IEEE P802.11
Wireless LANs

BreezeCom+NEC Performance per TGa Template 98/156 draft 2

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BreezeCom and NEC

Abstract

This document presents the performance of the joint BreezeCom+NEC proposal, as simulated by BreezeCom and by NEC. The submission is per tentative template 98/156 draft 2 as distributed among the proposers on April 8, 1998. Revision 1 of the document corrects some errors related to backoff requirements

This document merges data obtained independently by BreezeCom and NEC teams. In most of the items there was excellent agreement between the two teams. The performance data produced by BreezeCom assumes Decision Feedback Equalizer with 8 forward taps and 23 feedback taps. The carrier tracking loop is based on correlating the sampled data with waveform reconstructed from the decisions. The data produced by NEC assumes PMA-MLSCE receiver structure. Note that the PMA-MLSCE with (8+16) complexity closely matched the performance of DFE with 8 forward and 23 feedback taps. BreezeCom team simulated both binary and quaternary signaling, while NEC team focused on binary signaling alone.

The data in the tables is presented as a single number whenever the results were very close. In some cases, especially when both data complement each other, both are presented. The graphical data of both teams is presented as is.

TGA Performance Template

General Description, Parameters Common for all Rates

Parameter	BreezeCom + NEC	Lucent Tech. + NTT	RadioLAN
Data Rates Supported	20.9677 Mbit/s (mand), 25.0000 Mbit/s (mand), 41.9355 Mbit/s (opt), 50.0000 Mbit/s (opt), Next rates are covered by the definition but are virtually impractical: 62.9032 Mbit/s, 75.0000 Mbit/s, 83.8710 Mbit/s, 100.0000 Mbit/s		
Channel Spacing	20 MHz		
Center Frequencies	lower band: 5.170, 5.190, 5.210, 5.230, 5.250 GHz middle band: 5.270, 5.290, 5.310, 5.330 GHz upper band: 5.745, 5.765, 5.795, 5.815 GHz		
Power Levels	lower band: 30 mW middle band: 150 mW upper band: 600 mW (derived from 12.5 MHz)		
CCA threshold	-82 dBm (suggested)		
Clock Rate accuracy	10ppm		
Carrier Frequency accuracy	10 ppm (60 kHz)		
Waveform implementation accuracy specification method	RMS residual ISI when optimizing with respect to slack parameters – frequency, phase and timing offset, and a short equalizer		
Implementation Complexity	Breeze estimate: 100-200 Kgates, depending on equalizer length. The power consumption for the implementation with 8 tap forward filter is expected to be 300 mW with equalizer adaptation and 200 mW without adaptation along the packet. (based on 0.25 micron process) NEC estimate: 40kgate for simple receiver 100kgate for complex		

	receiver		

Per-Rate Feature Summary

Proposal and Rate	ECC method	Interleaving method	Suggested minimal sensitivity	Suggested Adjacent Channel rejection	Suggested Alternate Channel rejection	Implementation Accuracy
LT+NTT 5 Mb						
LT+NTT 10 Mb						
LT+NTT 15 Mb						
LT+NTT 20 Mb						
LT+NTT 30 Mb						
Br+NEC 21 Mb	Hamming (31,26,3)	8 bit depth row-col	-77 dBm	18 dB	30 dB	-20 dB residual ISI
Br+NEC 25 Mb	none	none	-75 dBm	18 dB	30 dB	-20 dB residual ISI
Br+NEC 42 Mb	Hamming (31,26,3)	16 bit depth row-col	-67 dBm	8 dB	20 dB	-30 dB residual ISI
Br+NEC 50 Mb	none	none	-65 dBm	8 dB	20 dB	-30 dB residual ISI
RadioLAN 10 Mb						
RadioLAN 20 Mb						
RadioLAN 20+RS						

Per-Rate Performance Summary

Performance in Noise and Multipath

Attach in a Word file the graphs of PER for the following scenarios:

1) PER vs. Received Power, one graph for all rates, in a AWGN channel
2) PER vs. Received Power, Exponential Profile Rayleigh Fading channel, one graph (with all rates) for each of the delay spread values T_{RMS} = 25 nsec, 50 nsec, 100 nsec, 150 nsec, 250 nsec
3) PER vs. Received Power, Exponential Profile Rayleigh Fading channel, one graph (with all delay spread values T_{RMS} = 25 nsec, 50 nsec, 100 nsec, 150 nsec, 250 nsec) for each of the rates.
4) Attach one graph (with all rates) of PER vs. T_{RMS} without additive noise, covering a range of 10 nsec to 500 nsec
5) Attach one graph (with all rates) of PER vs. RMS phase noise (without thermal noise), for 1000 byte packet length.
6) Attach one graph (with all rates) of PER vs.CCI (without thermal noise), for 1000 byte packet length. The CCI is defined as 10 log((interferer power)/(desired power)), i.e. smaller CCI means less interference.
7) Attach one graph (with all rates) of PER vs.ACI (without thermal noise), for 1000 byte packet length. The CCI is defined as 10 log((interferer power)/(desired power)), i.e. smaller ACI means less interference. Set the Backoff according to U-NII regulations.

The carrier frequency shall be offset by the maximum allowed amount (include Tx and Rx sides) according to the proposed text. The PER data will include the intended acquisition procedure performance.

The Received Power is defined as -174 dBm/Hz + (NF=10 dB) + 10log(Bit_Rate) + Eb/No. For example, at 20 Mbit/s, at Eb/No=12 dB, Pr= -174 dBm/Hz +10dB +73dBHz +12 dB = -79 dBm.

Bring the graphs for each data rate supported by the proposed PHY, for packet lengths of 64 and 1000 bytes.

SEE DATA AT END OF DOCUMENT

Proposal and Rate	Pr [dBm] at PER=10%, AWGN, 64b	Pr [dBm] at PER=10%, AWGN, 1000b	Trms at PER=10%, noise free, 64b	Trms at PER=10%, noise free, 1000b	Pr [dBm] @ 20%, with Trms @ 10%, 64b	Pr [dBm] @ 20%, with Trms @ 10%, 1000b
LT+NTT 5 Mb						
LT+NTT 10 Mb						
LT+NTT 15 Mb						
LT+NTT 20 Mb						
LT+NTT 30 Mb						
Br+NEC 21 Mb	-83.5 dBm	-82.5 dBm	182 nsec (8+23 DFE) 175 nsec (8+16 PMA-MLSCE) 120 nsec (4+16 PMA-MLSCE)	174 nsec (8+23 DFE) 175 nsec (8+16 PMA-MLSCE) 120 nsec (4+16 PMA-MLSCE)	-72 dBm	-71 dBm
Br+NEC 25 Mb	-81.5 dBm	-80 dBm	167 nsec (8+23 DFE) 175 (8+16 PMA-MLSCE) 120 nsec (4+16 PMA-MLSCE)	164 nsec (8+23 DFE) 175 nsec (8+16 PMA-MLSCE) 120 nsec (4+16 PMA-MLSCE)	-72 dBm	-71 dBm
Br+NEC 42 Mb	-76 dBm	-75.5 dBm	83 nsec	75 nsec	-66 dBm	-66 dBm
Br+NEC 50 Mb	-74 dBm	-73 dBm	77 nsec	73 nsec	-66 dBm	-65 dBm
RadioLAN 10 Mb						

RadioLAN 20 Mb						
RadioLAN 20+RS						

Performance in Interference

Proposal and Rate	Sensitivity @NF=10 dB, no degr. [dBm]	CCI immunity [dB]	ACI immunity [dB]	CW jammer immunity [dB]	Narrowband Gaussian noise immunity [dB]	Phase noise tolerance, [dBc]
LT+NTT 5 Mb						
LT+NTT 10 Mb						
LT+NTT 15 Mb						
LT+NTT 20 Mb						
LT+NTT 30 Mb						
Br+NEC 21 Mb	-82.5 dBm	-9 dB	22.5 dB (2 dB OBO)	-9 dB	12 dB	-12.5 dBc
Br+NEC 25 Mb	-80 dBm	-10 dB	20.5 dB (2 dB OBO)	-11 dB	14.5 dB	-14 dBc
Br+NEC 42 Mb	-75.5 dBm	-16 dB	14 dB (4 dB OBO)	-17 dB	19 dB	-17.5 dBc
Br+NEC 50 Mb	-73 dBm	-17 dB	11.5 dB (4 dB OBO)	-19 dB	21 dB	-19.5 dBc
RadioLAN 10 Mb						
RadioLAN 20 Mb						
RadioLAN 20+RS						

PA Backoff and Link Budget (see Appendix D for explanation)

Proposal and Rate	Sensitivity @NF=10 dB, no degr. [dBm]	Backoff [dB], average Pt=150 mW, (U-NII regulations)	Backoff [dB], average Pt=150 mW, (restricted regulations)	Loss [dB] at average Pt=150 mW	Loss [dB] at saturated Pt=250 mW, (U-NII regulations)	Loss [dB] at saturated Pt=250 mW, (restricted regulations)
LT+NTT 5 Mb						
LT+NTT 10 Mb						
LT+NTT 15 Mb						
LT+NTT 20 Mb						
LT+NTT 30 Mb						
Br+NEC 21 Mb	-82.5 dBm	-2 dB	7.5 dB	104 dB	104 dB	100.5 dB (6 dB OBO)
Br+NEC 25 Mb	-80 dBm	-2 dB	7.5 dB	101.5 dB	101.5 dB	98 dB (6 dB OBO)
Br+NEC 42 Mb	-75.5 dBm	-4 dB *1	8.5 dB	97 dB	95.5 dB	92.5 dB (7 dB OBO)
Br+NEC 50 Mb	-73 dBm	-4 dB *1	8.5 dB	94.5 dB	93 dB	90 dB (7 dB OBO)
RadioLAN 10 Mb						
RadioLAN 20 Mb						
RadioLAN 20+RS						

Note: The backoff at 42/50 Mb/s with U-NII regulations is dominated by performance degradation rather than by the regulatory restrictions.

Interference Limited Aggregate Rate (see Appendix E for explanation)

Indoor (35 log(distance ratio)) propagation model:

Proposal and Rate	CCI immunity [dB]	D2/D1, Interferer to Transmitter dist. ratio, indoor	Fraction of Area covered, indoor	Aggregate rate per AP, single rate, indoor	Aggregate rate per AP, multirate, indoor	Aggregate rate per AP, multirate, multichannel indoor
LT+NTT 5 Mb						
LT+NTT 10 Mb						
LT+NTT 15 Mb						
LT+NTT 20 Mb						
LT+NTT 30 Mb						
Br+NEC 21 Mb	9 dB	1.807	0.507	10.6 Mbit/s	10.6 (1 rate)	95.4 Mbit/s
Br+NEC 25 Mb	10 dB	1.931	0.465	11.6 Mbit/s	12.5 (2 rates)	112.5 Mbit/s
Br+NEC 42 Mb	16 dB	2.865	0.268	11.2 Mbit/s	17.0 (3 rates)	153 Mbit/s
Br+NEC 50 Mb	17 dB	3.06	0.243	12.1 Mbit/s	18.9 (4 rates)	170 Mbit/s
RadioLAN 10 Mb						
RadioLAN 20 Mb						
RadioLAN 20+RS						

Free Space (20 log(distance ratio)) propagation model:

Proposal and Rate	CCI immunity [dB]	D2/D1, Interferer to Transmitter dist. ratio, free space	Fraction of Area covered, free space	Aggregate rate per AP, single rate, free space	Aggregate rate per AP, multirate, free space	Aggregate rate per AP, multirate, multichannel free space
LT+NTT 5 Mb						
LT+NTT 10 Mb						
LT+NTT 15 Mb						
LT+NTT 20 Mb						
LT+NTT 30 Mb						
Br+NEC 21 Mb	9 dB	2.818	0.274	5.76 Mbit/s	5.76 (1 rate)	51.8 Mbit/s
Br+NEC 25 Mb	10 dB	3.162	0.231	5.77 Mbit/s	6.68 (2 rates)	60.1 Mbit/s
Br+NEC 42 Mb	16 dB	6.31	0.075	3.15 Mbit/s	7.95 (3 rates)	71.5 Mbit/s
Br+NEC 50 Mb	17 dB	7.08	0.061	3.06 Mbit/s	8.44 (4 rates)	76.0 Mbit/s
RadioLAN 10 Mb						
RadioLAN 20 Mb						
RadioLAN 20+RS						

Timing and Overhead related parameters

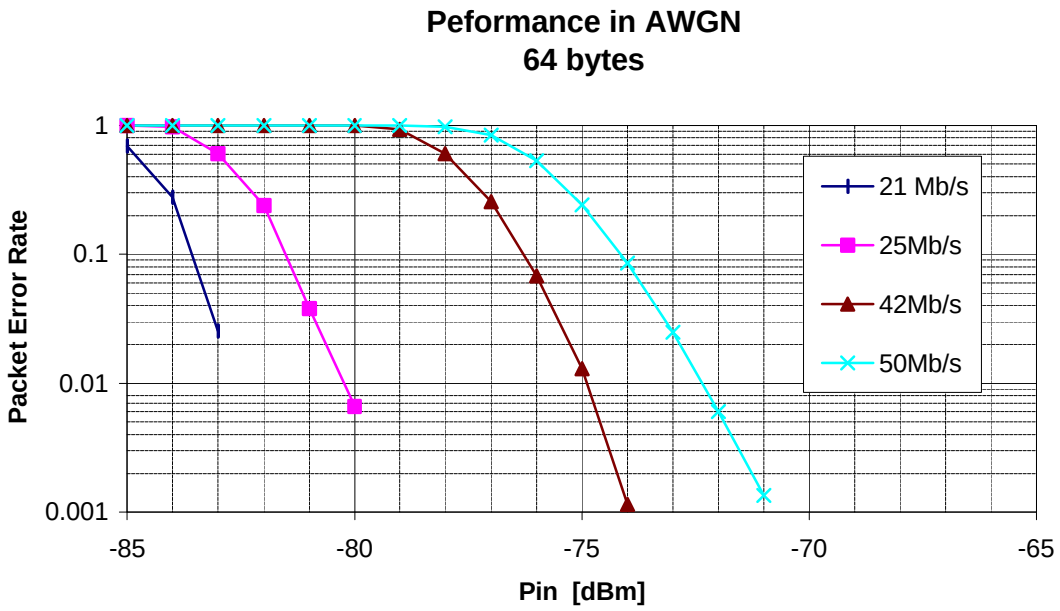
Attach verbal explanation of the assumptions taken for each parameter

