of Things (IoT) applications require an excellent wireless protocol. While there are many options out there for developers, we will focus on two of the most-used protocols — Zigbee® and Bluetooth® — and what they do best.

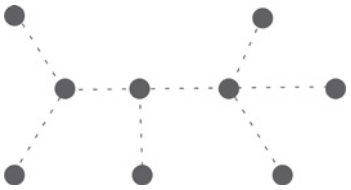
Both of these protocols are great choices, but each has specific strengths. Your ultimate choice will depend on what you want your wireless protocol to do for you. That said, it is possible to implement the two simultaneously, leveraging the combined strengths of both. This white paper is intended to help you make an informed decision between the two protocols. You will learn about the pros and cons of Zigbee and three types of Bluetooth — Bluetooth Mesh, BLE, and Bluetooth Classic.

We will describe what each offers and demonstrate how to get the best out of them. This should put you in a better position to choose the right protocol for your IoT application, whether you are deploying digital signage, smart city applications, mission critical industrial IoT projects or other connected use cases.

Zigbee Technology Explained

Zigbee is a world-class open standard for low-bandwidth, low-power, and cost-effective wireless mesh networking. The standard is developed and maintained by a consortium of companies in the Connectivity Standards Alliance (CSA), formerly the Zigbee Alliance. About 300 million Zigbee nodes are presently in use.

With its 2.4 GHz frequency range, this protocol facilitates data transmission over long distances by sending the messages via an interconnected network of intermediate and distant radio nodes. The information passes through intermediary nodes before it gets to the intended destination. Zigbee implementation does not require a license and can be done anywhere in the world.



mesh networking example

What Are the Strengths of The Zigbee Protocol?

Zigbee mesh networks extend the range capabilities of any single radio. These networks have the ability to self-form and self-heal.

Self-forming means Zigbee mesh networks are capable of automatic configuration. Self-healing means the network will dynamically reconfigure to repair itself upon the removal or disabling of a node. The smooth communication between different manufacturers' devices contributes to Zigbee's extensive adoption, especially in industrial IoT and home automation. Users have almost unlimited OEM equipment options at cost-effective rates.

Zigbee offers excellent and easily accessible documentation to support various use cases. The protocol contains acknowledgments, retries, security, address resolution, and routing tables to support faster and easier programming. It is also compatible with different network topologies, including mesh networks, star, point-to-point and point-to-multipoint.

With Zigbee, you can get up to 3.2 km (two miles) of regular line-of-sight outdoor transmission distance, as well as up to 65,000 nodes per network.

What Are the Limitations of The Zigbee Protocol?

Selecting a protocol for your application involves evaluating a number of trade-offs. One challenge with Zigbee networks is that all nodes that are routing or “hopping” messages *must be powered on at all times*. While you can introduce devices that "sleep" to extend battery life, they are only suitable as a component of the mesh rather than extending it. See the blue box below for information on DigiMesh® to learn about an alternative to this restriction.

Since IP addressing is not available in Zigbee, you must install gateways for effective communication with cloud services and the Internet. Communication with most computers, tablets, and phones also requires gateways since Zigbee is not built into those devices. Another requirement is to properly provision the modems to ensure that nodes can communicate with the right network and gateway.

As with all protocols, it is important to consider latency and range when selecting the right solution for your use case. Point-to-point protocols offer lower latency than mesh, but mesh provides better reliability and range.

In response to the Zigbee powered-on requirement, Digi developed DigiMesh®, a complementary and proprietary mesh networking technology for those who wish to deploy mesh networks that have many of the advantages of Zigbee without the requirement for always-on nodes. It is suitable for applications where the entire mesh network needs to sleep. Digi offers both DigiMesh and Zigbee solutions so developers can select the right protocol for their needs.

Practical Zigbee Applications

Zigbee started with home automation but has vastly grown to support applications in industrial, agriculture, smart city and commercial sectors. Zigbee networks connect vital systems such as retail monitoring, municipal street lighting, factory automation, medical device systems and smart energy.

An excellent example of the developing trend in Zigbee’s mesh networking is smart city street lighting. In this capacity, Zigbee facilitates important features like managing an extensive network of devices remotely. You can read a case study to learn more about this connectivity use case.

Farming applications integrate mesh network technology for various purposes as well, including effective management of devices linking precision agriculture and smart irrigation systems.

Bluetooth®

Bluetooth Technology Explained

Bluetooth today is a worldwide phenomenon, and today almost four billion Bluetooth devices are developed every year. But it was originally designed as an alternative to wired solutions used to connect devices like cell phones and computers to peripherals such as mice, keyboards and headphones. This is because Bluetooth is a personal area wireless networking protocol that is suitable for short-range communication. Like Zigbee and Wi-Fi, Bluetooth requires no license to integrate and offers a 2.4 GHz frequency range.

