IEEE 802.11
Wireless Access Method and Physical Layer Specifications

Title: **False Alarm Rate and CCA Times for FH PHY**

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Signal Detection and CCA

- Main types of detection approaches
  - RSL based
  - Waveform based
  - Hybrid
- RSL based approaches
  - Very fast for high SNR
  - Very low P_{fa} for high SNR
  - Susceptible to undesirable deferrals
  - Susceptible to false alarms or missed detections for non-AWGN environments or highly varying noise levels
- Waveform based approaches
  - Clock detect/sync sequence correlation
  - Slow at low BER for fixed P_{fa}
  - Only defers to 802.11 compliant signal
- Standard should allow sufficient time for either approach

False Alarm Probability For Sync Sequence Correlation Detection

$$P_{fa} = 2 \sum_{j=n}^{N} \binom{N}{j} (0.5)^N$$

N	n	Pfa	Pfa During[1] Average Random Backoff
8	8	7.8×10^{-3}	0.88
12	12	4.9×10^{-4}	0.037
12	10	3.9×10^{-2}	≈ 1
12	8	3.9×10^{-1}	≈ 1
16	16	3.1×10^{-5}	1.7×10^{-3}
16	14	4.2×10^{-3}	0.24
16	12	7.7×10^{-2}	≈ 1
20	20	1.9×10^{-6}	8.6×10^{-5}
20	18	4.0×10^{-4}	1.8×10^{-2}
20	16	1.2×10^{-2}	0.54

1 - Assumes Average Backoff = DIFS + 16 x Slot Time = 100 usec + 16 x 50 usec = 900 usec

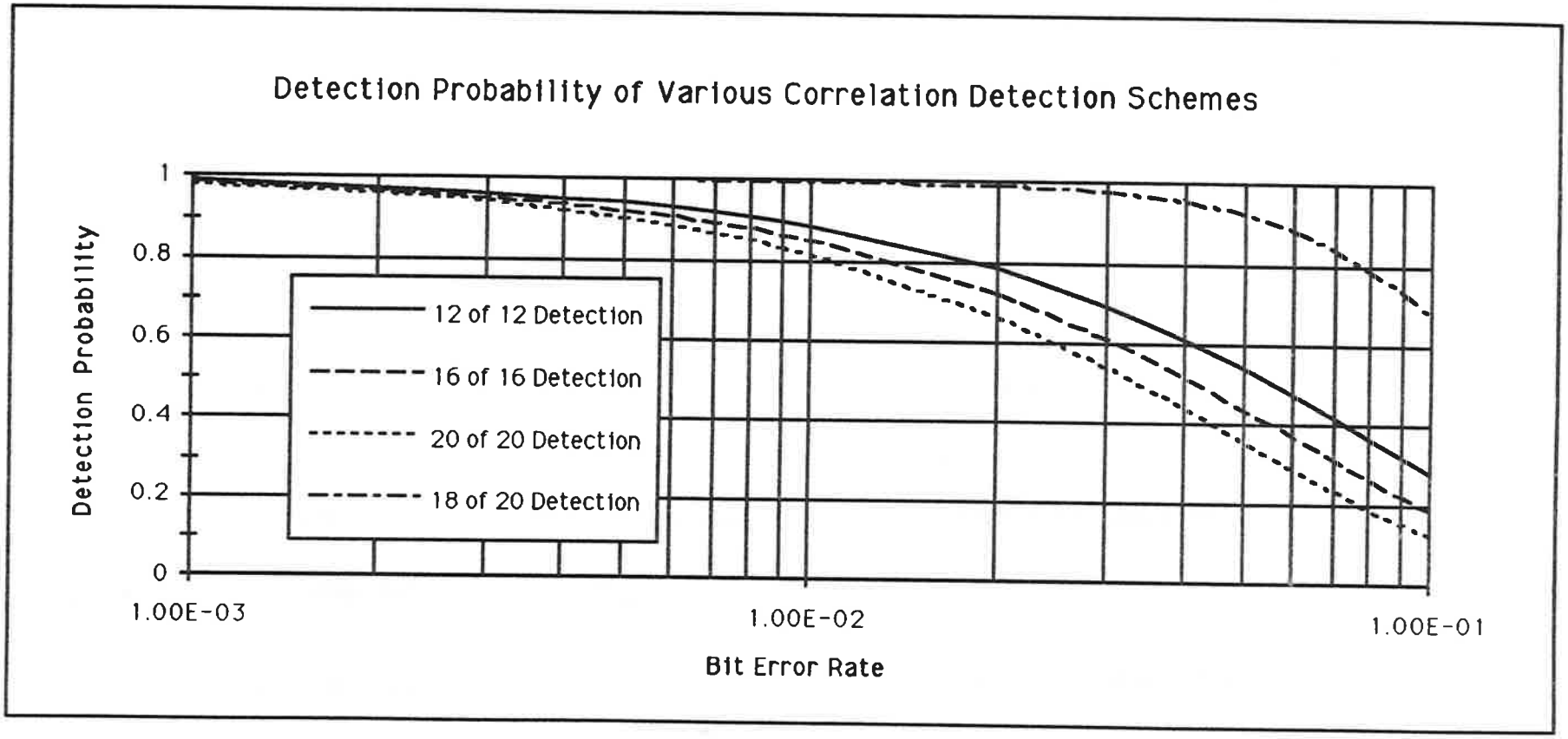
Detection Probability For Sync Sequence Correlation Detection