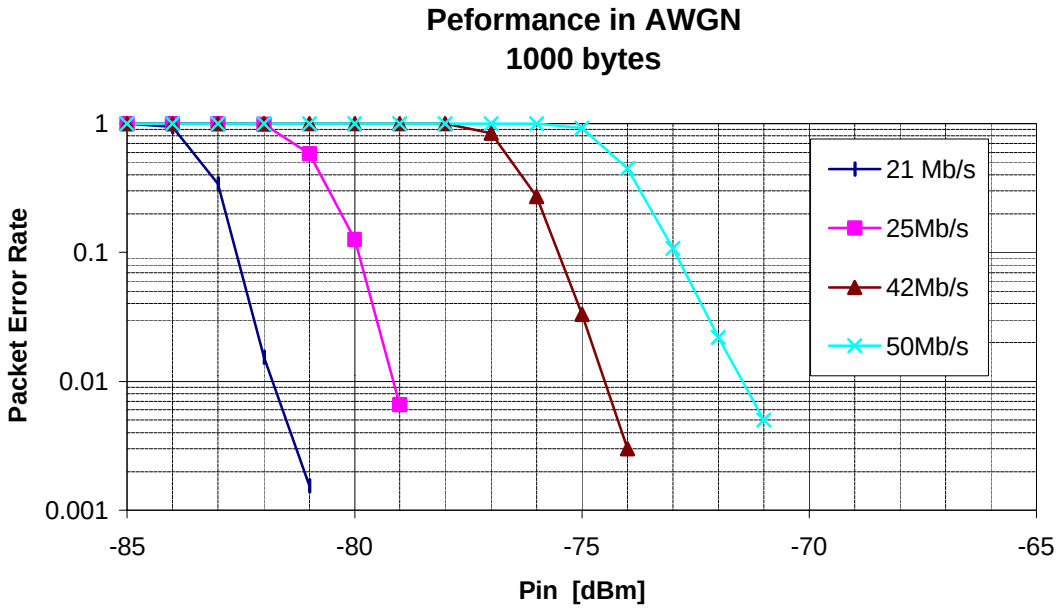
Parameter	BreezeCom + NEC	Lucent Tech. + NTT	RadioLAN
aSlotTime	7.4 µs in joint proposal		
aCCATime	3.0 µs		
aRxTxTurnaroundTime	1.4 µs		
aTxPLCPDelay	0.4 µs		
aRxTxSwitchTime	0.4 µs.		
aTxRampOnTime	0.4 µs.		
aTxRFDelay	0.4 µs.		
aSIFSTime	13.4 µs in joint proposal		
aRxRFDelay	1.0 µs.		
aRxPLCPDelay	7.0 µs.		
aMACProcessingDelay	2.0 µs in joint proposal		
aTxRampOffTime	0.4 µs.		
aPreambleLength	12.8 µs in joint proposal		
aPLCPHdrLength	3.2 µs	for each mode, if applicable	for each mode, if applicable
aMPDUDurationFactor	1.0000 (25, 50 Mbit/s) 1.1923 (21, 42 Mbit/s)	for each mode, if applicable	for each mode, if applicable
aAirPropagationTime	0.8 µs		
aCWmin	15		
aCWmax	1023		

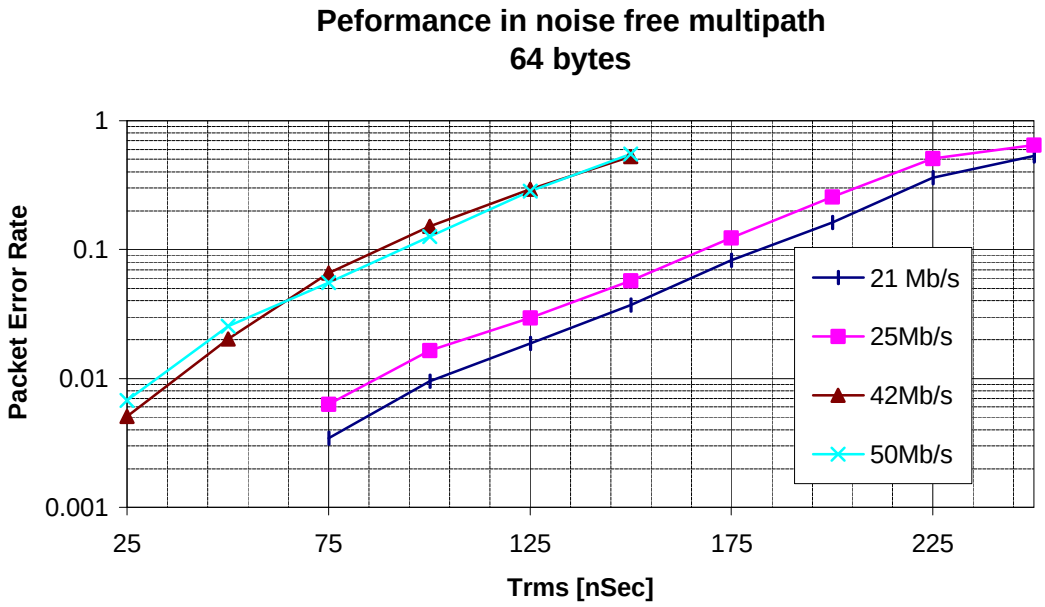
Compute throughput penalty according to appendix F

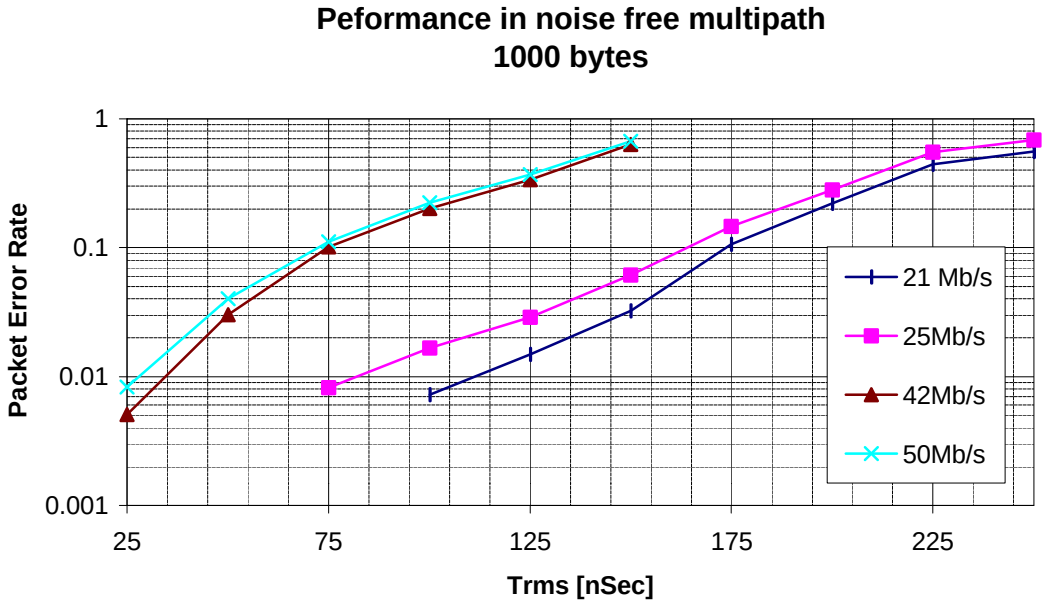
Proposal and Rate	1500B MPDU duration (µsec)	DIFS + backoff (µsec)	1500B packet duration	SIFS	ACK packet duration, same rate	ACK packet duration, basic rate	Efficiency, ACK at same rate	Efficiency, ACK at basic rate
LT+NTT 5 Mb								
LT+NTT 10 Mb								
LT+NTT 15 Mb								
LT+NTT 20 Mb								
LT+NTT 30 Mb								
Br+NEC 21 Mb	572.8	83.7	601.28	13.4	22.1	22.1	0.795	0.795
Br+NEC 25 Mb	480	83.7	506.88	13.4	20.5	22.1	0.769	0.767
Br+NEC 42 Mb	286.4	83.7	308.64	13.4	19.9	22.1	0.673	0.669
Br+NEC 50 Mb	240	83.7	261.44	13.4	18.3	22.1	0.639	0.630
RadioLAN 10 Mb								
RadioLAN 20 Mb								
RadioLAN 20+RS								

BreezeCom Graphical Data - DFE receiver, 8 forward taps, 23 feedback taps.

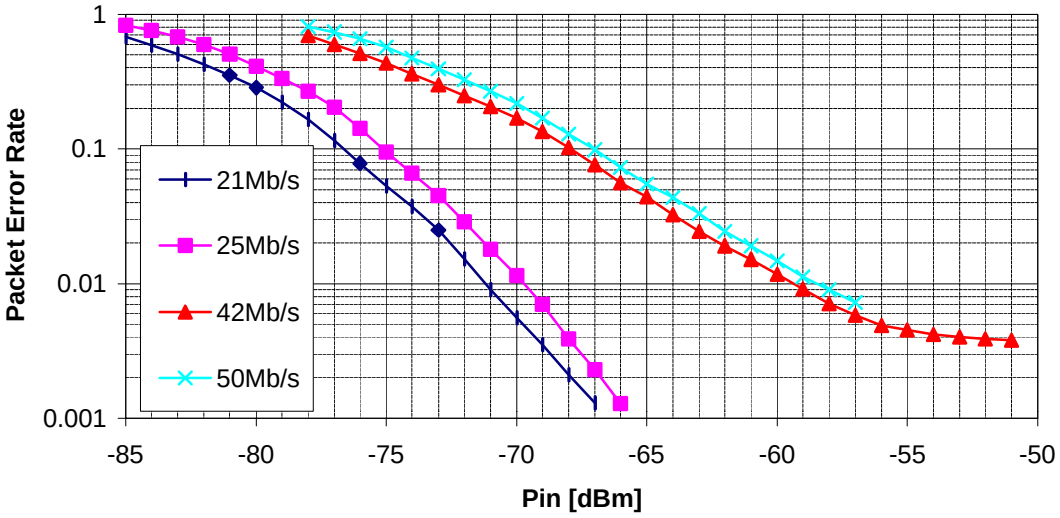




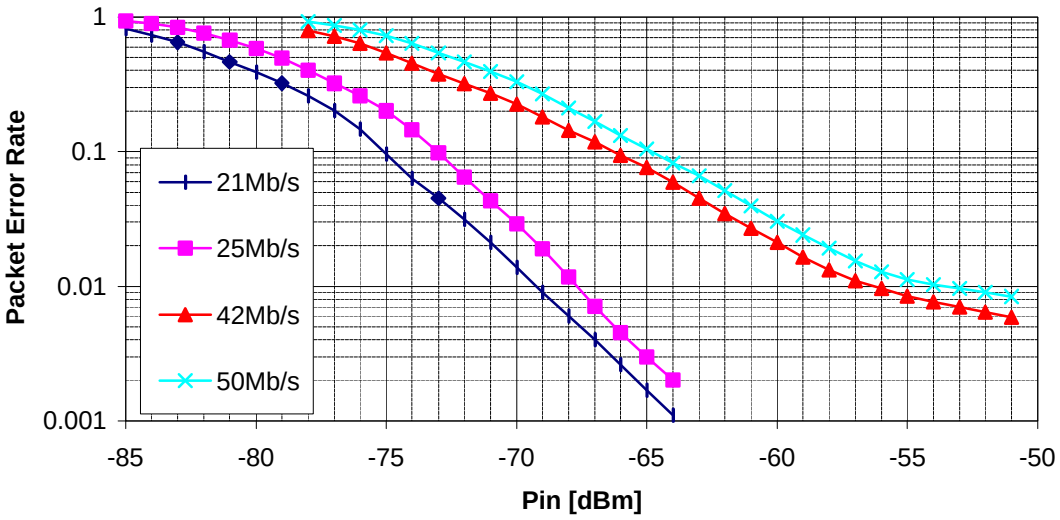

Peformance in noise free multipath
64 bytes
Packet Error Rate
1
0.1
0.01
0.001
25
75
125
175
225
Trms [nSec]
21 Mb/s
25Mb/s
42Mb/s
50Mb/s

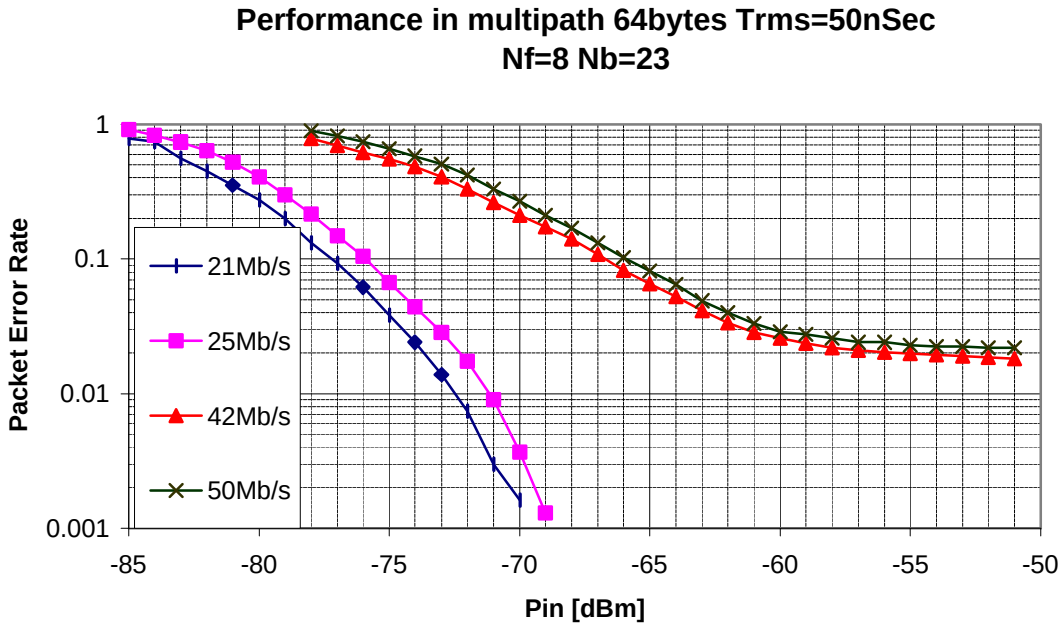

Peformance in noise free multipath
1000 bytes
Packet Error Rate
1
0.1
0.01
0.001
25
75
125
175
225
Trms [nSec]
21 Mb/s
25Mb/s
42Mb/s
50Mb/s