The standard is maintained by the Bluetooth Special Interest Group (SIG), which is comprised of the developers and administrators who oversee the interoperability between various brands of devices.

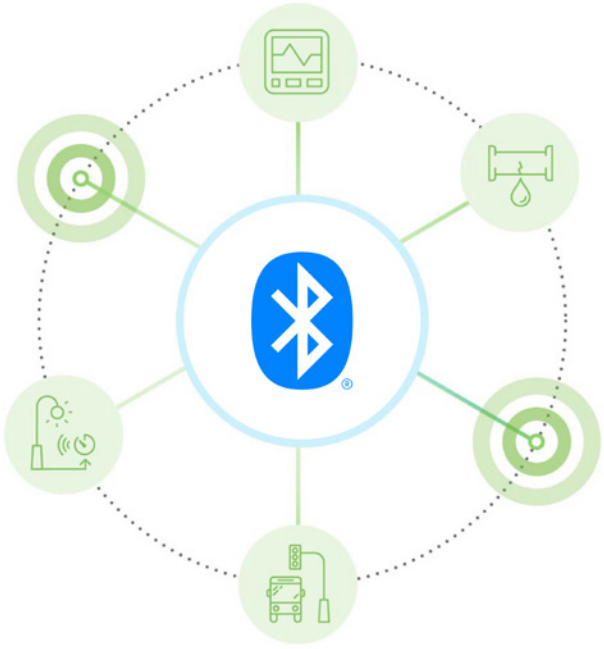
The three protocols encompassed under the Bluetooth umbrella are interoperable, but they are best considered individually. We will discuss Bluetooth Classic, Bluetooth Mesh, and Bluetooth Low Energy individually in this white paper.

Bluetooth "Classic" Protocol Explained

Bluetooth Classic is ideal for transmitting high-throughput data over short distances where extended battery life is not considered a problem. Its 2.1 Mbps transmission speed comes in handy for rechargeable video and audio devices requiring high bandwidth.

Almost all peripherals connected to mobile phones, vehicle entertainment systems, or computers are classic Bluetooth devices. These include printers, mice, keyboards, earphones, and mobile headsets, among others.

The master/client architecture adopted in Bluetooth Classic means a master can connect with up to seven client devices, provided they are all in a small personal-area network.



What Are the Strengths of Bluetooth Classic?

The high throughput offered by Bluetooth Classic comes in handy for projects requiring the transmission of a lot of data. Several devices — phones, laptops, and tablets among them — run on classic because the pairing is seamless. In audio and video feeds, it starts receiving information once it pairs with a device. It also supports serial streams. You can access this protocol's documentation in the official standards documentation, books, and other online resources.

What Are the Limitations of Bluetooth Classic?

First on the list of limitations of Bluetooth Classic is the complicated implementation of the protocol. You need a user interface and strong pairing for this process. It also consumes a lot of power, thanks to the high bandwidth. So, it is best suited for easily rechargeable devices, which is a feature absent in most IoT applications.

The Bluetooth Classic Protocol was initially designed as an alternative to short-range peripheral cables. The networks suffer considerable size limitations, making them unfit for scalable sensor networks hosting multiple devices.

What Are the Use Cases of Bluetooth Classic?

You will find Bluetooth Classic in most home entertainment systems, vehicle-smartphone pairing systems, and audio headsets. There are projections of more applications and adoptions of this protocol in the next few years, considering its industry-standard acceptance and high bandwidth. However, most IoT applications are better suited to the other two Bluetooth versions.

Bluetooth Low Energy (BLE) Protocol Explained

Bluetooth Low Energy combines both low-bandwidth connections over short distances and impressive power management. Hence, it comes in handy when a personal-area network does not have to deal with large data streams, and when extended battery life is required. Prominent BLE devices include cook pots, smartwatches, lighting controllers, temperature monitors, digital scales, location beacons, and similar low-bandwidth devices that run on batteries.

The client/server architecture in BLE means the hardware only needs to implement the required communication features. This saves bandwidth, battery and cost. Theoretically, you can integrate several devices into a BLE network. Still, there are limitations to a single BLE personal-area network size due to range, physical space and bandwidth. Therefore, you are mostly restricted to a few hundred nodes.

Why Should You Use BLE?

As the name implies, Bluetooth Low Energy requires minimal power. You can use only coin cells to power the devices for several hours. This is why most data-skinny devices work best with this Bluetooth protocol. The simplicity of both the protocol and hardware also means that both the devices and chips are affordable.

Thanks to the client-server model, implementing communications is seamless, which minimizes the development and engineering time considerably. Communication between devices doesn't depend on pairing. However, they can read and send data instantly on request.

Billions of devices run on BLE. The documentation is excellent, and the supporting OEM equipment is plentiful.

