

November 1998

doc.: IEEE 802.11-98/378A

Extension of Bluetooth and 802.11 Direct Sequence Interference Model

Jim Zyren
Harris Semiconductor
jzyren@harris.com

Submission

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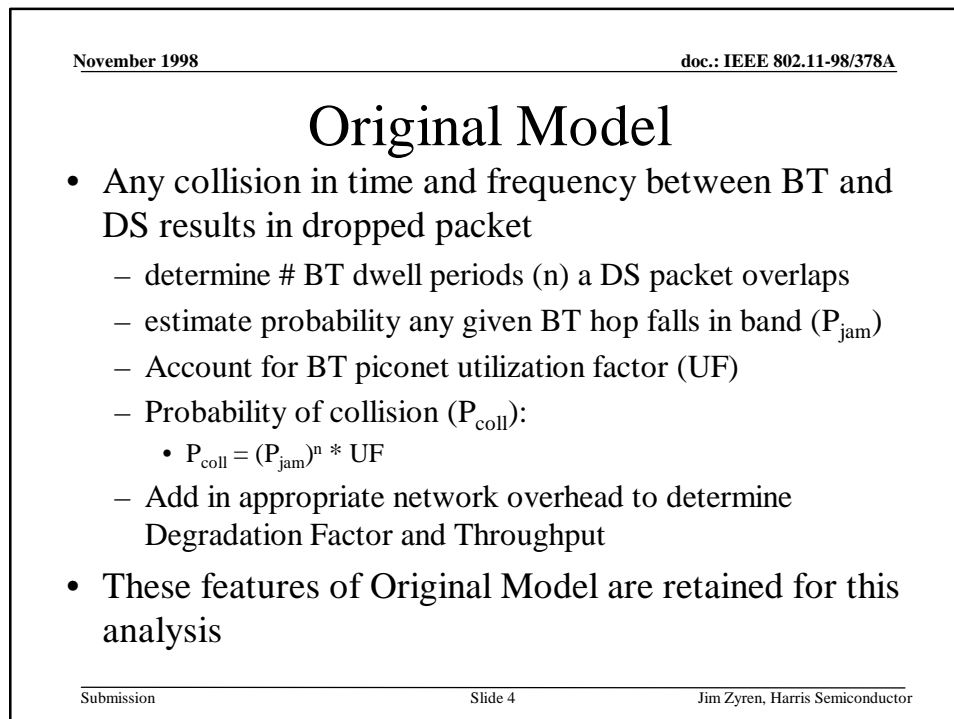
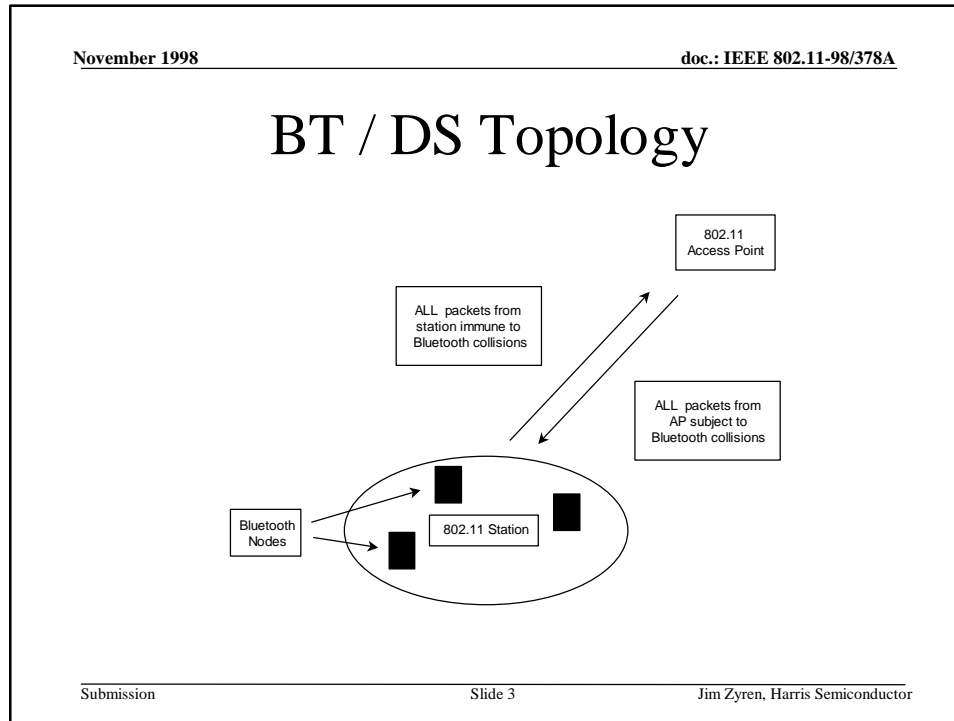
Summary