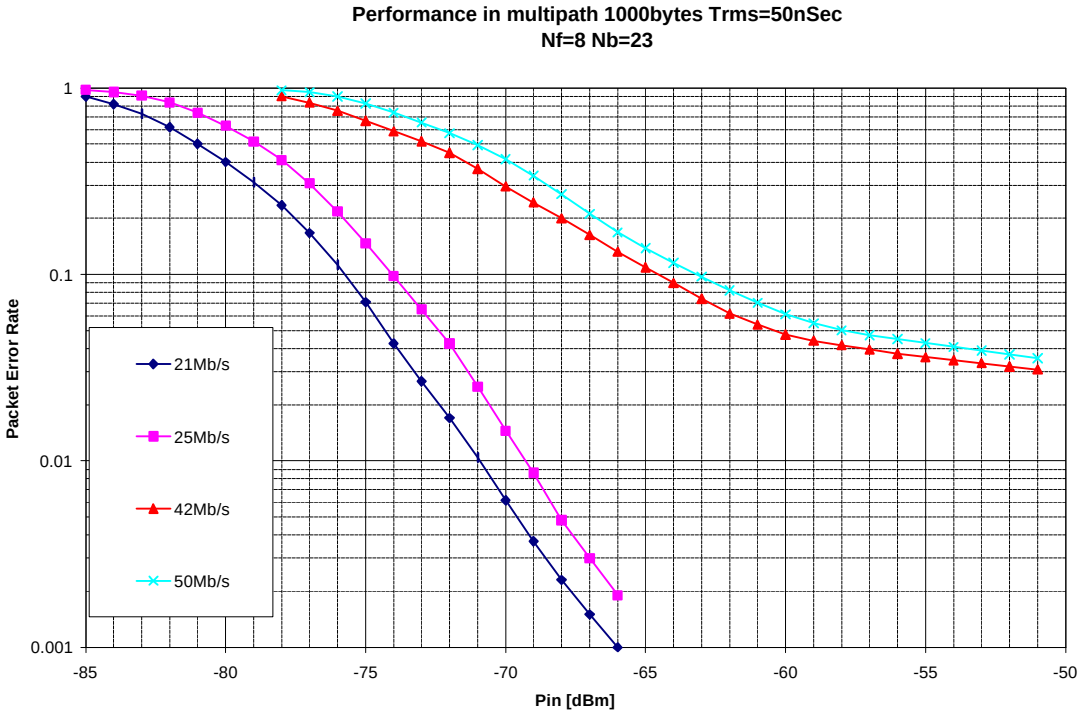
Performance in multipath 64bytes Trms=25nSec
Nf=8 Nb=23

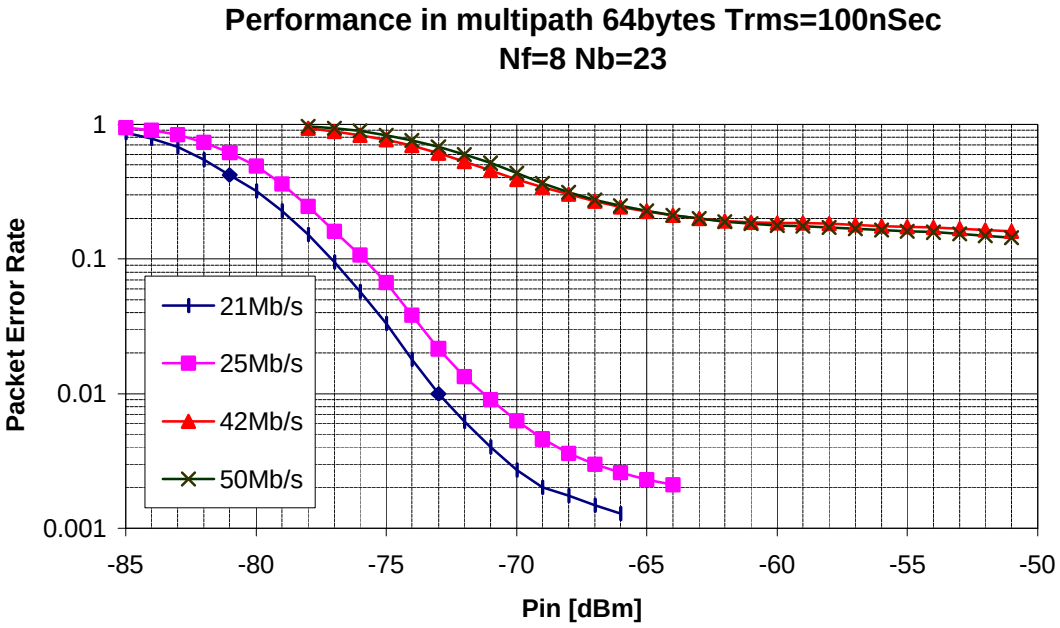


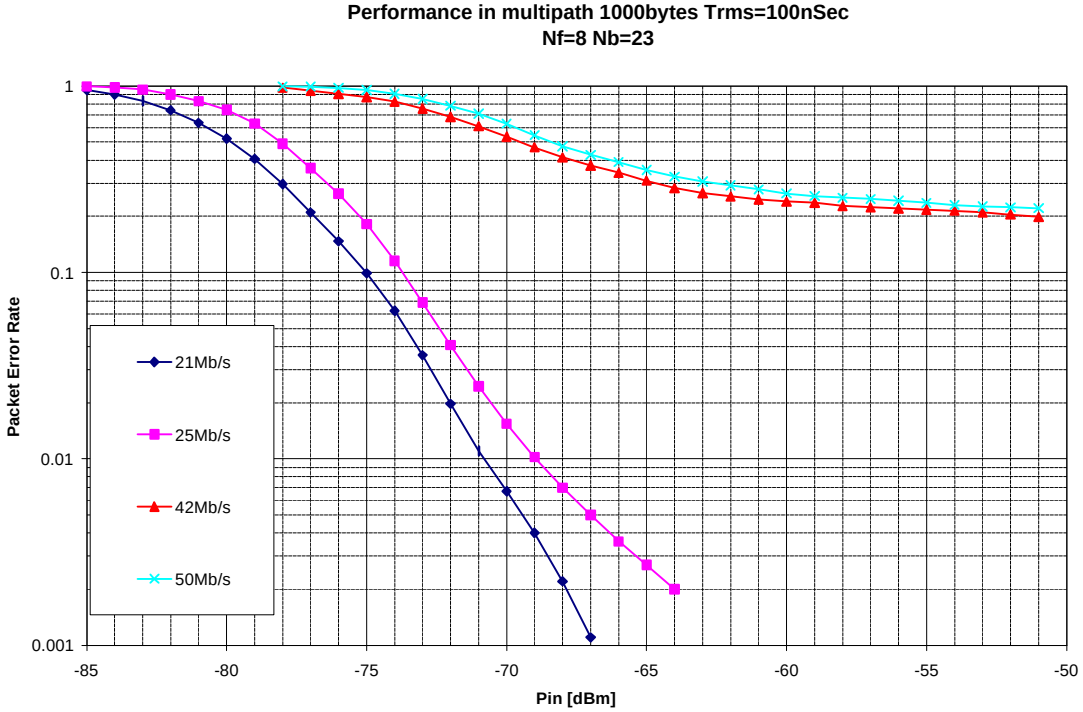
Performance in multipath 1000bytes Trms=25nSec
Nf=8 Nb=23

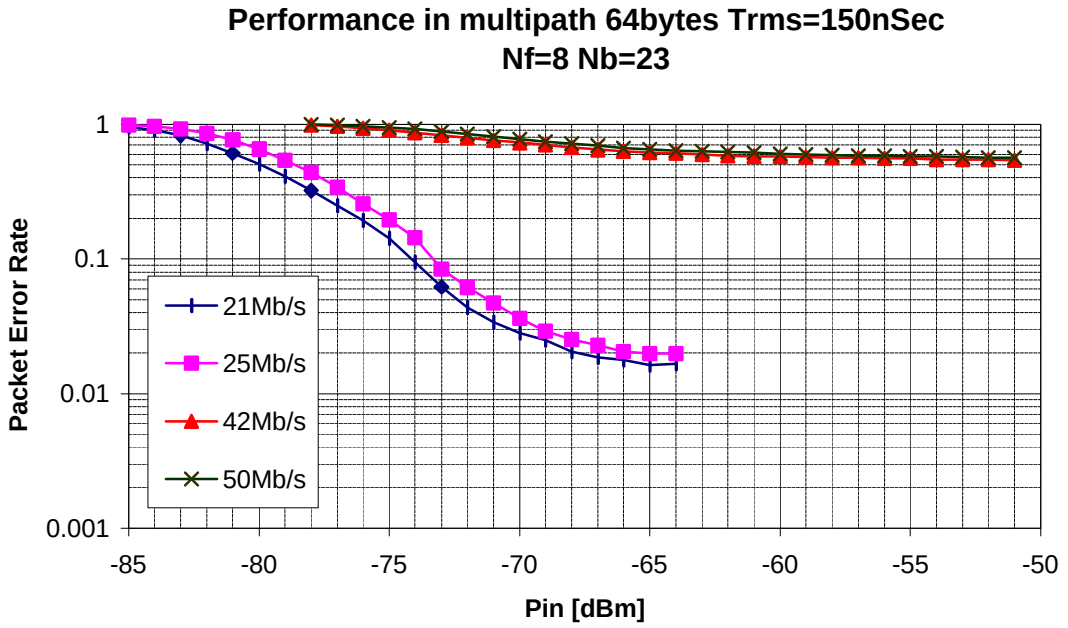


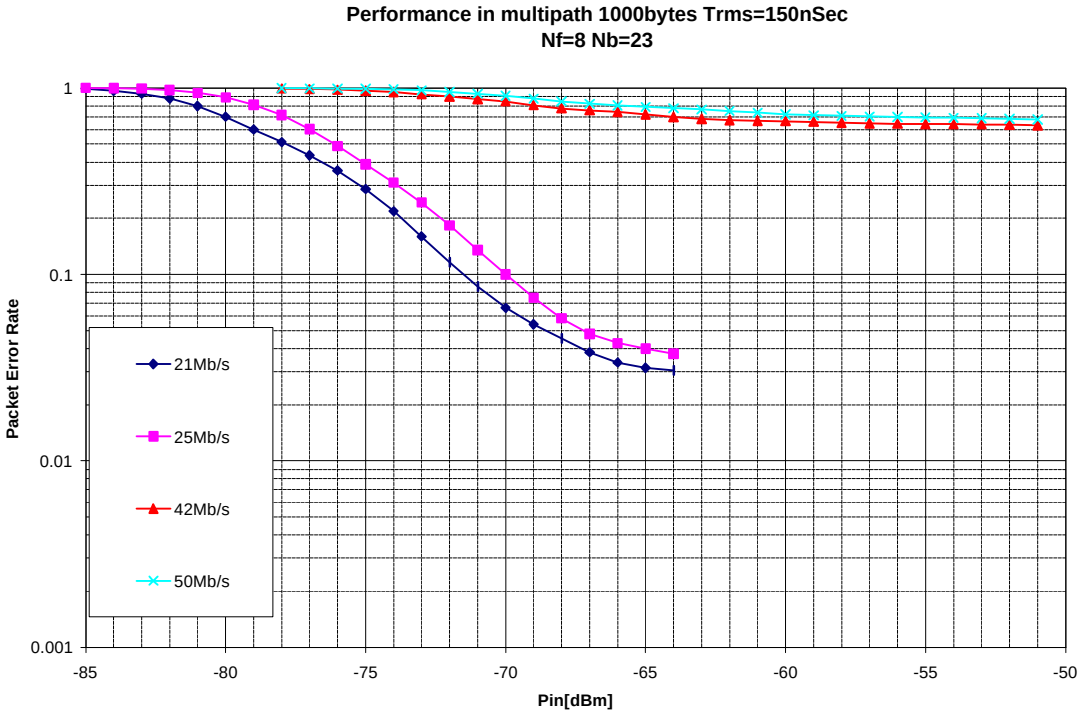

Performance in multipath 64bytes Trms=50nSec
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
21Mb/s
25Mb/s
42Mb/s
50Mb/s
-85
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]


Performance in multipath 1000bytes Trms=50nSec
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
21Mb/s
25Mb/s
42Mb/s
50Mb/s
-85
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]

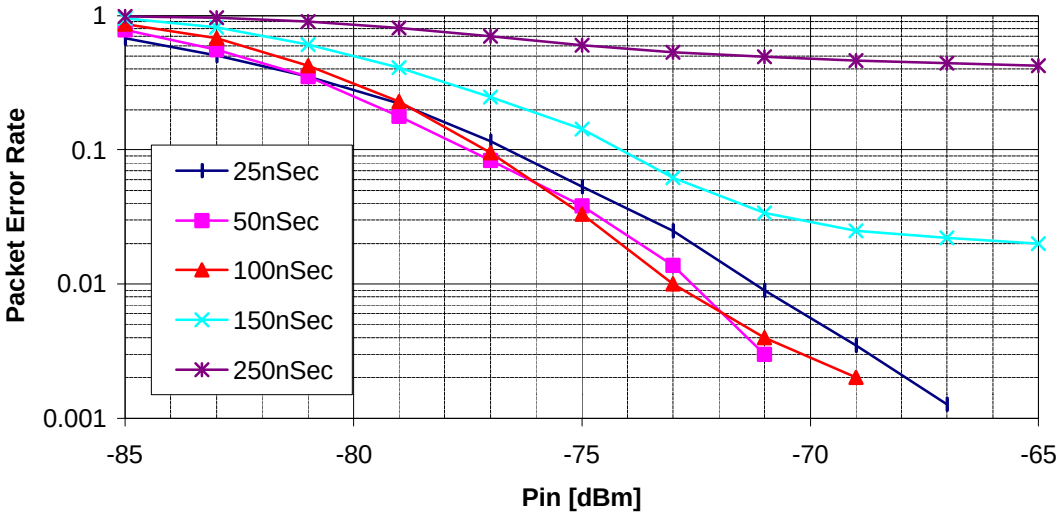

Performance in multipath 64bytes Trms=100nSec
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
21Mb/s
25Mb/s
42Mb/s
50Mb/s
-85
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]


Performance in multipath 1000bytes Trms=100nSec
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
21Mb/s
25Mb/s
42Mb/s
50Mb/s
-85
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]