What Are the Limitations of BLE?

BLE's point-to-point nature limits a radio's communication to its range and the range of the network's physical size (to 10 meters). For example, this means it will struggle to power municipal street lighting control or agricultural monitoring applications but will do well in offices and homes.

There is no IP addressing, so the only way to transmit information to the Internet and cloud solutions is via gateways. The most common gateway in BLE applications is the smartphone, which means the application will only work if a smartphone is present. While this is not a problem for fitness bands, smartwatches, and other wearables, it won't work in industrial and commercial applications since it is difficult to implement smartphone gateways.

Additionally, since the bandwidth in BLE is so much lower than what Bluetooth Classic offers, it is not ideal for media streaming.

What Are the Use Cases for Bluetooth Low Energy?

Let's start with personal-area networks, such as vehicle networks, fitness monitors and home appliances. Indoor positioning systems also use BLE's beaconing to set location in a large space.

Other use cases include home automation and other small commercial systems designed for home-sized spaces. In agriculture, it comes in handy for monitoring small commercial greenhouses. Installers working on IoT device configuration can use BLE for local communications instead of longer-range protocols like cellular mobile data or Zigbee mesh.

Bluetooth Mesh Protocol Explained

The Bluetooth Mesh protocol is relatively new; it's a basic point-to-point BLE extended by extra routing and network formation setups. The results are mesh networks that allow nodes to function as relays to expand the network for a range of multiple devices.

The architecture and functioning of both Zigbee and BT Mesh are similar yet different. For instance, a BT mesh supports up to 32,000 nodes, but individual networks are reduced to the low hundreds of devices due to the bandwidth and physical space limitations.

Why Use Bluetooth Mesh?

There is no limitation by any individual radio node's reach when it comes to mesh networks. You can transmit messages from each node to destinations beyond the usual range, resulting in extensive physical networks.

Bluetooth Mesh is BLE-based, so it offers similar advantages, such as good documentation, beaconing support, excellent security, and low energy use. Networks are self-healing and self-forming. The parent/child relationship in Bluetooth Mesh offers store-and-forward sleep support for end devices, just as in Zigbee.

What Are the Limitations of Bluetooth Mesh?

Because Bluetooth Mesh is relatively new, it's prone to modifications and improvements. Support is currently limited, and most handheld devices, gateways, and OEM equipment will not be compatible.

The network design is simpler, thanks to the "managed flood" protocol. However, this means lower efficiency and power use than fully-routed mesh protocols like Zigbee. Bluetooth Mesh can only work on mains-powered devices.

Like Zigbee nodes, BT Mesh nodes cannot sleep. And since they don't use IP addressing, Internet traffic must pass through a gateway or border router. Additionally, mesh networks have higher latency due to message hopping through multiple nodes. Therefore, as a trade-off for a larger network size, the application must not require fast response times.

What Are the Use Cases of Bluetooth Mesh?