- **Earlier paper presented analysis of influence of BT on co-located 802.11 DS STA**
 - “Impact of Bluetooth on 802.11 Direct Sequence”
 - Doc.: P802.11-98/319
- **Most of original model is retained**
 - Modifications to model are proposed for:
 - Change probability of co-channel interference
 - Use of short preamble and header
 - Modified BT interference profile
 - Use of longer IFS on dropped packet
 - Results using modified assumptions are presented

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Proposed Modifications

Model Feature	P802.11-98/319	Proposed Mod
Probability of Co-channel interference	33%	25%
Packet Headers	long header (192 usec)	short header (96 usec)
BT interference profile	same as dwell period (625 usec)	BT burst 366 usec of 625 usec dwell
Interframe Spacing on Dropped Packet	ACKTimeout + DIFS + 7 slot times	ACKTimeout + DIFS + 15 slot times

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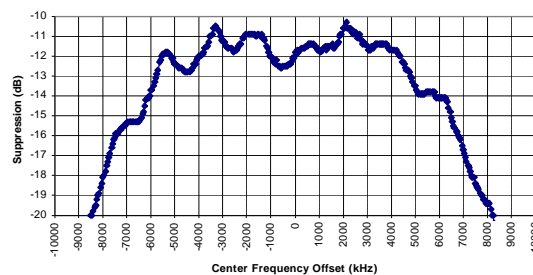
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Co-channel Interference



- Original model assumed probability that BT hop falls in DS passband (P_{co}) is 1/3. This corresponds to 26 MHz DS bandwidth
- Measured data for CCK CW jammer suppression suggests assuming DS BW = 20 MHz is more accurate ($P_{co} = 1/4$)

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Co-channel Interference

CW Jammer suppression due to combined effects of IF Filter and $\sin(x)/x$ post-correlation jammer PSD

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Packet Headers

Preamble (144 bits)	Header (48 bits)
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← 192 msec = 144 bits @ 1 Mbps + 48 bits @ 1Mbps →