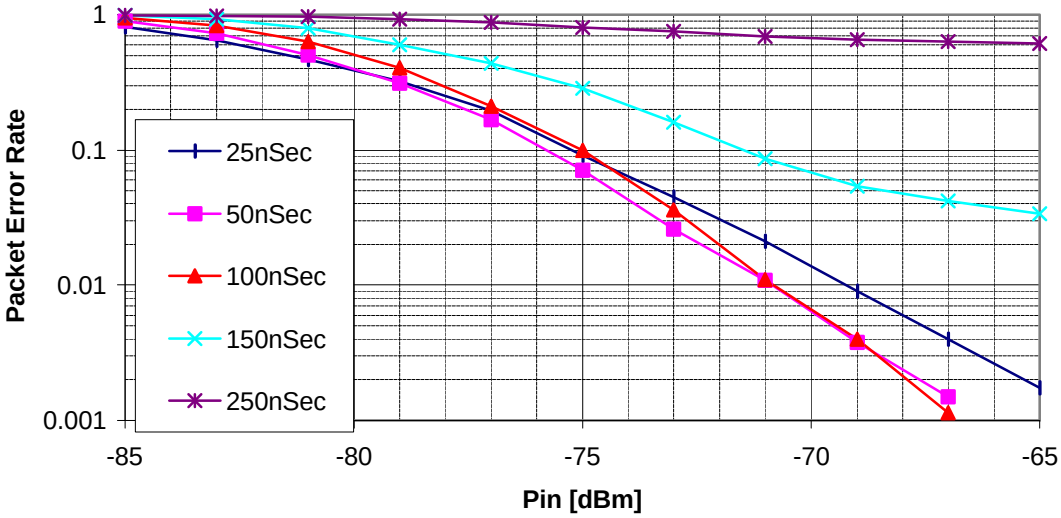

Performance in multipath 64bytes Trms=150nSec
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
21Mb/s
25Mb/s
42Mb/s
50Mb/s
-85
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]

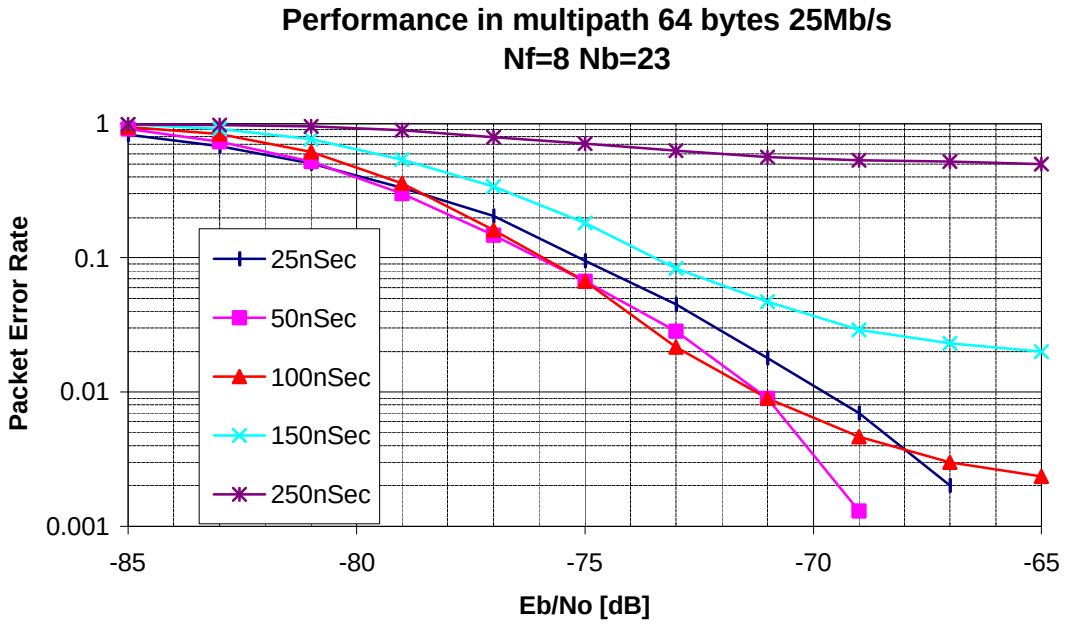

Performance in multipath 1000bytes Trms=150nSec
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
21Mb/s
25Mb/s
42Mb/s
50Mb/s
-85
-80
-75
-70
-65
-60
-55
-50
Pin[dBm]

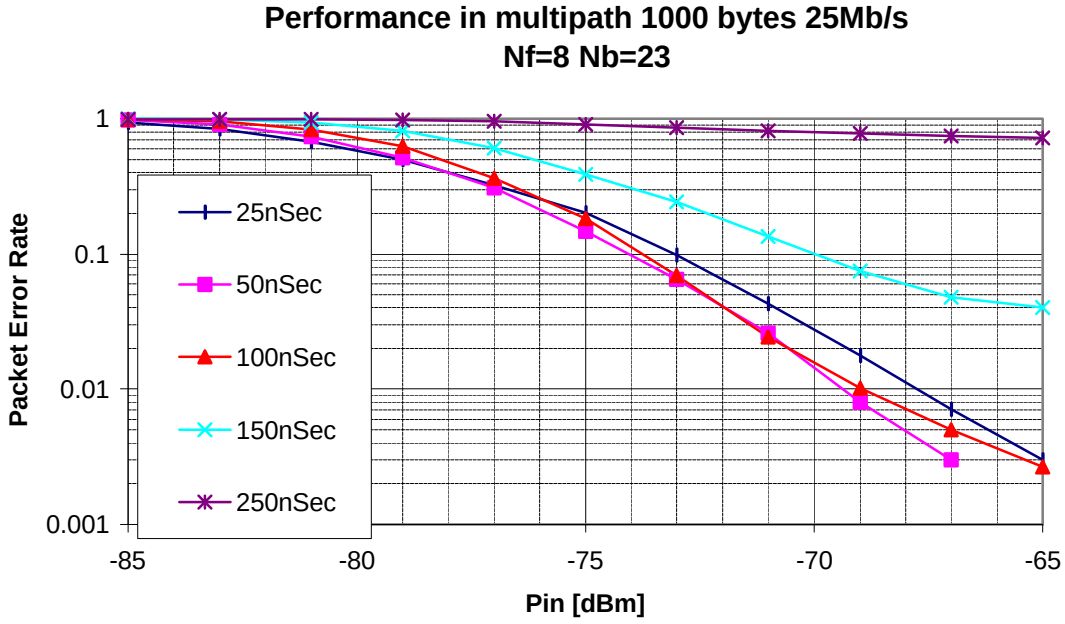
Performance in multipath 64 bytes 21Mb/s
Nf=8 Nb=23

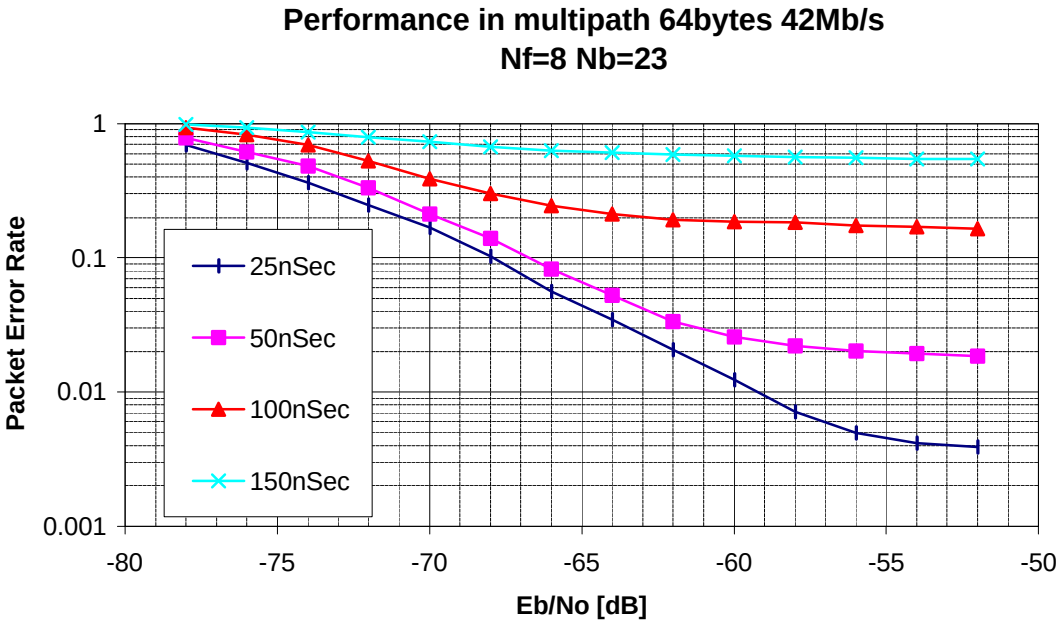


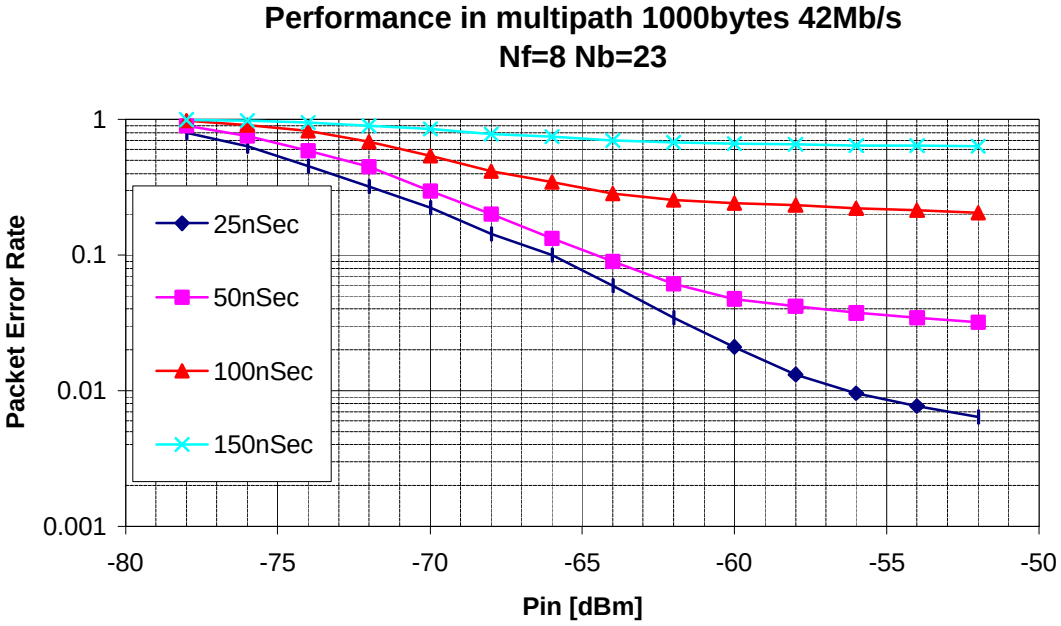
Performance in multipath 1000 bytes 21Mb/s
Nf=8 Nb=23

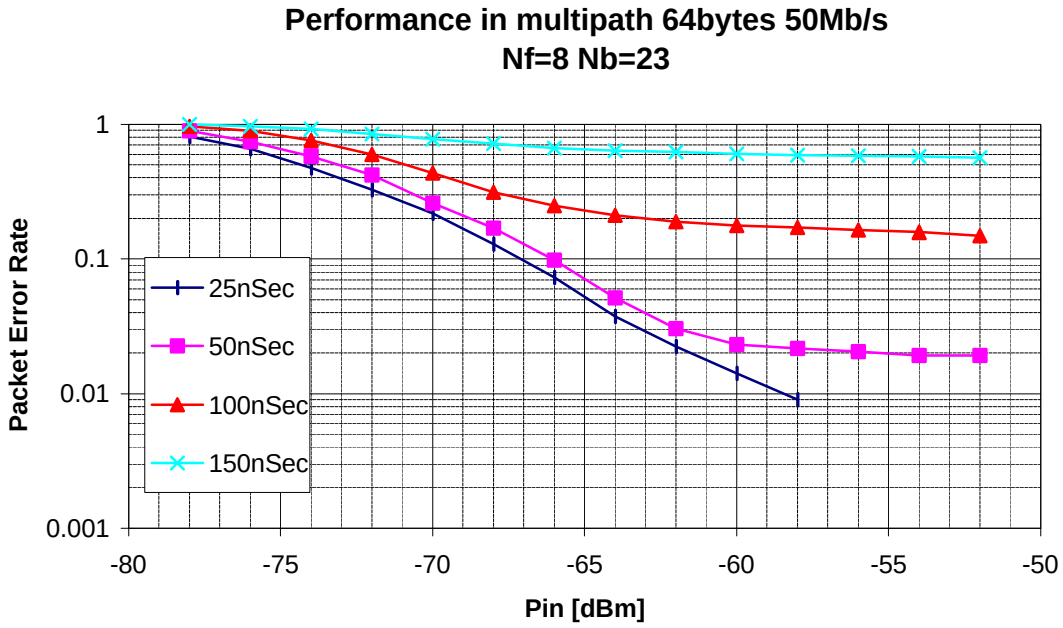


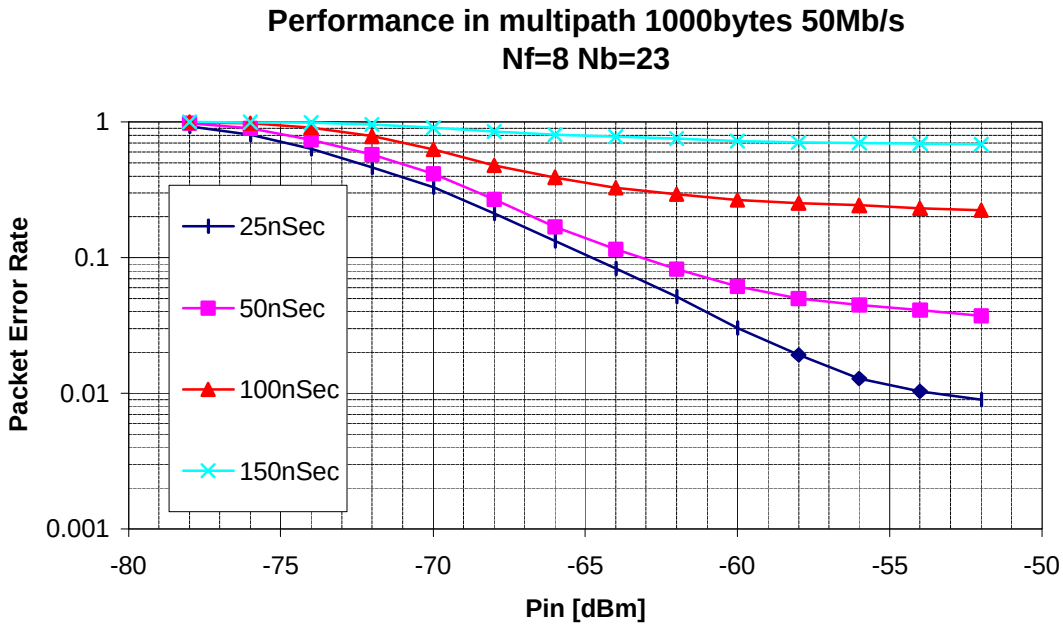

Performance in multipath 64 bytes 25Mb/s
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
-85
-80
-75
-70
-65
Eb/No [dB]
25nSec
50nSec
100nSec
150nSec
250nSec

