Wi-Fi and Bluetooth coexistence

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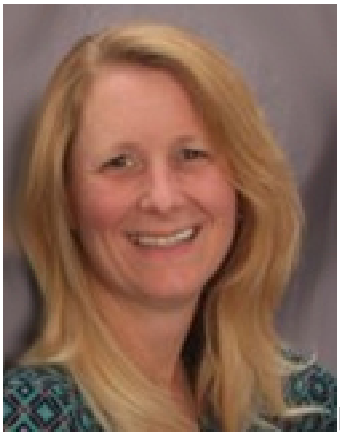

Because Bluetooth and Wi-Fi transmit in different ways using different protocols, interference can occur when Wi-Fi operates in the 2.4GHz band.This article discusses effective methods forachieving successful coexistence (through temporal, spatial, and frequency isolation) of Bluetooth and Wi-Fi devices.

Spread Spectrum
Both Wi-Fi and Bluetooth are based on spread spectrum signal structuring – a technique where a narrowband signal is expanded to a wideband signal.
The two most popular spread spectrum signal structuring techniquesare Frequency Hopping Spread Spectrum (FHSS, used by Bluetooth devices) and Direct Sequence Spread Spectrum (DSSS, used by Wi-Fi devices).The use of these differing techniques is the heart of Wi-Fi/Bluetooth coexistence issues when both technologies operate in the same frequency band.

FHSS spreads a narrowband signal by “hopping” across a given frequency band (in a pattern known by both the transmitter and receiver).

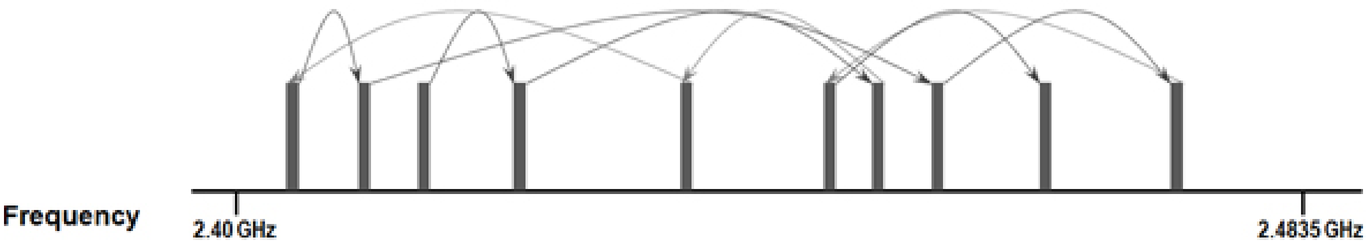

Figure 1. With Frequency Hopping Spread Spectrum, the signal is transmitted on different frequencies at intervals to spread the signal across a relatively wide operating band.

With **DSSS**, the narrowband signal is divided and then combined with a bit sequence (or chipping code). The sequencespreads multiple copies of the original signal across a wider portion of the operating band to form a channel.The receiving station decodes the original narrowband signal by using the same sequence as the transmitting station.

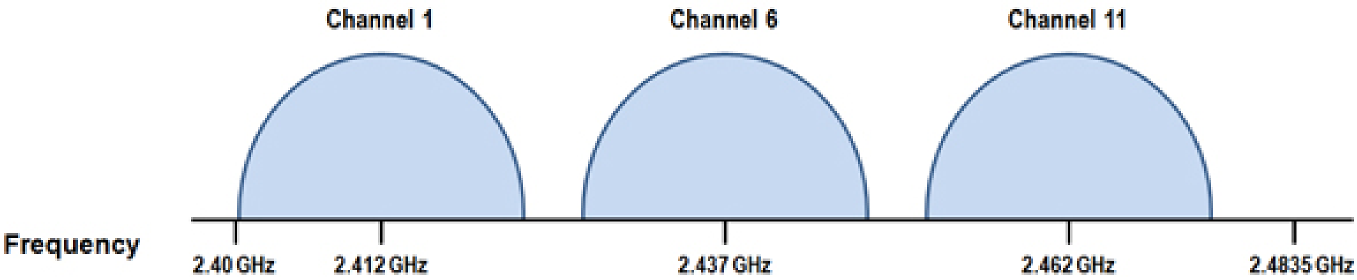

Figure 2. With Direct Sequence Spread Spectrum, the signal is transmitted on a continual basis across a range of frequencies known as a channel.

A transmission using FHSS is nothing but noise or interference to a receiver using DSSS (and vice versa).Strong interference may cause a decrease in performance; the transmission may need to be resent and the device could even lose connectivity.