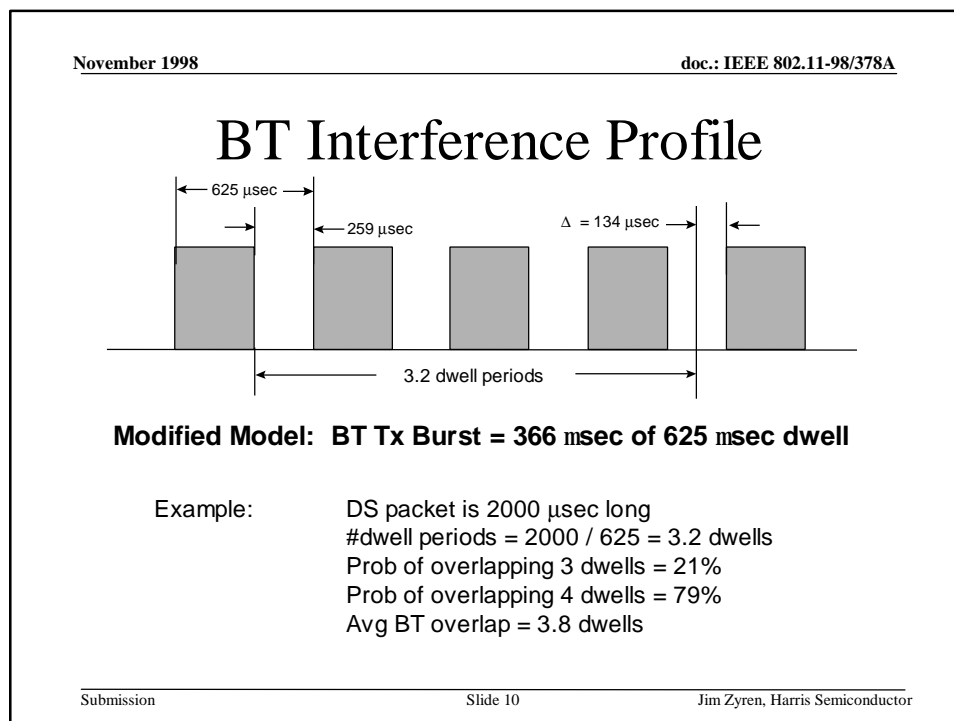
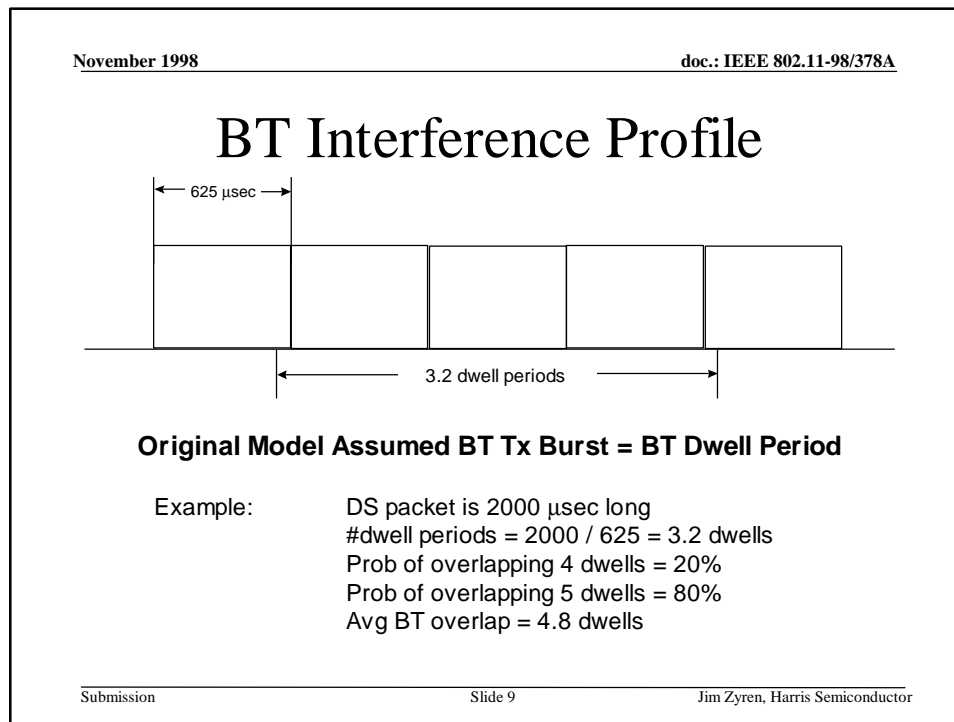
Original Model assumed long preamble & header

Preamble (72 bits)	Header (48 bits)
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← 96 msec
(72 bits @ 1 Mbps + 48 bits @ 2 Mbps) →

Modified Model assumes short preamble & header

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Interframe Spacing

Original Model:

IFS on dropped packet = ACKTimeout + DIFS + 7 slot times

Modified Assumption:

IFS on dropped packet = ACKTimeout + DIFS + 15 slot times

DS PHY MIB specifies default value of CWmin = 31 slot times

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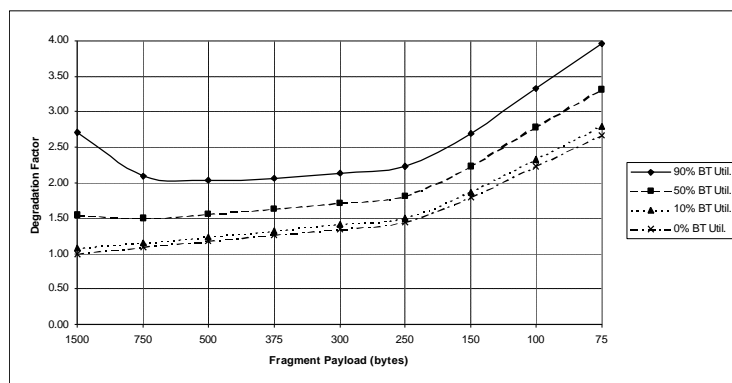
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Results w / Modified Assumptions