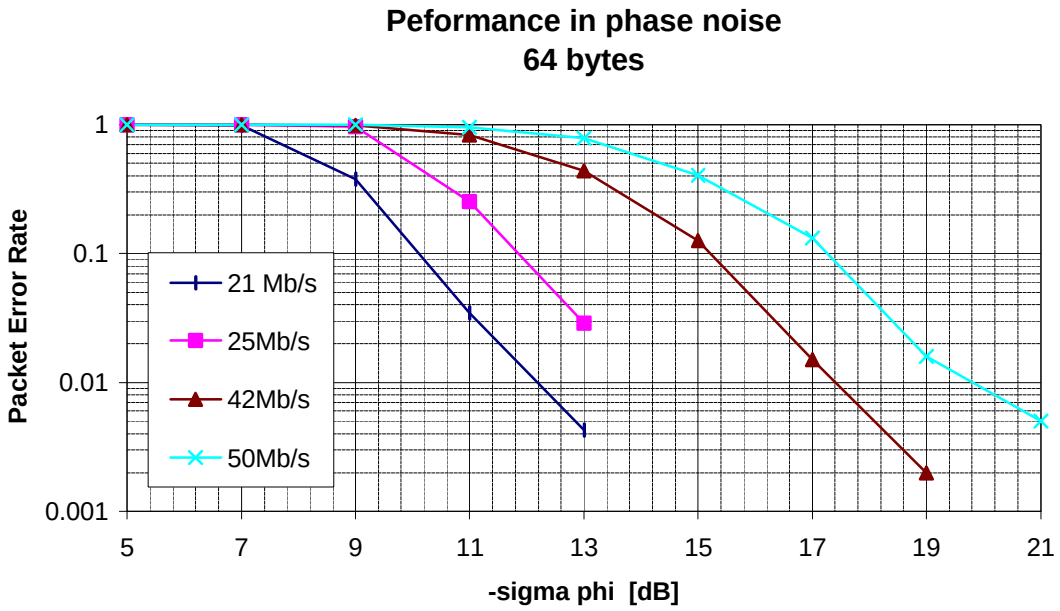

Performance in multipath 1000 bytes 25Mb/s
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
-85
-80
-75
-70
-65
Pin [dBm]
25nSec
50nSec
100nSec
150nSec
250nSec

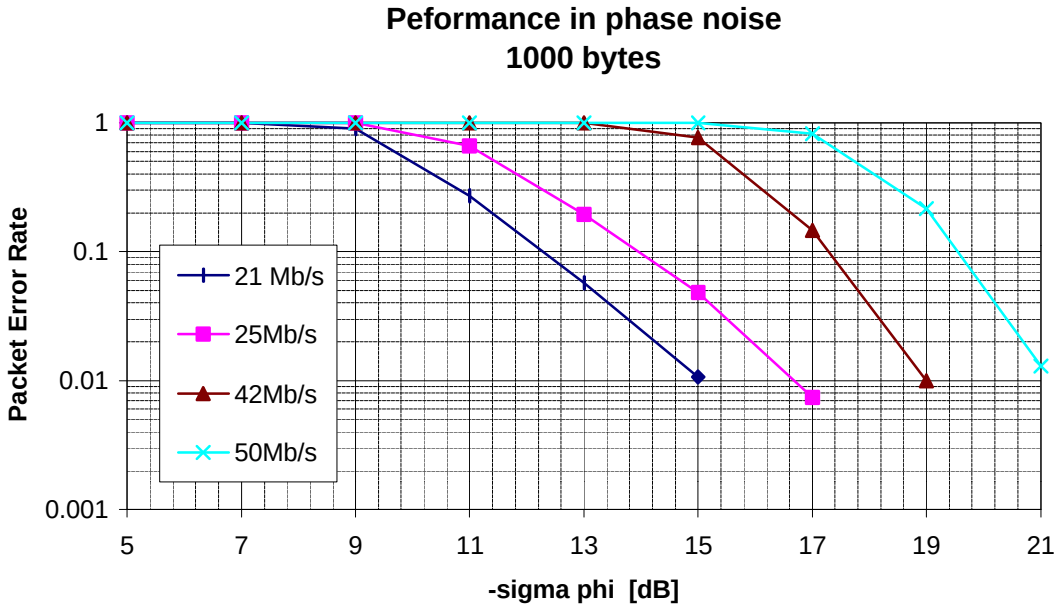

Performance in multipath 64bytes 42Mb/s
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
-80
-75
-70
-65
-60
-55
-50
Eb/No [dB]
25nSec
50nSec
100nSec
150nSec

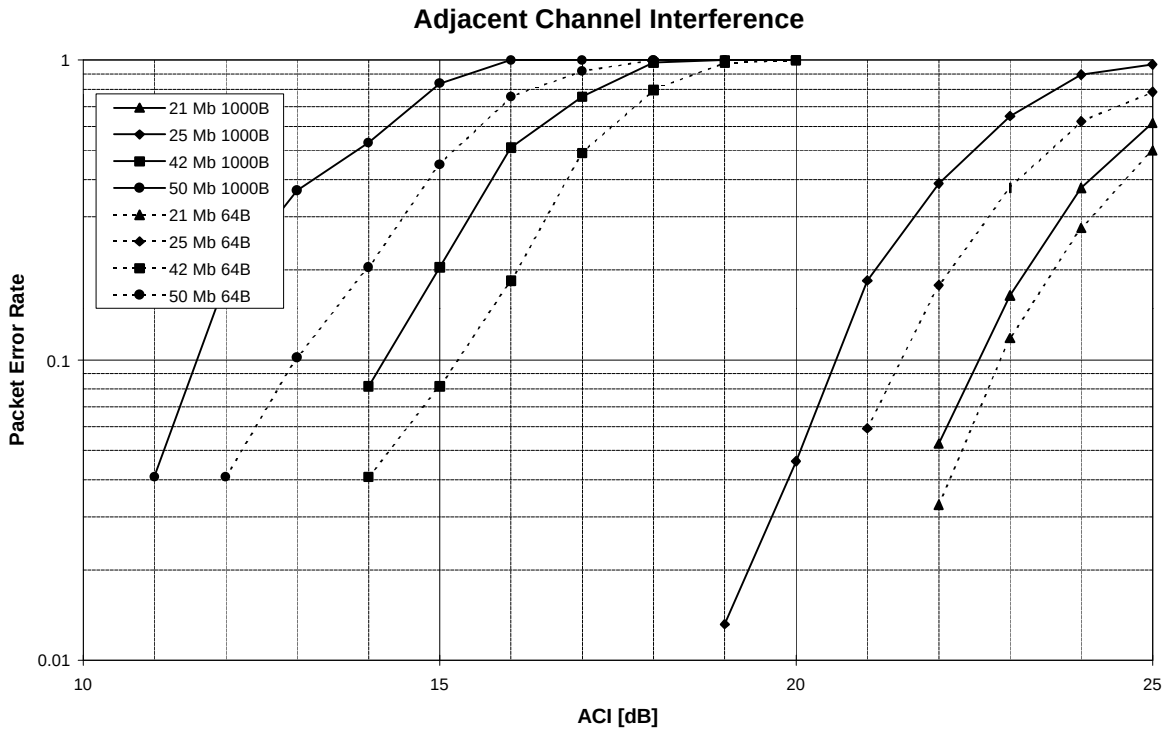

Performance in multipath 1000bytes 42Mb/s
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]
25nSec
50nSec
100nSec
150nSec

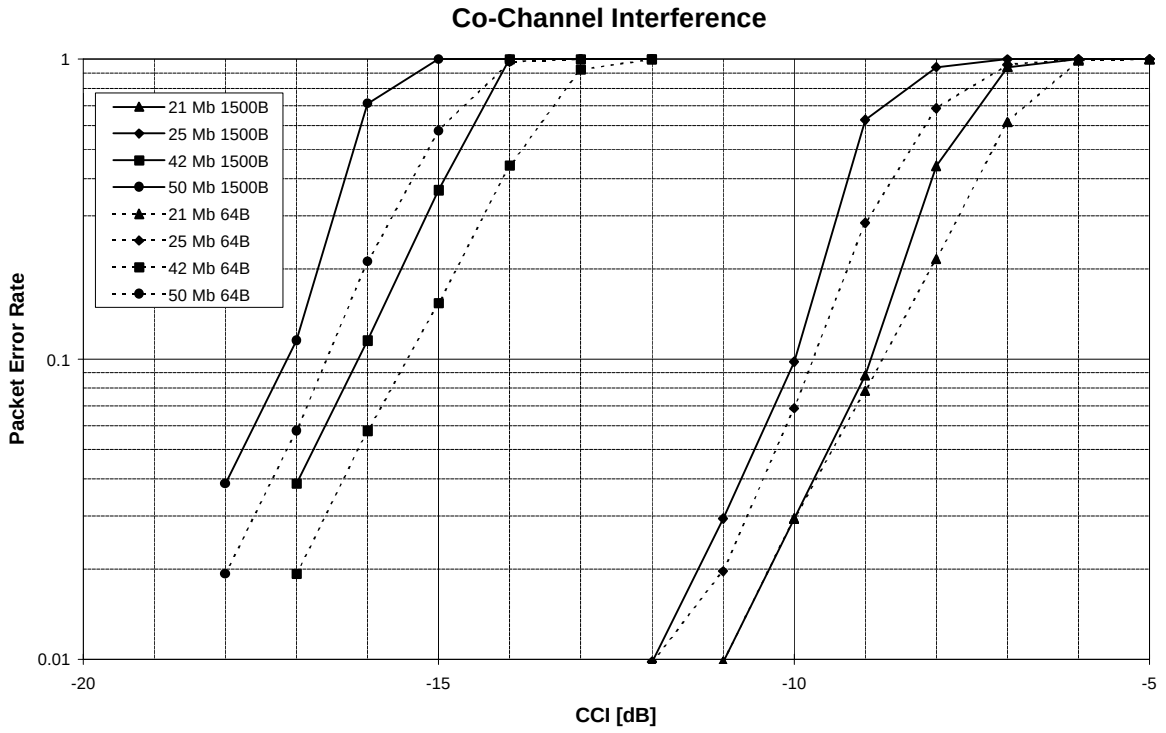

Performance in multipath 64bytes 50Mb/s
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]
25nSec
50nSec
100nSec
150nSec


Performance in multipath 1000bytes 50Mb/s
Nf=8 Nb=23
Packet Error Rate
1
0.1
0.01
0.001
-80
-75
-70
-65
-60
-55
-50
Pin [dBm]
25nSec
50nSec
100nSec
150nSec


Peformance in phase noise
64 bytes
Packet Error Rate
1
0.1
0.01
0.001
21 Mb/s
25Mb/s
42Mb/s
50Mb/s
5
7
9
11
13
15
17
19
21
-sigma phi [dB]

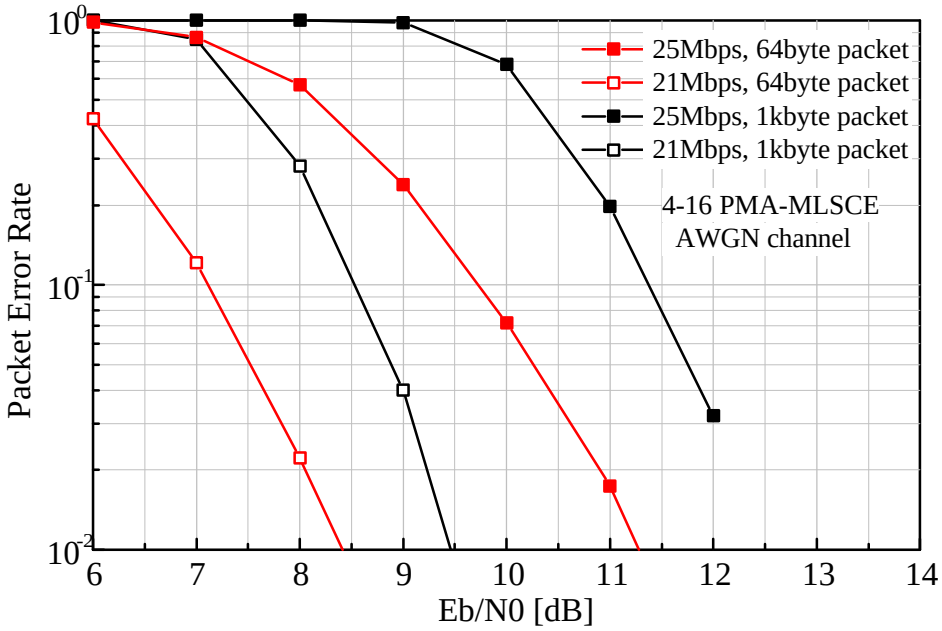

Peformance in phase noise
1000 bytes
Packet Error Rate
1
0.1
0.01
0.001
21 Mb/s
25Mb/s
42Mb/s
50Mb/s
5
7
9
11
13
15
17
19
21
-sigma phi [dB]


Adjacent Channel Interference
Packet Error Rate
1
0.1
0.01
10
15
20
25
ACI [dB]
21 Mb 1000B
25 Mb 1000B
42 Mb 1000B
50 Mb 1000B
21 Mb 64B
25 Mb 64B
42 Mb 64B
50 Mb 64B


Co-Channel Interference
Packet Error Rate
1
0.1
0.01
-20
-15
-10
-5
CCI [dB]
21 Mb 1500B
25 Mb 1500B
42 Mb 1500B
50 Mb 1500B
21 Mb 64B
25 Mb 64B
42 Mb 64B
50 Mb 64B

