

Solving the Challenge of Many Devices with Multiple Standards in the Connected Home

By John Anderton

The number of connected devices within our homes continues to rise as consumers increasingly rely on them for convenience, comfort, health and safety. Some are inside our homes; some are outside. And while these devices are designed to be part of a network, they often communicate via different standards – languages, if you will – depending on the application.

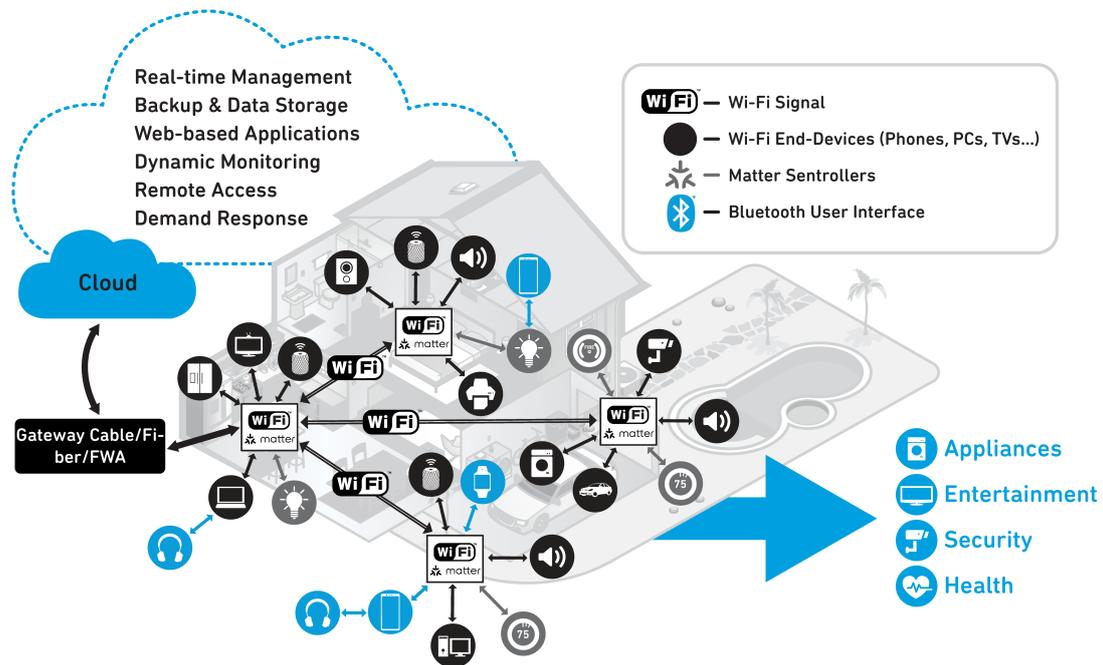
Most of us are familiar with the Wi-Fi standard, which enables content sharing and internet access in the home. But there are a number of Internet of Things (IoT) technologies other than Wi-Fi, such as **Bluetooth®** Low Energy (LE), Zigbee® and Thread®. These low-power, low-data-rate wireless standards are commonly used in IoT-connected products such as door locks, LED lighting and appliances.

The challenge that these multiple and different technologies pose is that vendors must decide in advance what kind of technology they are selecting for their device. For example, in selecting either Zigbee or Bluetooth LE – or both – each choice has its own impact in terms of product design.

Looking forward, there are even more technologies coming that are targeting similar smart home use cases, such as the Connected Home Over IP initiative, which combines multiple other technologies (802.15.4 and Bluetooth LE) into a single standard. This will make the choice between technologies and future-proof solutions even more challenging.

While today's communications devices have some form of dynamic multi-protocol (DMP) support, this approach requires different types of tradeoffs. DMP alone is not sufficient to realize the full benefits of the connected home. Truly seamless connectivity can only be achieved by the ability to listen to and hear *all* devices on the network simultaneously, not just a few.

