

Bluetooth Radio Basics

Features, Specifications, Protocols, and How it Works



Bluetooth Radio Summary

- Normal Range : 10 meters
- Normal Xmit Power : 1 milliWatt
- Receiver Sensitivity : -70 dB
- Spectrum : 2.4 GHz (ISM band)
- Max Data Rate : 721 kbit + 56 kbit/3 voice ch.

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Bluetooth Radio Frequency Band

- ISM (Industrial, Scientific, Medical) Band
 - 2.402GHz - 2.480GHz (79MHz total bandwidth)
- Advantages
 - Free
 - Open to everyone worldwide
- Disadvantages
 - Noise sources everywhere
 - Cordless phones, microwave ovens, garage door openers, other wireless LAN technologies, baby monitors,...

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Bluetooth's Noise Solutions

- Frequency Hopping Spread Spectrum technology
 - Divides the band into 79 separate 1MHz channels
- Uses short packets and makes 1600 hops/second
 - Minimizes exposure to noisy channels
 - Enables bad voice packets to be discarded
- Forward Error Correction (FEC) of data packets
 - Data often recoverable even on a noisy channel without retransmission

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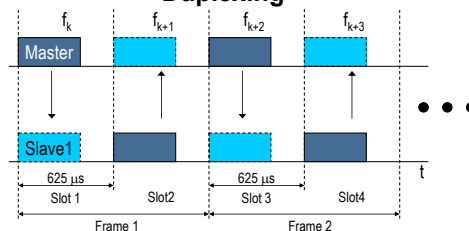
Bluetooth Transmission Protocol

- Frequency Hopping with Time Division Duplexing
 - Transmission rapidly hops among the available channels
 - Transactions are divided into dedicated time slots each for the Master and the Slave
 - Typically odd cycles for the Master and evens for the Slaves
- Terminology
 - Frame = a complete transmit/receive cycle
 - Slot = a 625 microsecond segment within a frame

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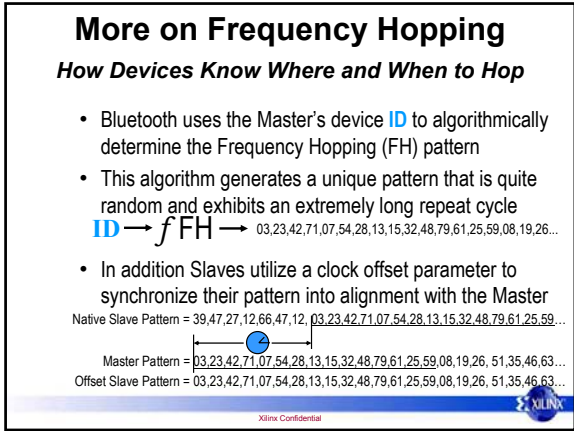
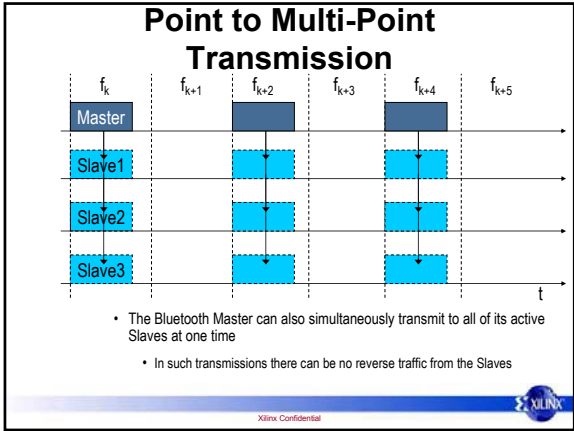
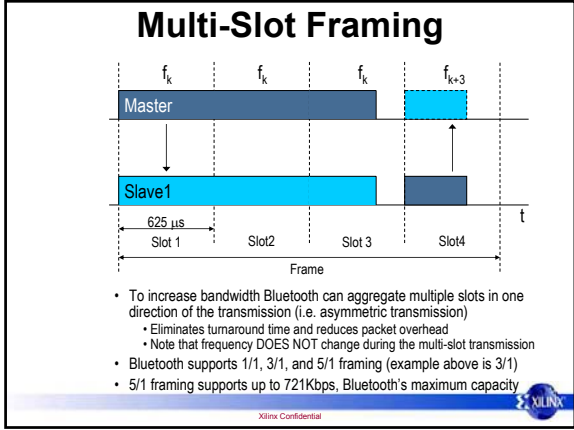
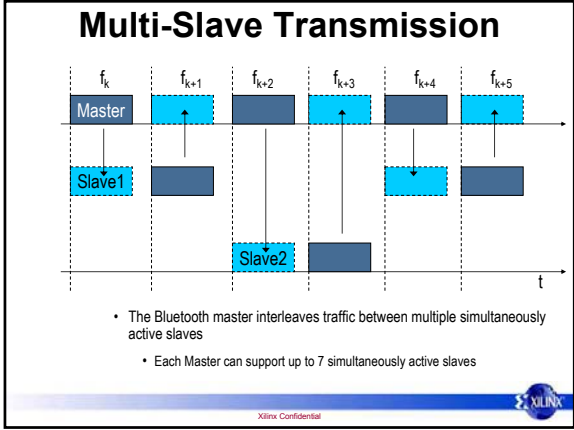
Bluetooth Transmission Protocol Frequency Hopping & Time Division Duplexing