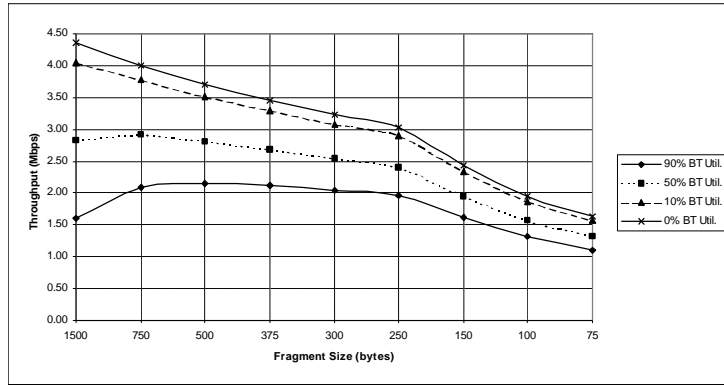
Degradation Factor v. Fragment Size @ 5.5 Mbps

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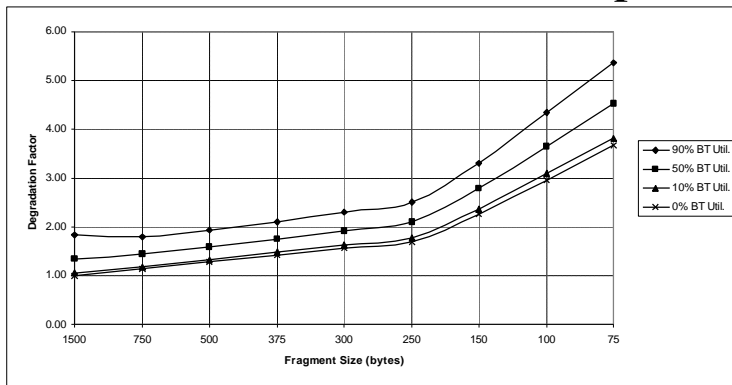
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Results w / Modified Assumptions



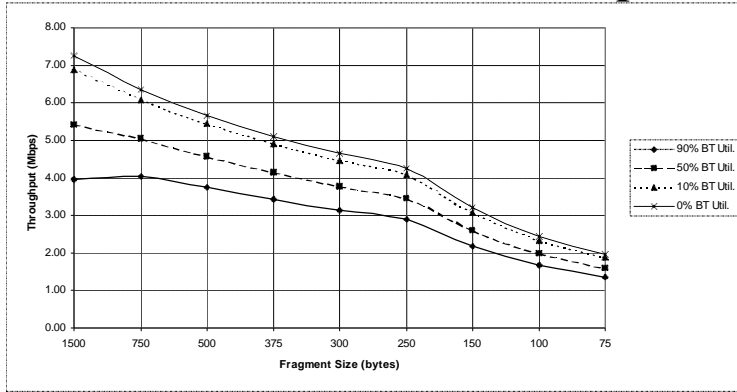
Throughput (Mbps) v. Fragment Size @ 5.5 Mbps

Results w / Modified Assumptions



Degradation Factor v. Fragment Size @ 11 Mbps

Results w / Modified Assumptions



Throughput (Mbps) v. Fragment Size @ 11 Mbps

Predominantly Upstream Traffic

BT Utilization Factor	Throughput @ 5.5 Mbps	Throughput @ 11 Mbps
90%	3.6 Mbps	6.0 Mbps
50%	3.9 Mbps	6.6 Mbps
10%	4.2 Mbps	7.1 Mbps
0%	4.3 Mbps	7.2 Mbps

- **Upstream Traffic (STA to AP) is affected much less because BT Interference is Localized, and Downstream ACK's are very short packets**

Conclusions

- DS network thruput w/BT interference is better than initially predicted
- Shorter packets at 5.5 and 11 Mbps enable DS to avoid most BT interference
- BT interference effects are localized
- Fragment size of 750 bytes works well for 5.5 and 11 Mbps
- High power BT devices present a completely different problem
 - BT piconet will be distributed over greater area
 - higher power increases “bubble of interference”, but
 - distributed topology mitigates “near/far” problem for DS-STA
- DS/BT interference is still an issue
 - effect on BT is TBD
 - coexistence/interoperability is a desirable goal