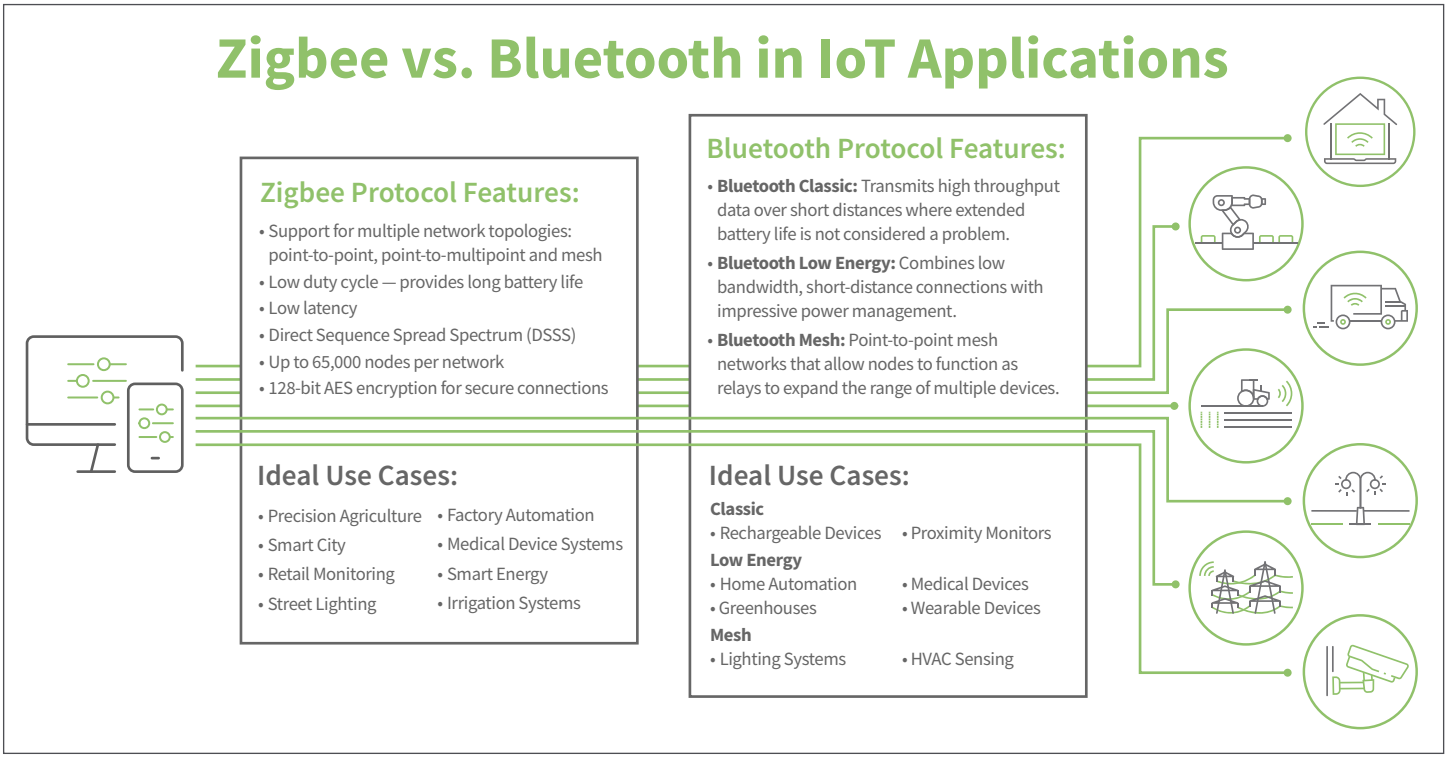
Bluetooth Mesh protocol is intended for lighting systems due to the "no-sleep" requirement of the router nodes. An application layer developed by Bluetooth Mesh ensures devices from different manufacturers can interoperate in smart lighting scenarios.
In essence, switches from Manufacturer X can control lighting devices from Manufacturer Y. BT Mesh works with sensor networks, provided the sensors are integrated into mains-powered networks.

BLE and Zigbee Combined

The Digi XBee 3 Zigbee RF module is a single hardware solution compatible with Bluetooth Low Energy. A combination of Zigbee and BLE supports a seamless smartphone-based module configuration with the Digi XBee Mobile App. The Digi XBee Mobile SDK (Software Development Kit) can help to develop beaconing applications. The SDK contains a set of libraries, code examples and documentation.

The combination of BLE and Zigbee facilitates iOS and Android mobile app development to interact with Digi XBee 3 modules. Aside from supporting beaconing applications, the SDK comes in handy in communicating with local BLE sensors in future applications. This communication may help create a fully interoperable network of multiple vendors, including Zigbee and Bluetooth devices.

In conclusion, Zigbee and Bluetooth can work separately or together to develop highly flexible applications that leverage these individual interoperable protocols' strong points. Knowing each of the protocols' pros and cons enables developers to build excellent communication systems, such as a robust wireless IoT network with balanced power use, device costs and bandwidth.



Why Digi?

Digi is a complete IoT solutions provider, supporting every aspect of your project, from mission-critical communications equipment to wireless design services to get your application designed, installed, tested and functioning securely, reliably and at peak performance.

Digi builds its products for high reliability, high performance, and versatility so customers can expect extended service life, quickly adapt to evolving system requirements and adopt future technologies as they emerge. Digi cellular routers, servers, adapters and gateways support the latest applications in traffic, transit, energy and smart cities.

Our solutions enable connectivity to standards-based and proprietary equipment, devices and sensors, and ensure reliable communications over virtually every form of wireless or wired systems. An integrated remote management platform helps accelerate deployment and provide optimal security using highly efficient network operations for mission critical functions such as mass configuration and firmware updates, including system-wide monitoring with dashboards, alarms and performance metrics.

Company Background

- Digi is publicly traded on the NASDAQ stock exchange, symbol DGII
- Founded in 1985, Digi has 35+ years of experience connecting the “things” in the “Internet of Things” — devices, vehicles, equipment and assets
- Headquartered in the Twin Cities of Minnesota, Digi employs over 700 people worldwide
- The business has been profitable for 18 consecutive years
- Digi’s annual revenue is around $300 million
- The company has 285 patents issued and pending (150 issued)
- In our three decades in business, we have connected over 100 million devices

As an IoT solutions provider, Digi puts proven technology to work for our customers so they can light up networks and launch new products. Machine connectivity that’s relentlessly reliable, secure, scalable, managed — and always comes through when you need it most. That’s Digi.

Contact a Digi expert and get started today

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