Figure 1: As smart home technology proliferates, so does the challenge of ensuring that devices built on different standards can quickly and effectively communicate.



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ConcurrentConnect™ Technology as a Solution

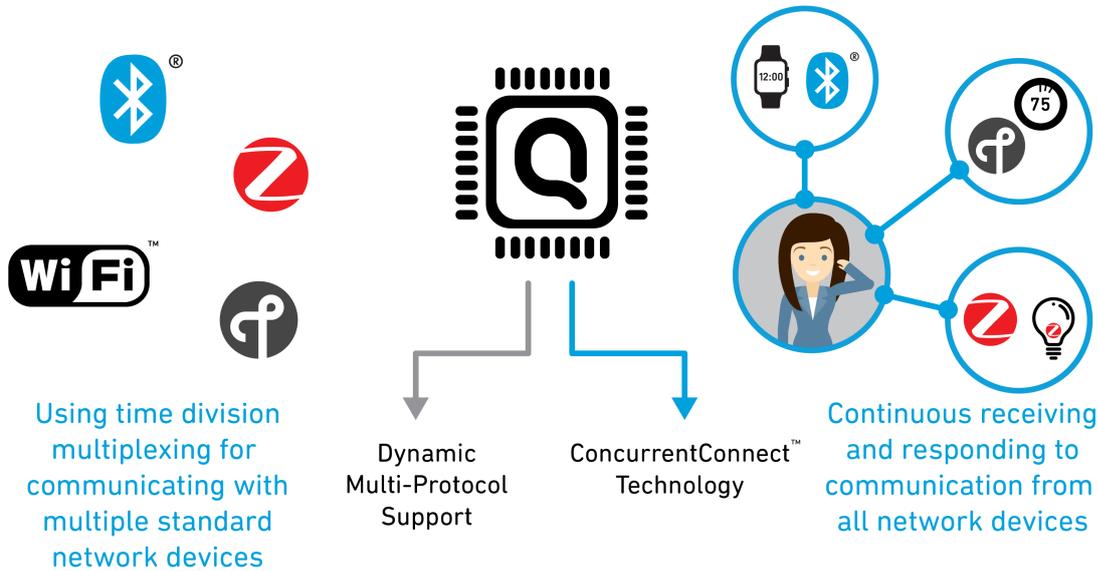
Today, customers have the benefit of *not* having to choose or compromise. The next major leap in multi-standard capabilities – ConcurrentConnect technology, from Qorvo – fluently and continuously services two or multiple networks using different protocols, whether Zigbee + Matter (formerly Project CHIP) or Zigbee + Bluetooth LE to a smartphone or Matter + Bluetooth LE Mesh, or other multi-network protocol use cases. The ConcurrentConnect technology will deliver the unique experience of seamless operation of devices in the home that are connected via different networks without performance loss.

To illustrate, let's look at a real-world network situation combining Zigbee or Thread and Bluetooth LE devices using a standard node without ConcurrentConnect support. Since the node does not have concurrent connection/listening abilities, it switches back and forth between these standards and has to communicate with one standard at a time. In addition to the obvious inefficiency, this switching can result in dropped communications and latency, as only one standard is communicated while the other is blocked until the medium becomes free again. Thus, in a set timeframe the amount of communication is challenged.

With a node that utilizes ConcurrentConnect technology, concurrent listening is achieved, which in turn allows near-instantaneous switching from Bluetooth LE to Zigbee or Thread with little or no dropped communications. Thus, the communications between devices are faster, more efficient, more scalable and able to receive more data packets. This enables unprecedented single-device concurrency capabilities between these protocols.

Qorvo's unique single-chip, single-radio solution, combined with a powerful software development kit, can manage data traffic from multiple standards or protocols at the same time and with no detectable latency. Plus, designers can reduce part content, resulting in smaller, sleeker form factors and lower product costs that are easier to support. With ConcurrentConnect support, the options for customers to develop innovative use cases are virtually unlimited, as they have greater flexibility in standards support.