NEC Graphical Data - PMA-MLSCE receiver

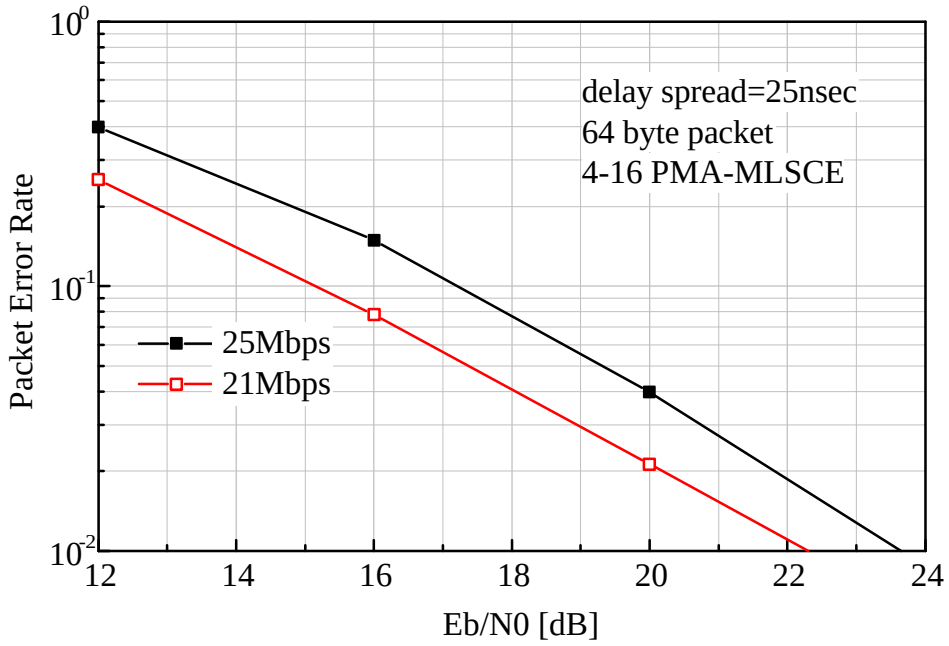
1) PER vs. Received Power, one graph for all rates, in a AWGN channel



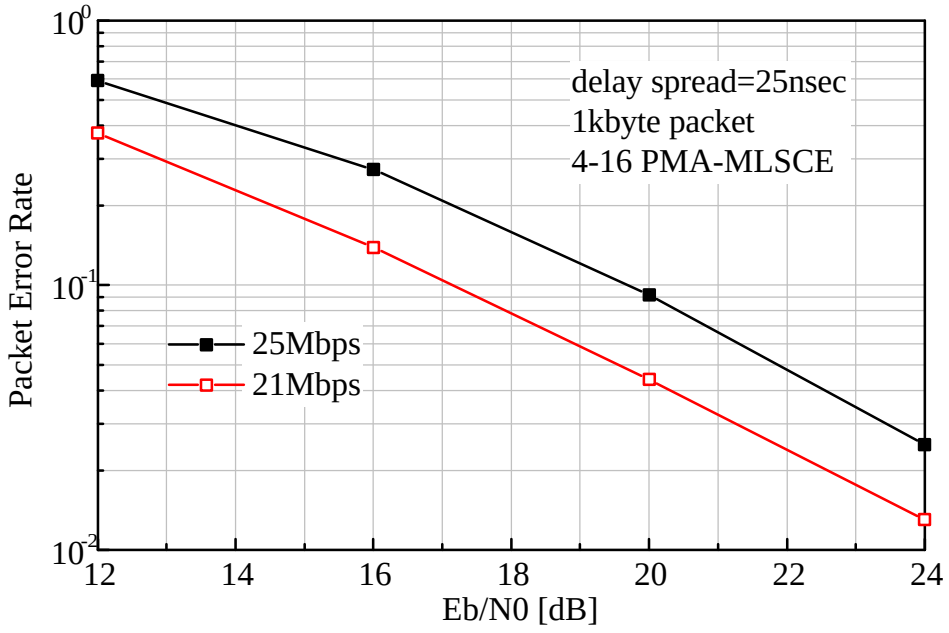
Graph 1 PER v.s. Eb/N0 (AWGN channel)

2) PER vs. Received Power, Exponential Profile Rayleigh Fading channel, one graph (with all rates) for each of the delay spread values T_{RMS} = 25 nsec, 50 nsec, 100 nsec, 150 nsec, 250 nsec

Simple Receiver Structure (4-16 PMA-MLSCE)

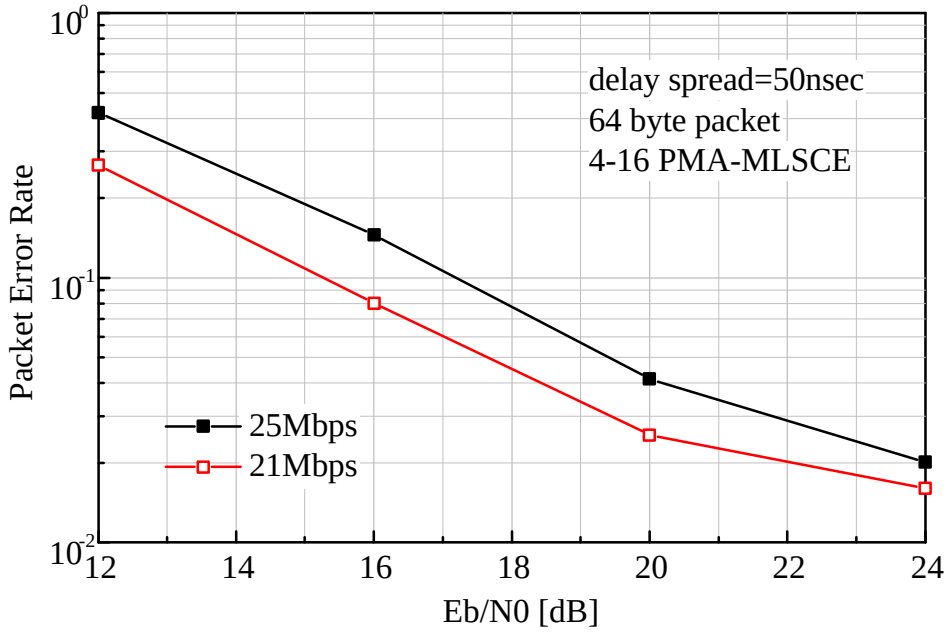


One) 64byte packet

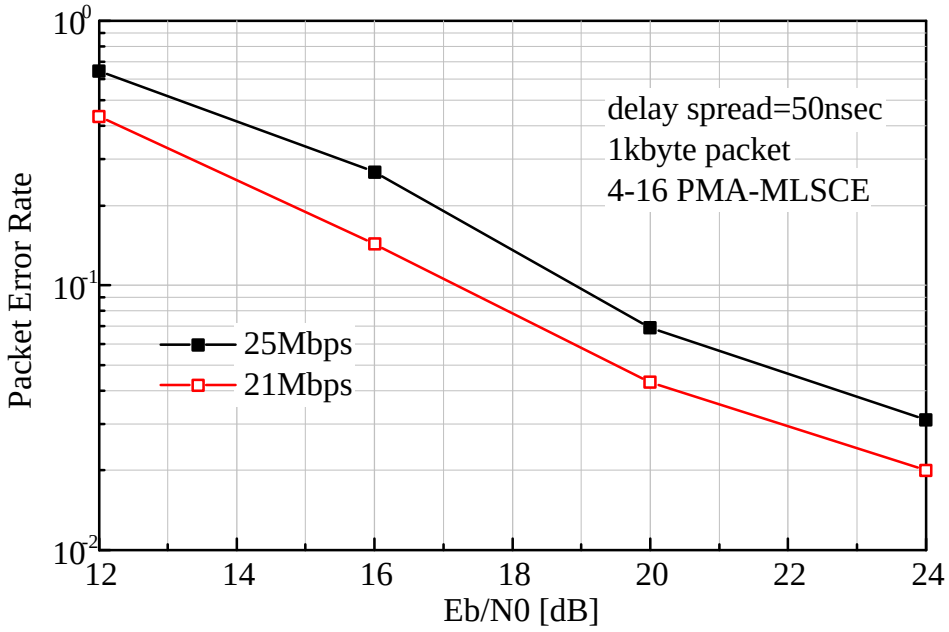


b) 1kbyte packet

Graph 2 PER v.s. Eb/N0 (delay spread=25nsec, simple receiver)

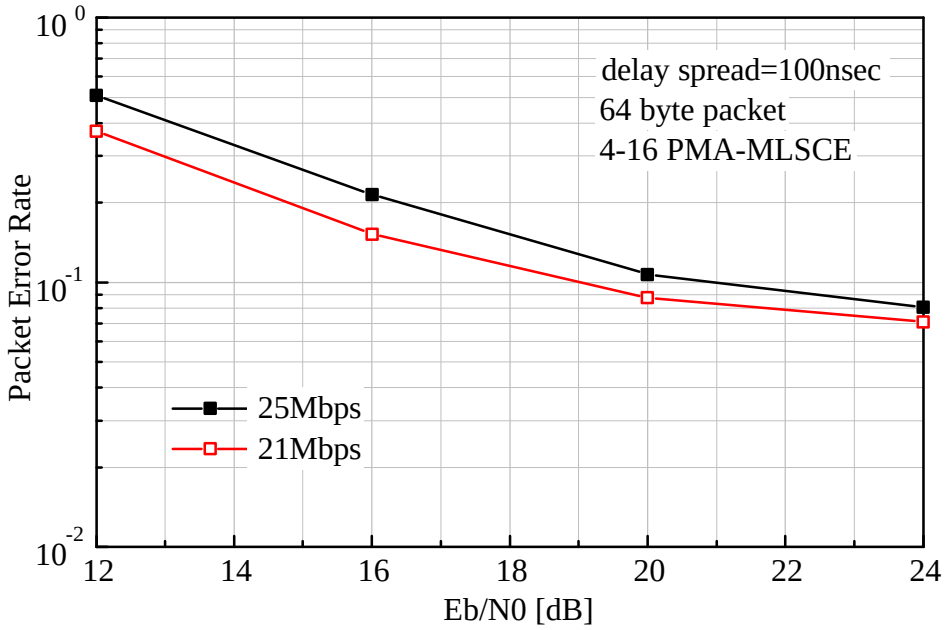


One) 64byte packet

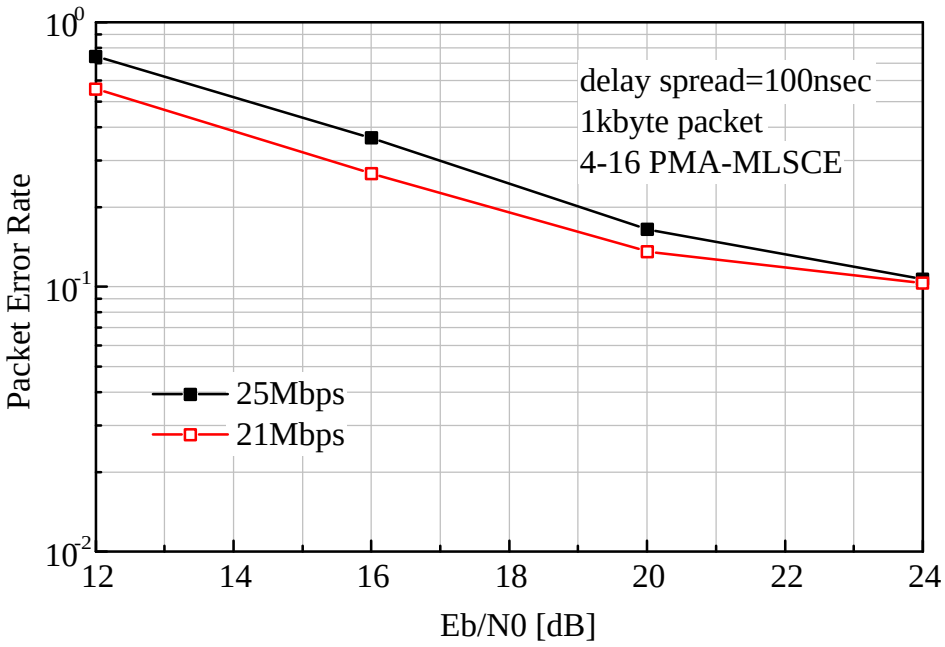


Two) 1kbyte packet

Graph 3 PER v.s. Eb/N0 (delay spread=50nsec, simple receiver)

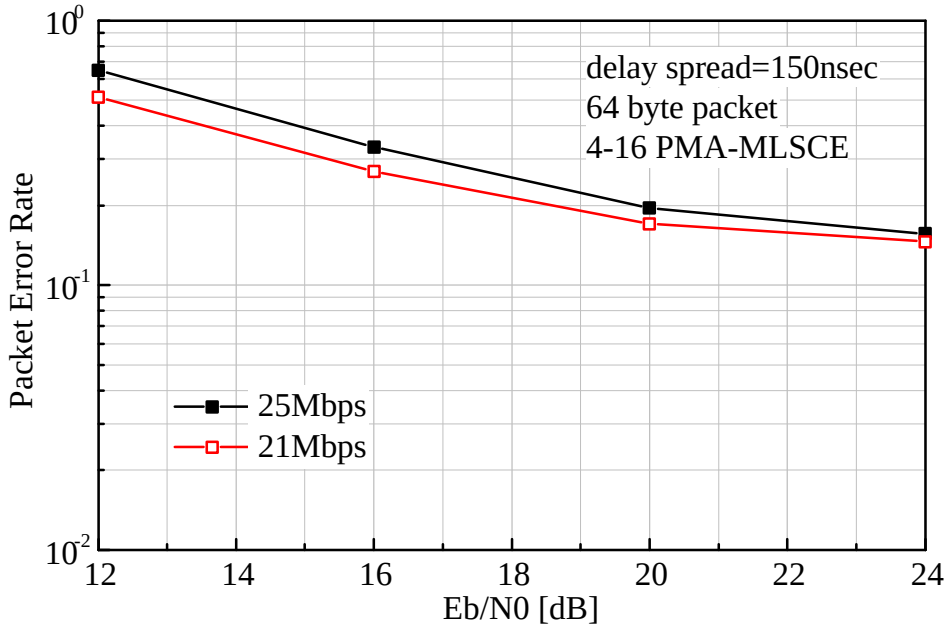


One) 64byte packet

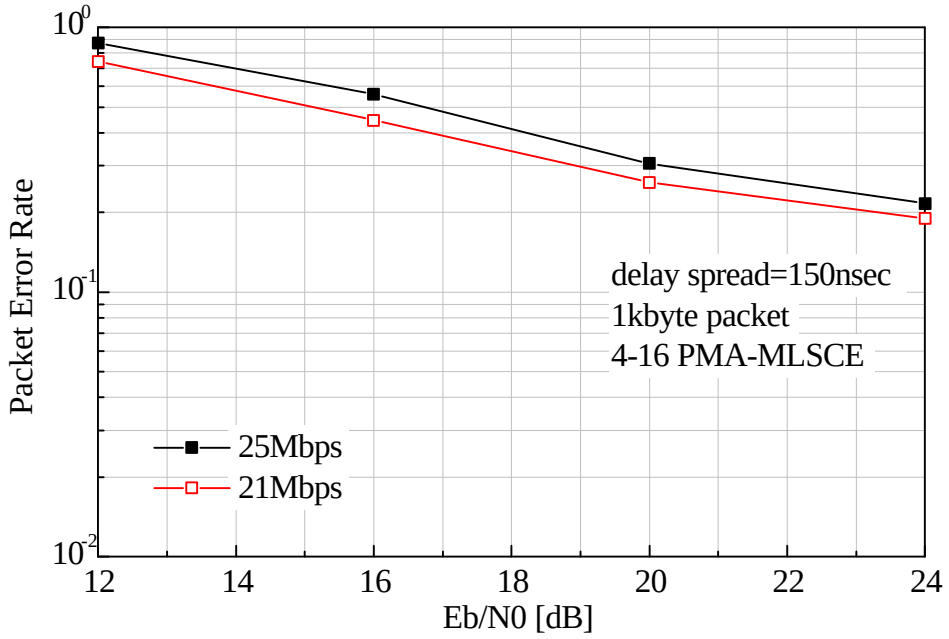


b) 1kbyte packet

Graph 4 PER v.s. Eb/N0 (delay spread=100nsec, simple receiver)

