

Bang & Olufsen wireless speaker platform – technical background

Bang & Olufsen has worked on wireless speaker technology since 2007. Until now, however, there has been no convincing solution that is capable of delivering robust sound performance. Since the radio frequency environment itself ultimately determines the quality of the audio stream, a congested environment that is prone to interference has made it almost impossible to use wireless speakers without compromising audio quality. Although listeners may experience decent results if the environment is suitable upon installation, quality can drop precipitously if new systems are introduced in the vicinity.

While some manufacturers have already introduced wireless speakers, there has been no official industry standard for high-quality audio. Existing systems are susceptible to the inherent weaknesses of congestion in the available frequency bands.

Bang & Olufsen has committed to a newly-developed open standard promoted by WiSA, the Wireless Speaker and Audio Association, which was formed to create an international standard for wireless audio technology. WiSA is the first platform to use the wireless U-NII frequency band and the first to apply rigorous quality standards for audio performance. See more at www.wisaorganization.org.

Bang & Olufsen's close partnership with Summit Semiconductor has meant that Bang & Olufsen products have been used in the development and testing of their latest wireless chip set. This has given Bang & Olufsen not only direct influence on solving the quality issues that have plagued wireless audio performance – but also a head-start in developing new products that integrate the emerging WiSA standard.

Key technical benefits of the Bang & Olufsen wireless system:

- Exceptional audio quality for wireless speakers
- Reliably robust sound performance
 - Delivers up to 7.1 channels of 48 kHz/24-bit uncompressed audio signal
 - No pops, clicks, or hiss
- Interference-free
 - Uses the uncongested wireless U-NII frequency spectrum of the 5Ghz band with up to 24 RF channels
 - Dynamic Frequency Selection uses forward error detection and correction to switch frequency when errors or interference are detected – without loss of samples
 - No interference with other wireless users in the customer's home - or their neighbours'.
- Extremely low latency – approximately 5ms – eliminating lip sync issues
- The first wireless system in the U-NII band that offers multi-channel performance - up to a full 7.1 surround sound configuration
- Out-of-the-box setup convenience: Easy to configure new setups or retrofit to existing setups
- No cable clutter
- Interoperability and easy integration with all WiSA compliant products including non-Bang & Olufsen audio sources

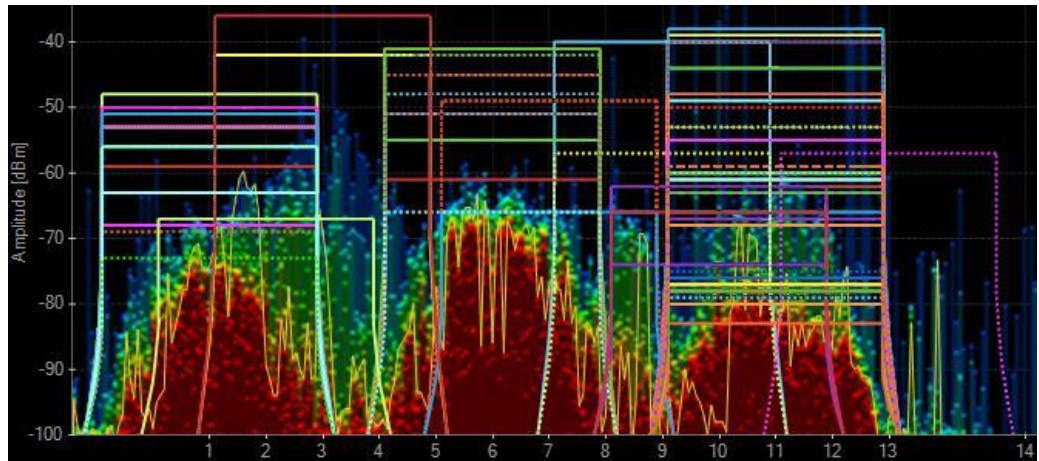
Background:**Range and robustness**

Until now, wireless technologies have struggled to find space on the cluttered radio frequency spectrum without interference from other users.