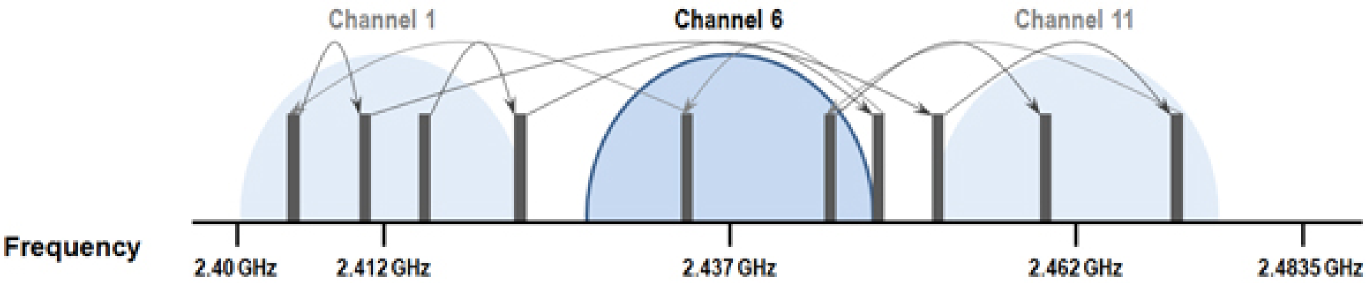

Figure 3. FHSS and DSSS transmissions will collide when the FHSS transmitted hops to a portion of the operating band occupied by the DSSS transmitter.

Interference Solutions
Using time, space, and/or frequency to isolate radios, the following coexistence methods(alone or combined) may allow for acceptable performance and reliability for collocated Bluetooth and Wi-Fi radios.

Temporal Isolation: Time Division Multiplexing (TDM) is a coexistence method where Bluetooth and Wi-Fi radios (embedded in the same device and linked together with input/output signaling pins or “wires”) take turns transmitting. An output wire is asserted by a radio when transmitting to indicate to the device on the corresponding input wire that it should refrain from transmitting during this time. TDM can be implemented between separate Bluetooth and Wi-Fi chips by linking them together via a printed circuit board. With increasingly popular combination Bluetooth/Wi-Fi chips, TDM is implemented within the same chip and therefore arbitrates between the two interfaces quickly.

Spatial isolation involves placing collocated Bluetooth and Wi-Fi radios (and their antennas) as far apart from each other as possible and, when possible, placing insulating material between them. Spatial isolation is impossible with combination Bluetooth/Wi-Fi chips and modules that share a common transmitter, receiver, and antenna.

Frequency Isolation: Adaptive Frequency Hopping (AFH) is a built-in coexistence feature that is found in most Bluetooth devices today. With AFH, a Bluetooth radio scans the operating band for interference and adapts its frequency hopping patterns to avoid DSSS channels. This decreases interference (and therefore increases performance) between Bluetooth and Wi-Fi radios.

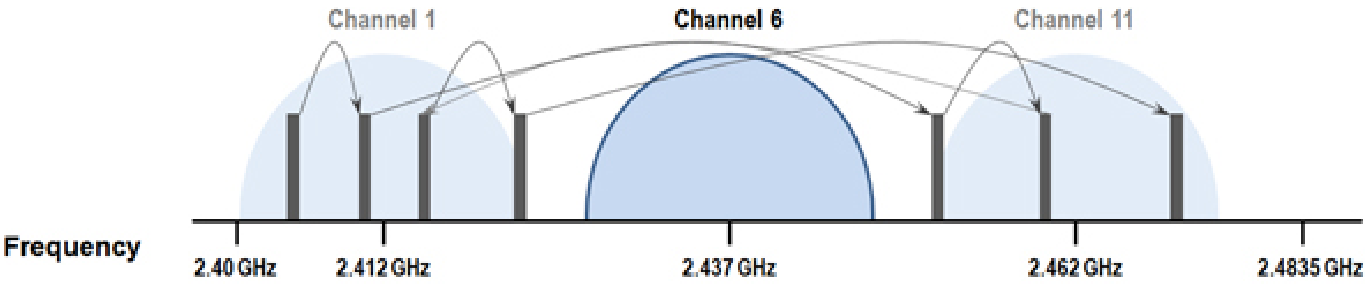

Figure 4. With AFH, FHSS devices avoid DSSS channels to allow for improved performance for both Bluetooth and Wi-Fi devices.

Wi-Fi Migration to the 5 GHz Band
Although effective, the above methods do reduce performance for both Bluetooth and Wi-Fi devices. The most effective means of addressing Bluetooth and Wi-Fi mutual interference is tomigrateWi-Fi operation to the 5 GHz band. In addition to eliminating (rather than mitigating) Bluetooth/Wi-Fi mutual interference, Wi-Fi operation in the 5 GHz band provides for seven times the network capacity when compared to Wi-Fi operation in the 2.4 GHz band.

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