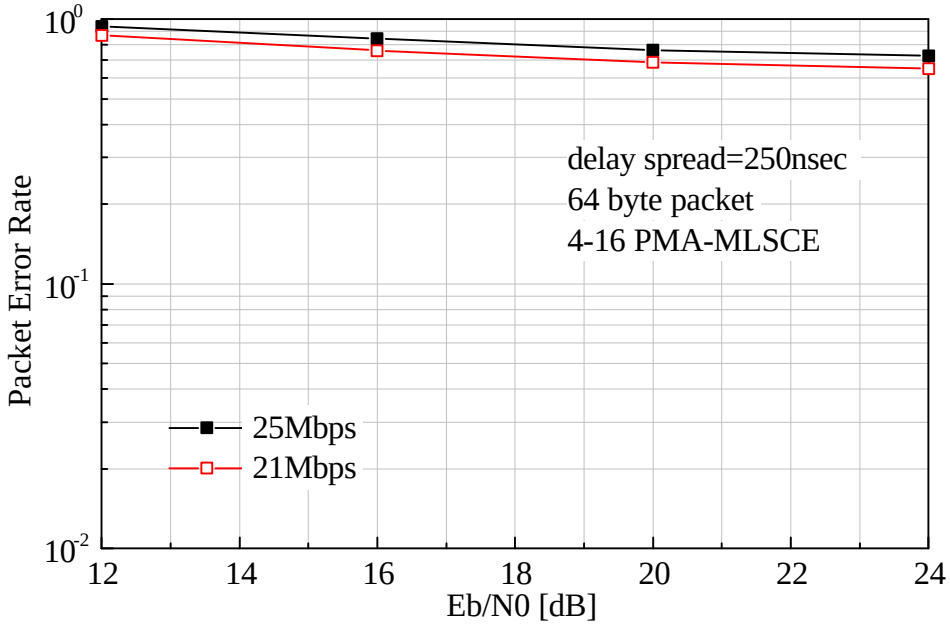


a) 64byte packet

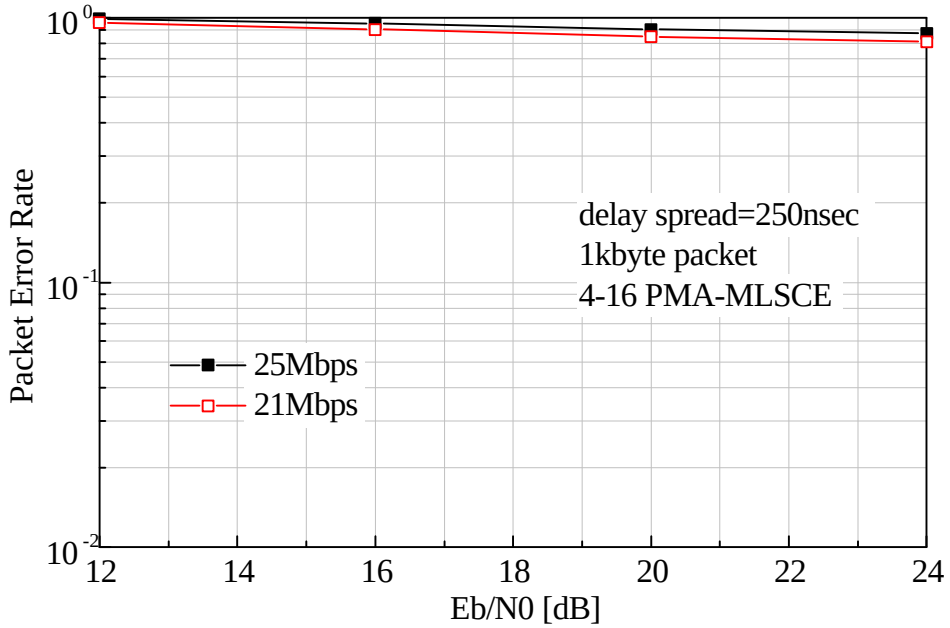


b) 1kbyte packet

Graph 5 PER v.s. Eb/N0 (delay spread=150nsec, simple receiver)



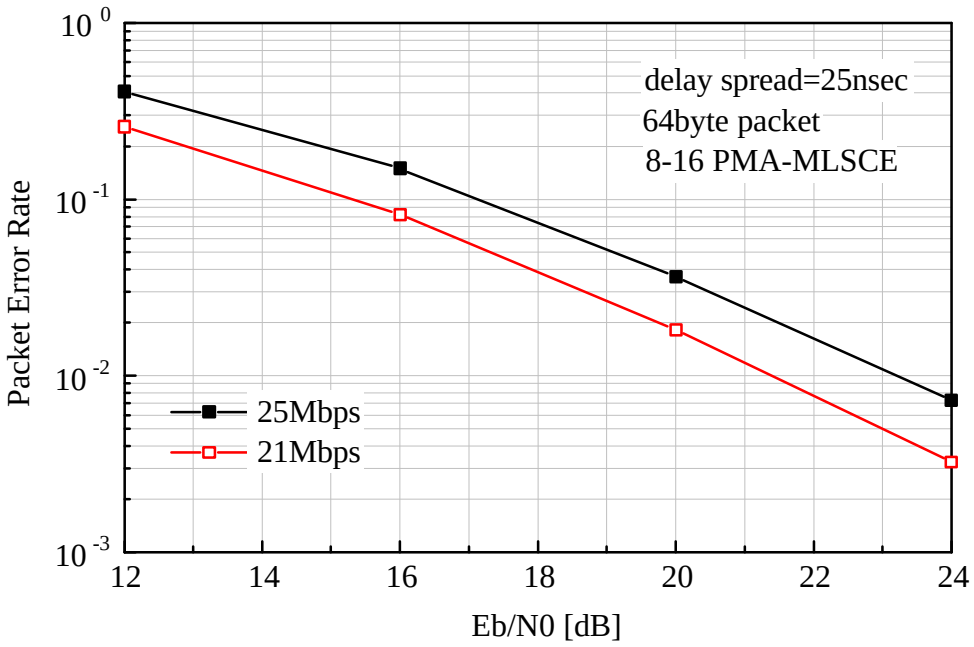
a) 64byte packet



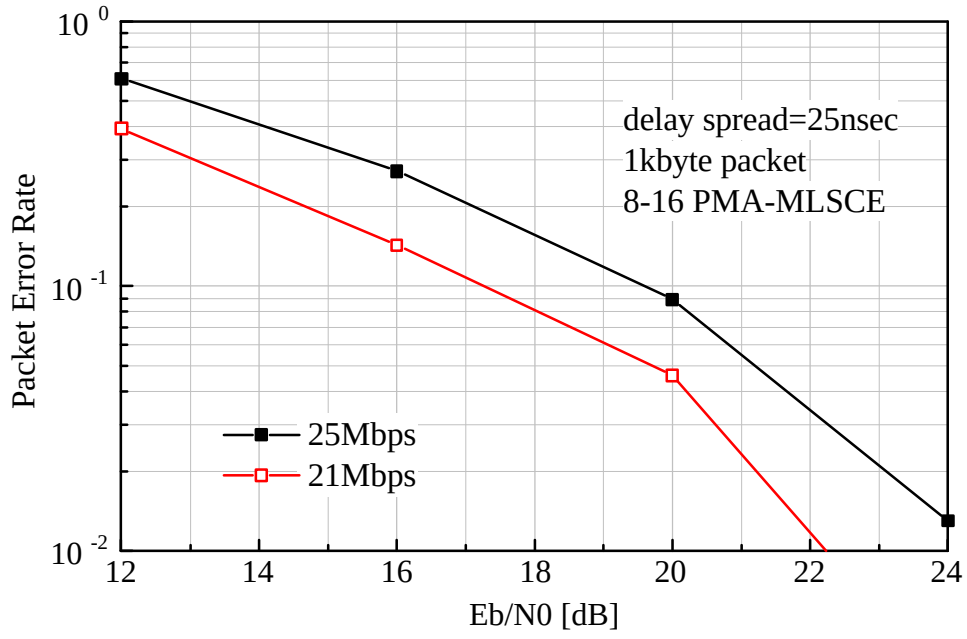
b) 1kbyte packet

Graph 6 PER v.s. Eb/N0 (delay spread=250nsec, simple receiver)

Complex structure (8-16 PMA-MLSCE)

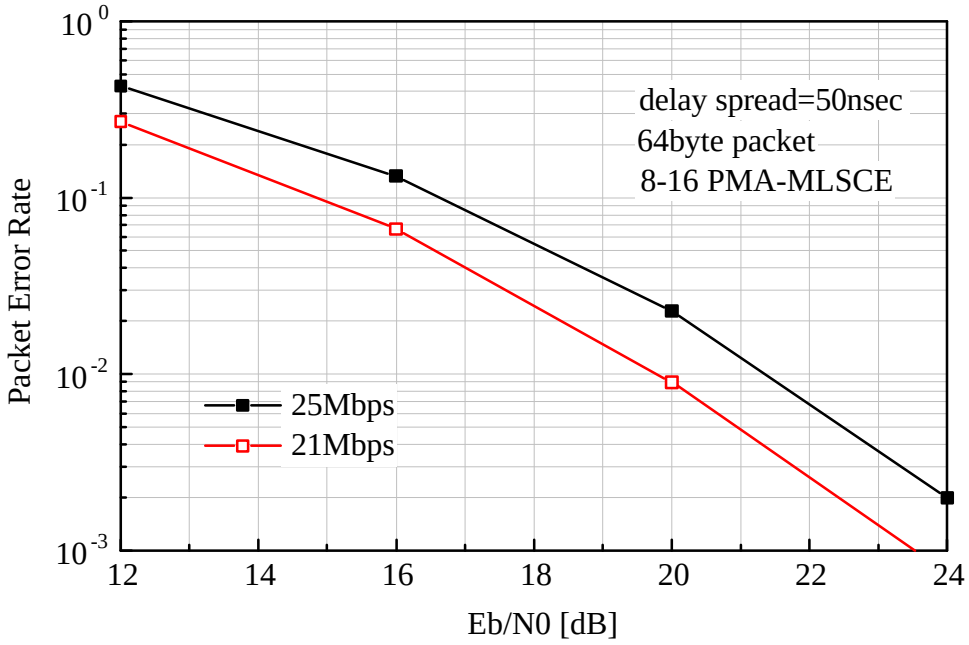


a) 64byte packet

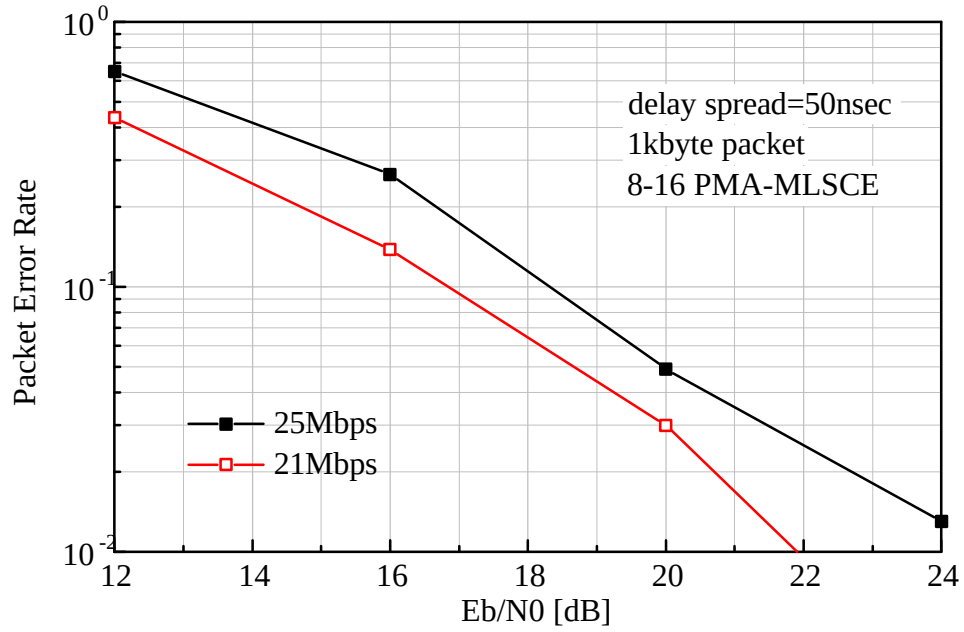


b) 1kbyte packet

Graph 7 PER v.s. Eb/N0 (delay spread=25nsec, complex receiver)