Figure 2: ConcurrentConnect technology, shown at the right of the illustration, manages communications from different standards and protocols simultaneously with no detectable latency.



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Why Does it Work Better?

There are major challenges on both the hardware and software levels when a single radio must support multiple protocols simultaneously. This is because every protocol has its own specifications on how and when devices should listen to incoming packets and transmit outgoing packets.

Some phases in the protocol may have fixed-time intervals during which the radio can predict when it should switch to the right frequency (e.g., Bluetooth LE “in connection” phase). However, most of the time, especially during the listening phase – before the actual connection phase, while detecting candidates for connection – the radio is required to constantly detect incoming packets *asynchronously* without prior knowledge of specific times in which the radio is required to open its receive window to receive the packet.

Additionally, an application requires a simple-to-use interface to operate over multiple protocols in a seamless way, such that the application developer becomes agnostic to protocol dependencies, removing the burden of switching to the corresponding protocol when needed.

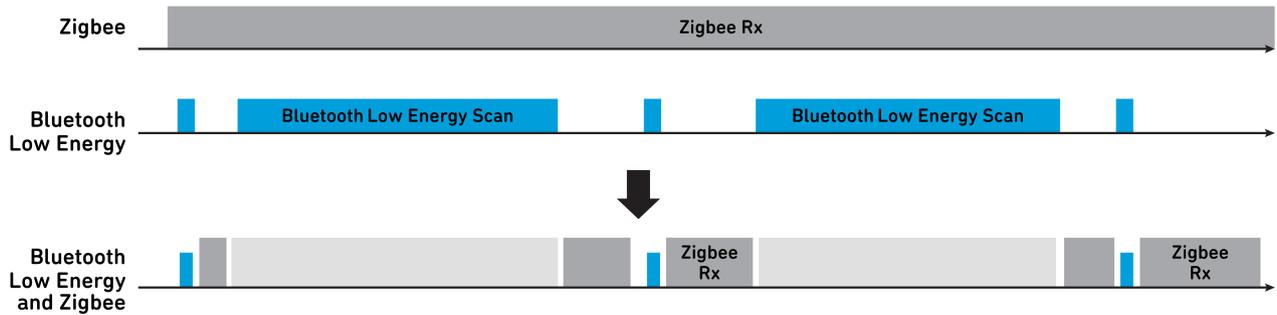
This is where the Qorvo concurrent listening technology shifts the current paradigm. It enables asynchronous interleaving of packets from different protocols on the hardware level, such that the device virtually listens to multiple protocols at the same time and no blind spots are observed during the listening phase.

ConcurrentConnect technology is abstracted in the accompanied software development kit, which provides straightforward APIs so the application developer can utilize the capability in a seamless way in their application.

This maximizes the utilization of the medium, as ConcurrentConnect technology maintains a synchronized connection at the same time as it is listening to asynchronous events from multiple protocols.

The key differentiator here with DMP is predictability vs. unpredictability. DMP support is based on the predictability of the packets that are being received and sent; it must know the times to switch to Bluetooth LE and then back to Zigbee or Thread, for example. ConcurrentConnect technology supports unpredictability, for simultaneous synchronous and asynchronous operation.

Figure 3: This illustrates the interleaving of Zigbee and Bluetooth LE packets with ConcurrentConnect support.