The WiSA standard utilizes a newly approved, dedicated U-NII¹ frequency spectrum in the 5GHz band. The U-NII frequency spectrum contains up to nine unlicensed bands and 15 DFC² bands that require radar detection.

There is much less congestion here. This means products based on the WiSA standard can make use of what is normally referred to as “protected” channels (normally used for radar transmission by the military, weather services, police, etc.) to reduce audio signal dropouts and other disturbances to an absolute minimum.

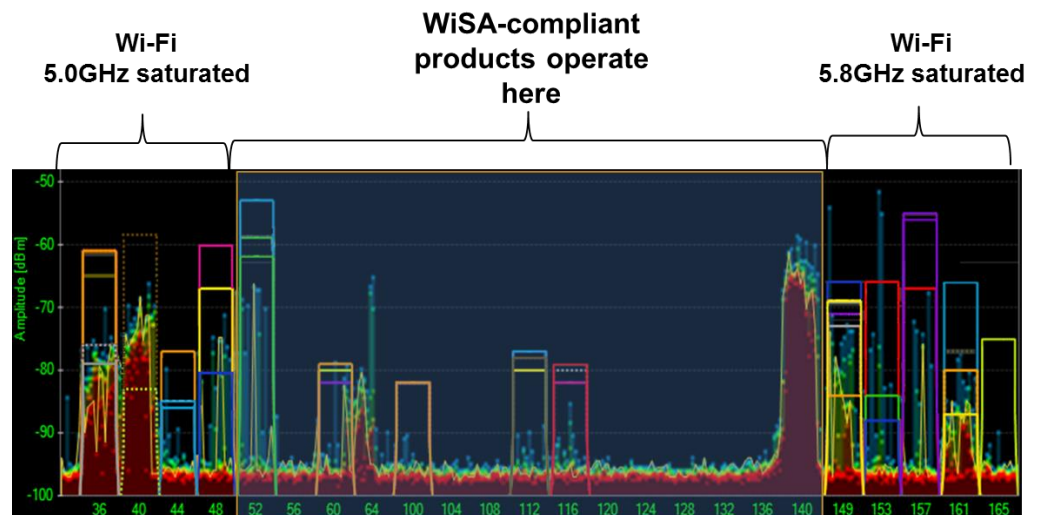
While use of these protected channels has clear advantages, it is not without its restraints. The number of frequencies available differs from region to region, as some countries utilize some of the frequencies for military purposes. Another consequence of selecting the 5GHz band is that the range is limited to one-room setups – at least for the time being.



The figure above shows a completely saturated 2.4 GHz band, used by 802.11b/g/n, Bluetooth, wireless telephones, baby monitors, security cameras, etc. It is also affected by microwave ovens. Notice the amount of energy (in red) that is spread across the entire radio frequency spectrum (the horizontal axis).

¹ U-NII - 5.2 – 5.8 GHz Unlicensed National Information Infrastructure – selected to maximise channel availability and eliminate interference.

² Dynamic Frequency Selection – a sub-band shared with the military and aviation radar. WiSA-enabled systems are among the very few who are allowed to work here.



As can be seen in the above figure, the 5 GHz band is much less crowded. Using it requires dedicated 5 GHz equipment and Dynamic Frequency certification.

Audio quality

There are two basic issues that impact the experienced quality of wireless audio systems: errors and latency.

Errors are caused by interference in the wireless transmission path and are experienced audibly as additional noises such as pops, clicks and hiss. While it is still impossible to build a wireless transmission system that is *completely* free of errors due to the inherent instability of the radio frequency environment and the presence of interference caused by signals from other sources, the Summit Semiconductor system used in Bang & Olufsen's new wireless speaker platform has radically reduced audible errors in a number of innovative ways:

- First, it uses forward error detection and correction to "look around and ahead" and monitor the current channel's transmission integrity.
- Second, it employs Dynamic Frequency Selection (DFS) to hop from one channel to another in case of transmission problems. Audio is ideally suited for DFS operation since audio requires a steady stream of data rather than high-speed bursts. If interference is detected on the existing channel, the audio stream is automatically switched to a channel that has been available for the past minute.
- Third, occasionally, a measurable error might occur. However, Bang & Olufsen's wireless speakers use Summit Semiconductor's advanced chip set and its own proprietary signal processing algorithms to ensure that errors are concealed to reduce their audibility to an absolute minimum.