- Detection probability is a function of BER during preamble
- BER during preamble can be very poor (i.e., $P_b > 10^{-2}$)
  - CCA performance specified at 5 dB below 10^{-5} sensitivity
  - Detection performed prior to timing recovery and AFC
    - Worst Case Timing Error = 0.25 symbol time (assuming two sample/symbol)
    - Worst Case Frequency Error = 2 x 25 ppm = 120 kHz

$$P_d \cong \sum_{j=n}^{N} \binom{N}{j} (1-P_b)^j P_b^{N-j}$$

N	j	P_d		
		$P_b = 1 \times 10^{-2}$	$P_b = 2.5 \times 10^{-2}$	$P_b = 5 \times 10^{-2}$
12	12	0.886	0.738	0.540
16	16	0.851	0.667	0.440
20	20	0.818	0.603	0.358
20	18	0.999	0.987	0.925

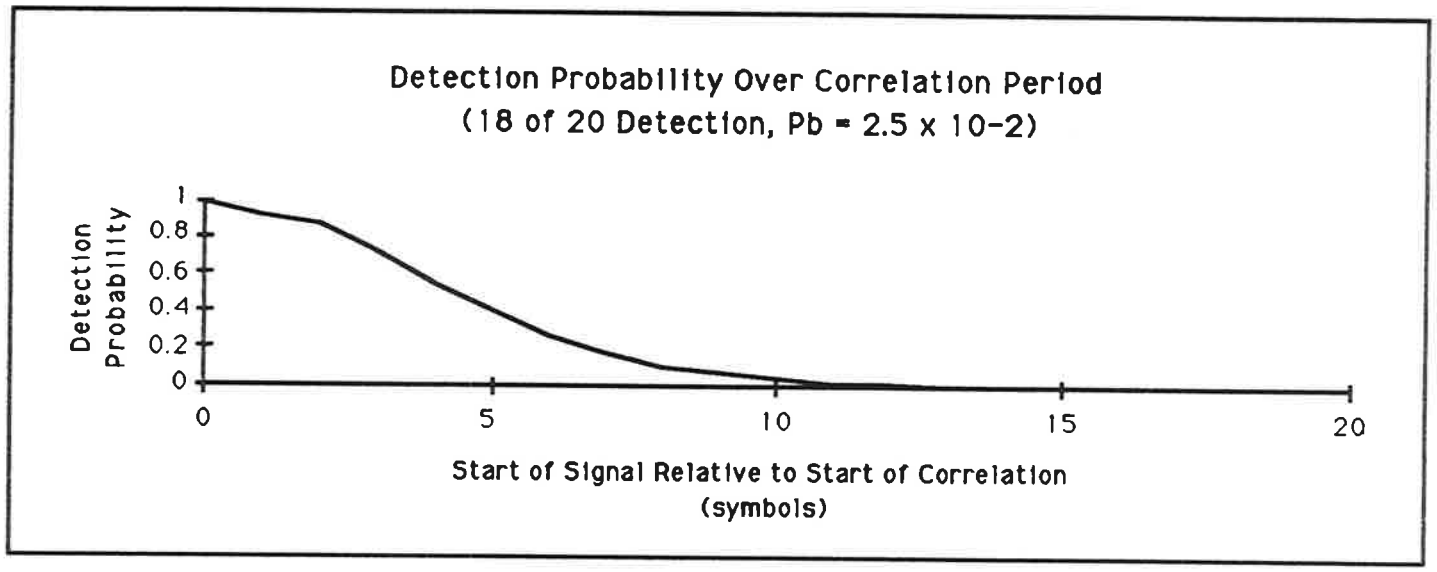
Detection Probability For Sync Sequence Correlation Detection (continued)