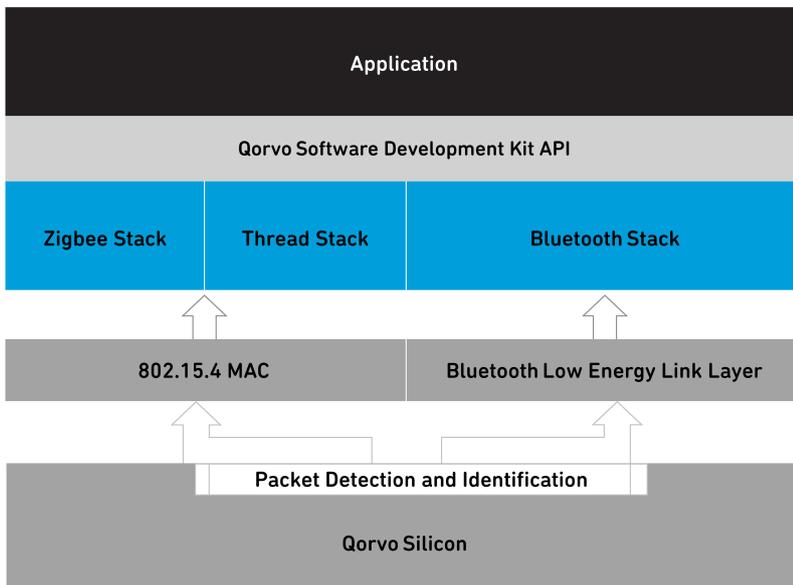


ConcurrentConnect technology is based on unique hardware features in Qorvo's platform that enable detection and identification of the packet in the most efficient way. Once detected, the packet goes through an identification process in real time on the hardware level, and then sends the packet to the appropriate protocol stack, eliminating the need for additional, non-real-time routing logic on the higher software layers.

The accompanying software development kit takes the next step in enabling combinations of the preferred protocols for the application in such a way that the application "thinks" it has its own radio. This simplifies application development and enables the developer to focus on the actual application differentiators.

As a result, it opens a wide variety of use cases across the home network, including gateways, hubs and end devices, which require capabilities to support high frequency of data transfer between multiple different devices. With ConcurrentConnect technology, a gateway can seamlessly switch between all the standards and protocols that are present in the home network, allowing more end devices based on different standards to be connected and controlled. In addition, designers and device owners are not locked into a certain technology as they expand their home connections.

Figure 4. This block diagram depicts ConcurrentConnect support for packet routing on Qorvo hardware. The processing is completed on the hardware and software levels.



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What ConcurrentConnect Technology Enables

With the gateway supported by ConcurrentConnect technology now able to understand multiple protocols at the same time and allowing a mix of end devices, new use cases in the IoT are possible.

In addition, the end devices themselves will allow for additional use cases. For example, devices can be connected to Bluetooth LE Mesh and Zigbee or Thread networks at the same time. Or a Bluetooth LE-based smartphone can be connected directly to the device while operating in a Zigbee or Thread network.

The ability to concurrently listen also opens up new use cases for combined protocols that were not possible before, for example, a Zigbee- or Thread-based device can become location aware by continuously scanning for Bluetooth LE beacons from Bluetooth LE trackers.

In the smart home market, connected lighting is one important application that will benefit from ConcurrentConnect technology. For the first time ever, a lightbulb can simultaneously be controlled by Zigbee- or Thread-based switches at the same time as Bluetooth LE switches. Similar benefits can be achieved in motion sensors, thermostats and other smart home sense and control devices

Conclusion

Standards are scattered and devices are developing quickly. Qorvo's patented ConcurrentConnect technology is the next step beyond dynamic multi-protocol support. It brings to the IoT market a very high degree of efficiency that is enabling a new level of concurrence and allowing designers and consumers to keep their options open across multiple protocols and standards. It is no longer necessary for them to choose or compromise as almost any use case becomes possible.

About the Author



John Anderton is the director of product line management for the Wireless Connectivity business at Qorvo, delivering core RF solutions, innovation and product leadership in Wi-Fi and the IoT. He has more than 20 years' engineering experience in innovative and leading semiconductor and consumer electronics companies, including NEC, Nokia and NXP. In 2010, John joined IoT startup, GreenPeak Technologies, now part of Qorvo, leading product teams to deliver the first wave of low power enabled connected devices.

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