The second issue that affects perceived quality is known as "latency" – a measure of the total delay of the wireless system from input to output. In order to create a wireless audio signal that was completely free of errors, the system would have to detect errors at the receiver and ask the system to re-transmit any data that had been lost due to

interference. The extra time required to re-transmit would mean that audio signals would no longer be lip-sync'ed to the television picture.

Summit's system used in the new Bang & Olufsen wireless platform has been carefully engineered to provide the ideal balance to solve error and latency problems. Overall latency is reduced to just 5ms (this is less time than it typically takes for sound to travel from a loudspeaker to the listening position). This ensures synchronisation not only with televisions, but also with wired loudspeakers in the same constellation. At the same time, any possible errors that might occur due to wireless interference are prevented or handled appropriately so as to be inaudible in almost all cases.

The multi-channel system can stream up to eight channels simultaneously, so a 7.1 surround sound system can easily be set up. You can also combine wired with wireless speakers in the same setup, for example wired front speakers and wireless rear speakers and subwoofer. Bang & Olufsen offers the entire range.

The WiSA wireless platform will be able to carry as much as 96 kHz / 24-bit audio signals. For now, however, we have decided to limit it to utilize a 24-bit/48 kHz solution in order to ensure a higher level of signal robustness and a much more intelligent use of the available RF path.

Convenience

Living and decorating with multi-channel speakers – and configuring surround sound systems – have never been easier.

Cable management is reduced to plugging the individual active speakers into the electrical mains.

For the Bang & Olufsen TVs that integrate the wireless technology the setup process for the WiSA certified BeoLab speakers will be very simple as the TV will know the exact specifications of the individual Bang & Olufsen wireless speakers, enabling the surround sound processor to automatically set up the system to the best performance possible.

Because the wireless connection can also be used to transmit non-audio data to the loudspeakers, they can also be software-updated automatically; introducing new features wirelessly is an obvious next step.

3rd party integration

As WiSA adaptation by other manufacturers grows, adding Bang & Olufsen's signature sound to any third-party television, Blu-ray player, AV receiver or the like will be simple, as our speakers now will work with any WiSA certified master.

The new Bang & Olufsen platform also makes it possible to "retrofit" existing systems with wireless transmitter and receiver devices.

***Bang & Olufsen** was founded in Struer, Denmark, in 1925 by Peter Bang and Svend Olufsen, two innovative, young engineers devoted to high quality audio reproduction. Since then, the brand has become an icon of performance and design excellence through its long-standing craftsmanship tradition and the strongest possible commitment to high-tech research and development.*

Still at the forefront of domestic technology, Bang & Olufsen has extended its comprehensive experience with integrated audio and video solutions for the home to other areas such as the hospitality and automotive industries in recent years. Consequently, its current product range epitomizes seamless media experiences in the home as well as in the car and on the move.

For more information on Bang & Olufsen, please visit www.bang-olufsen.com.

About the WiSA Association

Established in 2011 and headquartered in Sunnyvale, California, the Wireless Speaker & Audio (WiSA) Association is an industry group dedicated to bringing reliable, high-performance interoperable wireless audio products to the consumer. The Association is responsible for developing specifications and performing testing and interoperability certification of WiSA-certified products, Association administrative management, and outbound marketing campaigns to promote the broad adoption of WiSA interoperability. WiSA, LLC, the

agent for the WiSA Association, is a wholly owned subsidiary of Silicon Image, Inc. (NASDAQ: SIMG). For more information about the WiSA Association, visit www.wisaassociation.org.

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