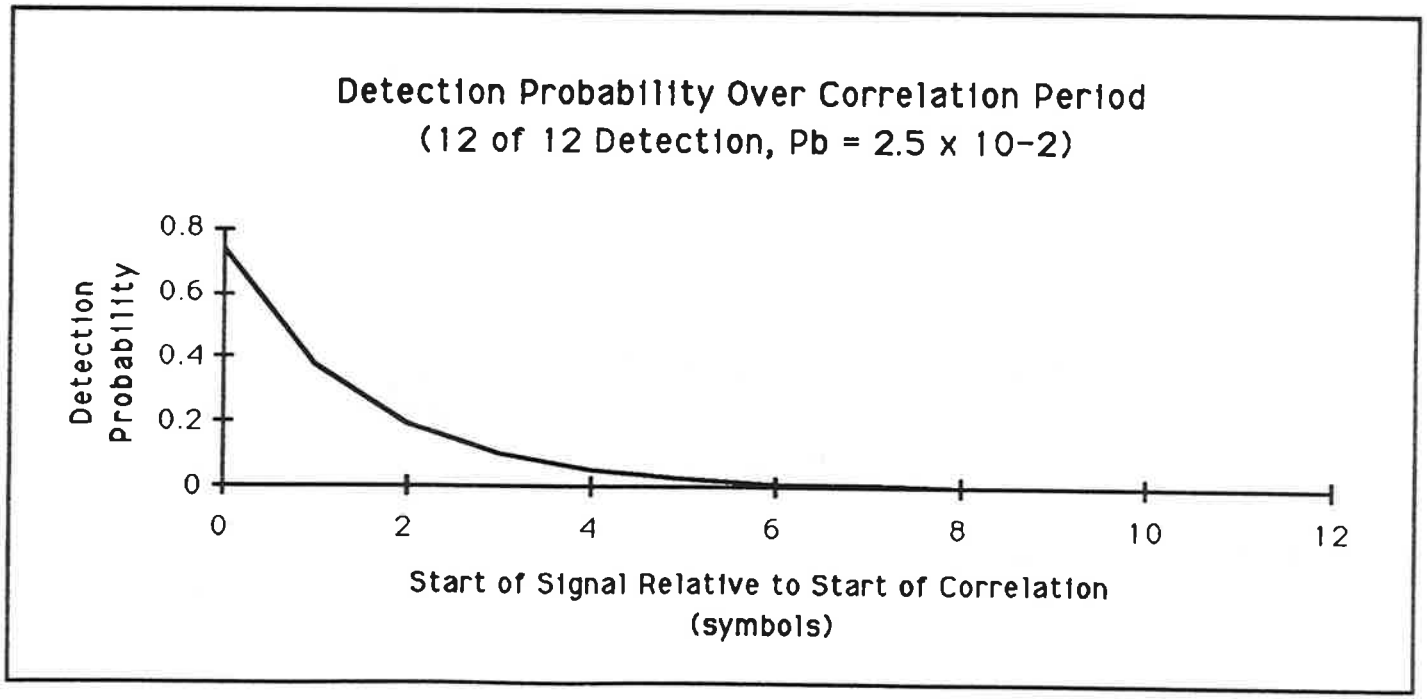


Detection Probability For Sync Sequence Correlation Detection (continued)

- Transmission to be detected does not start synchronously with start of correlation or start of antenna dwell.
- Result, two complete correlations must be performed to achieve reasonable detection probability
- Detection Probability for $P_b = 2.5 \times 10^{-2}$

Detection Scheme	P_d after 1 Correlation	P_d after 2 Correlations
18 of 20	0.259	0.990
12 of 12	0.126	0.771


Detection Probability Over Correlation Period
(18 of 20 Detection, Pb = 2.5 x 10-2)
Detection Probability
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
Start of Signal Relative to Start of Correlation
(symbols)


Detection Probability Over Correlation Period
(12 of 12 Detection, Pb = 2.5 x 10-2)
Detection Probability
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
Start of Signal Relative to Start of Correlation
(symbols)

Recommendations

1) Increase CCA time to 42 usec
   (2 correlations x 20 usec/correlation + 2 usec delay after antenna switch = 42 usec)

2) Remove requirement for detection during data portion of burst.

3) Increase slot time to 60 usec
   (10 usec Rx/Tx Turnaround + 8 usec Ramp + 42 usec CCA)