*Technical Article*

# *From Car Access to Tire Pressure Monitoring, Discover How Bluetooth® Low Energy Is Changing the Connected Car*

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*Bluetooth*® Low Energy is on a path to become ubiquitous. The Bluetooth Special Interest Group estimates that by 2024, all new phones, tablets and laptops will support Bluetooth Classic and Bluetooth Low Energy. They also expect 35% of devices to ship with single-mode Bluetooth Low Energy by 2024, which represents 300% growth in annual shipments.

The reason for this is the versatility of Bluetooth Low Energy. Bluetooth Low Energy continues to expand its capabilities to meet new applications. Features including LE audio, mesh, positioning services and many more have been added to adapt to the growing demand in applications such as asset tracking, health and fitness, Internet of Things, access control and more. Due to its versatile capabilities and widespread use in smartphones which enables interoperability and immediate deployment in existing systems, Bluetooth Low Energy is becoming the go-to standard for a variety of automotive applications.

Recent trends suggest that automotive manufacturers are embracing Bluetooth Low Energy for tire pressure monitoring systems (TPMSs), cable replacement, telematics, wireless battery management systems, personalization, smart wearables and LE Audio. Let's explore a few of these applications.

### Stand-alone Bluetooth Low Energy benefits in automotive

Cars today tend to have many different wireless technologies on board, including low-frequency radio, ultra-high-frequency radio, Wi-Fi® and Bluetooth Classic. All of these technologies require some amount of power in order

to operate, but what happens when the car is off? In most cases, various systems are also powered off, but preserving some form of wireless connectivity might still be necessary. For example, when returning to a parking lot, we would still like to perform actions such as turning on the headlights, air conditioning and unlocking the car.

Usually, the car is equipped with a Wi-Fi and Bluetooth combination chip. So what's the problem? Power. It is possible to power down these chips partially, but they require their host module to be in sleep mode (as opposed to being powered off completely), which ultimately wastes power. The solution is a single, power-efficient wakeup source for the vehicle's wireless systems.

Stand-alone Bluetooth Low Energy is a single chip capable of performing Bluetooth Low Energy only.

From a connectivity standpoint, it's possible to achieve a better power budget by adding a stand-alone Bluetooth Low Energy node in the head unit or telematics box that acts as a wakeup source for the entire system. Once a smartphone or key fob comes into range, the node sends a wakeup signal that turns on the other wireless systems on the vehicle.

Beyond power savings, using a stand-alone Bluetooth Low Energy chip has these advantages:

- You can leverage stand-alone Bluetooth Low Energy chips to act as a central node for TPMS nodes or as a passive node for car access applications.
- TI offers Bluetooth Low Energy and microcontroller (MCU) combination chips where the stand-alone Bluetooth Low Energy chip acts not just as a wireless transceiver but as a stand-alone MCU to perform housekeeping tasks or monitor other peripherals.
- You can leverage stand-alone Bluetooth Low Energy nodes as range extenders by using a single node as Central and Peripheral simultaneously.

## Bluetooth Low Energy benefits in TPMSs

Bluetooth Low Energy's versatility and compatibility with smartphones enable a variety of applications, which have inspired designers to attempt consolidating wireless technologies in the vehicle into Bluetooth Low Energy. A great example is TPMSs.

In the past, drivers would have to check the pressure at each tire separately. As technology progressed and wireless communication has become simpler to design and maintain, TPMS has become a passive safety standard in the automotive world.

Most TPMSs use two separate integrated circuits (IC) – a low-frequency radio IC and an ultra-high-frequency IC. The downside is that this method requires the vehicle's central processing unit (CPU) to use a separate, dedicated receiver for both wireless technologies, requiring maintenance of each.

Alternatively, we could design the TPMS nodes with Bluetooth Low Energy only, which offers long range support and power efficiency that allows for higher robustness and longevity as well as native support in smartphones which allows for excellent interoperability between the vehicles other Bluetooth Low Energy systems. Moreover, TPMS can be incorporated as part of a Bluetooth Low Energy network in the vehicle.

By using smart and efficient design, designers can save costs by combining multiple applications on a single Bluetooth Low Energy node. For example, since the vehicle's main CPU already includes Bluetooth Low Energy, you can leverage this node to act as a data collector for the TPMS, increasing efficiency and reducing the total amount of wireless nodes in the vehicle, which in turn saves total system costs and increases node interoperability.

## Conclusion

Bluetooth Low Energy brings many benefits to the world of automotive by offering multiple possibilities through a single wireless technology, including power savings, interoperability, and hardware and software reuse, while also eliminating the need to certify, maintain and develop multiple wireless technologies.

Leveraging the SimpleLink™ CC13x2 and CC26x2 software development kit makes it possible to use Bluetooth Low Energy as a unified hardware and software baseline, which also makes it easier to develop, port and debug the system, increase robustness and traceability, and help save total system costs.

## Additional resources

- Read our technical article, Exploring connectivity trends for Bluetooth® Low Energy in the car.
- Watch the video, Connect: Why wireless for battery management systems (BMS)?

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