- Complete packet transmission occurs during a Slot
- Frequency hops from Slot to Slot
- Frames define matched Master / Slave Slot transmissions

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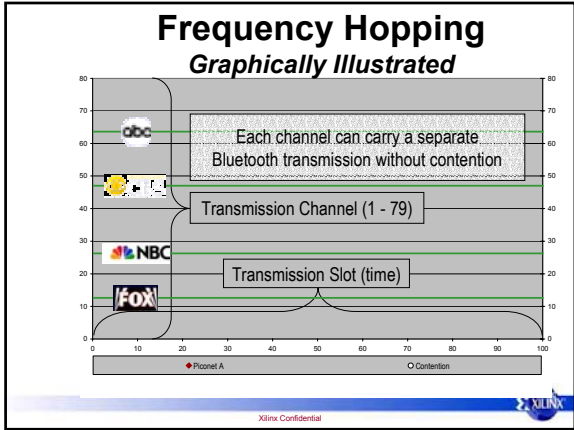




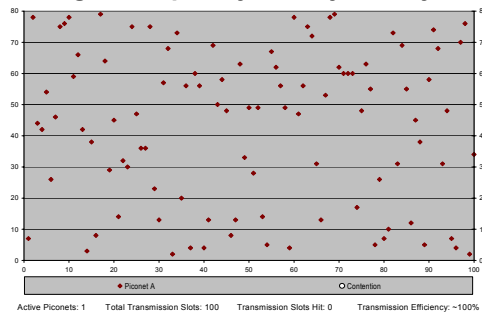
Advantages of Bluetooth's Architecture and Protocol

- Bluetooth can support a high density of devices all within range of each other without undue contention
- Transmission efficiency degrades gracefully as device density increases
- The baseline 10 meter range limitation further extends device capacity
- Fast hopping and short packets minimize the impact of noise on performance

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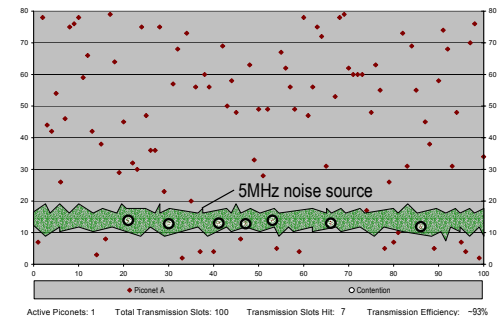
Each Bluetooth Piconet Randomly Changes Frequency Slot by Slot by Slot



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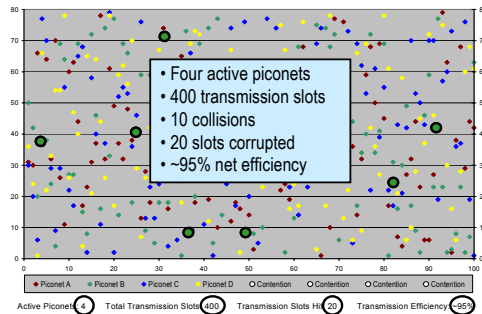
Frequency Hopping Minimizes Exposure to Data Loss Due to Noise



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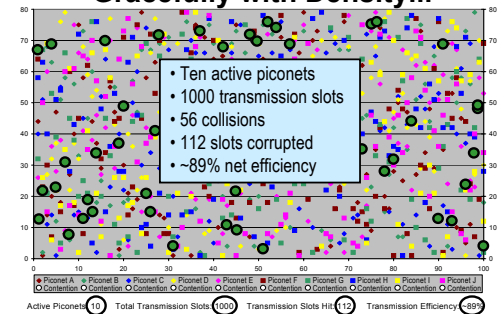
Frequency Hopping With Multiple Piconets Each Piconet Uses a Unique Frequency Hopping Pattern



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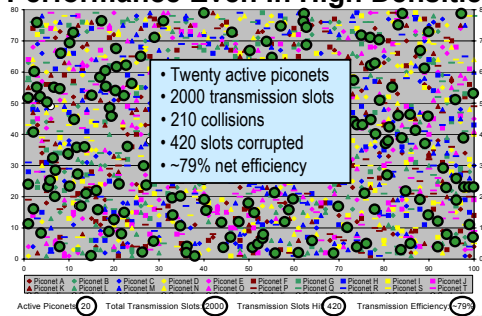
Bluetooth Piconets Degrade Gracefully with Density...



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...And Maintain Reasonable Performance Even In High Densities



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