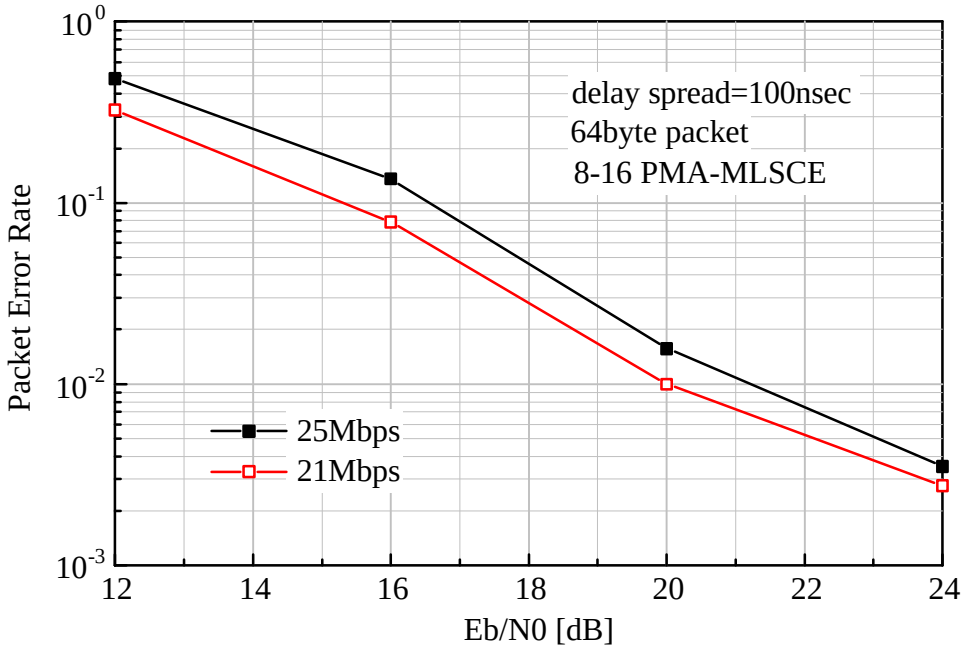


a) 64byte packet

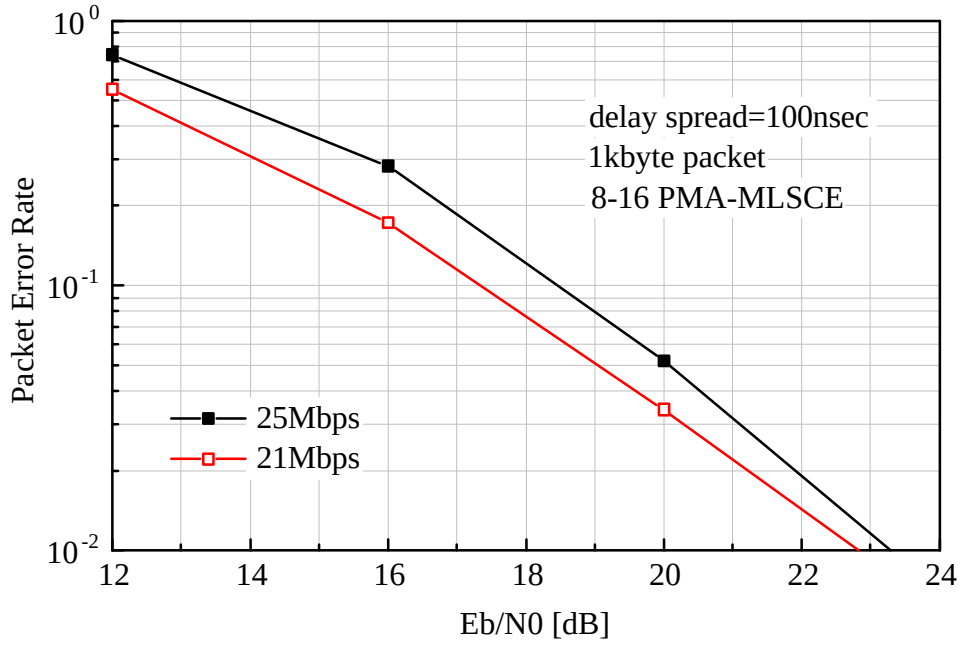


b) 1kbyte packet

Graph 8 PER v.s. Eb/N0 (delay spread=50nsec, complex receiver)

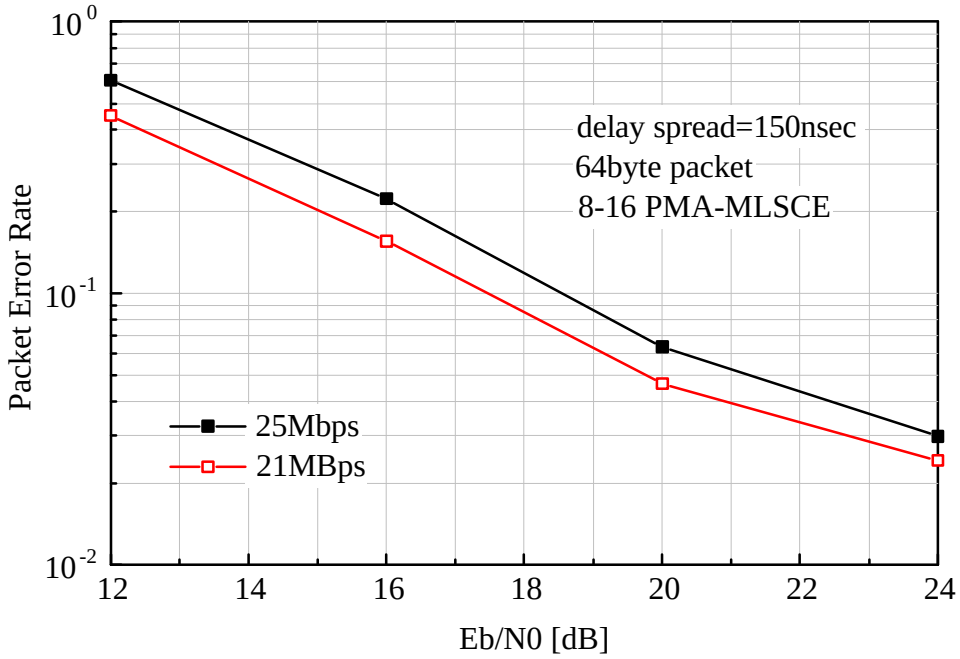


a) 64byte packet

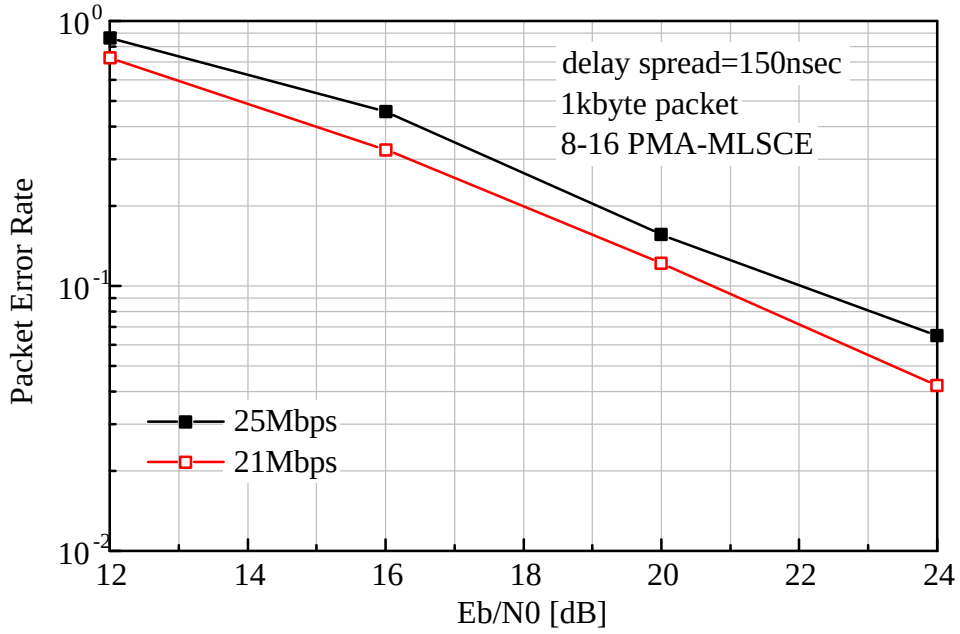


b) 1kbyte packet

Graph 9 PER v.s. Eb/N0 (delay spread=100nsec, complex receiver)

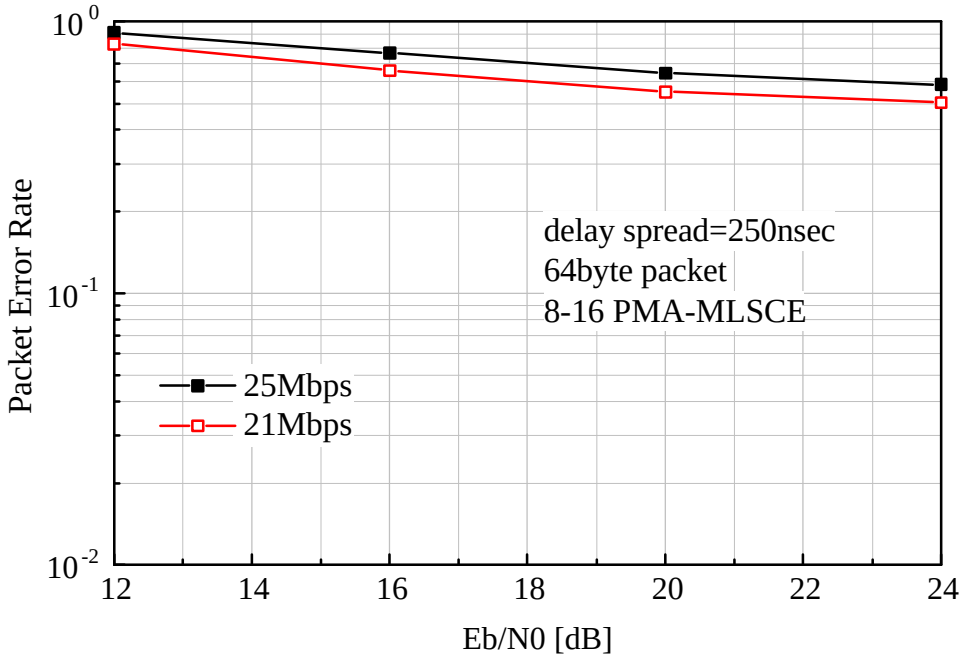


a) 64byte packet

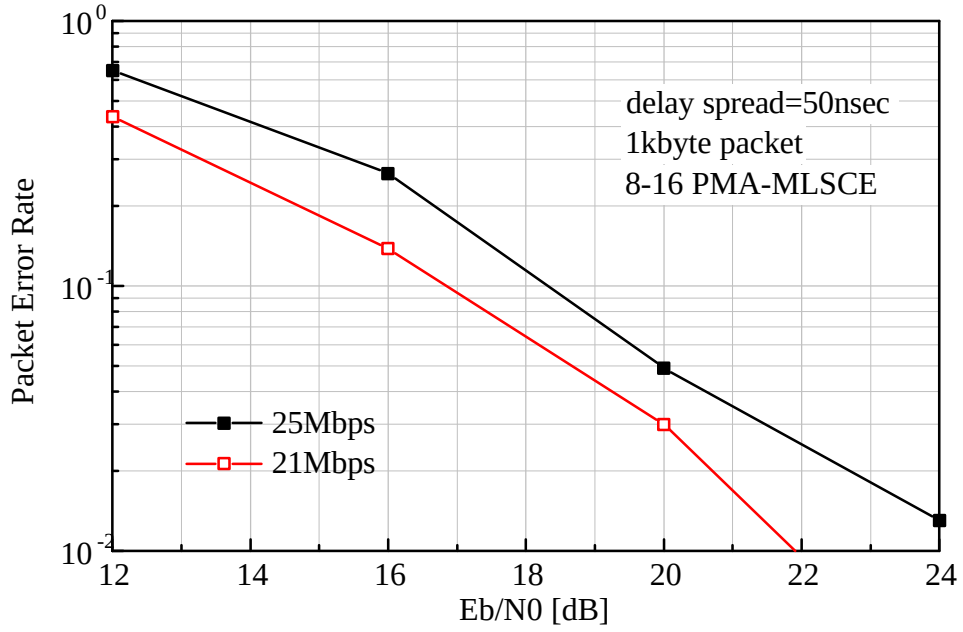


b) 1kbyte packet

Graph 10 PER v.s. Eb/N0 (delay spread=150nsec, complex receiver)



a) 64byte packet

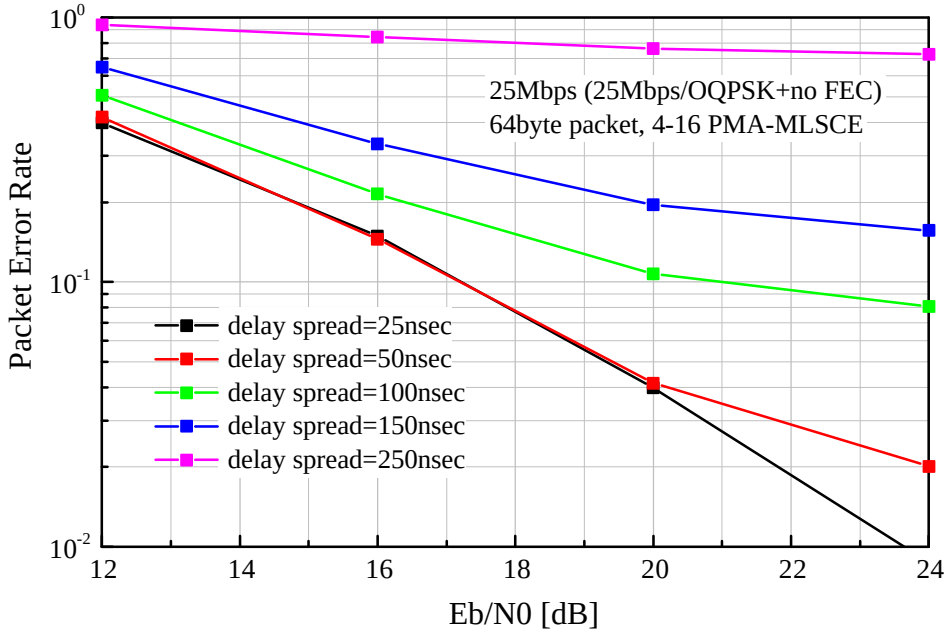


b) 1kbyte packet

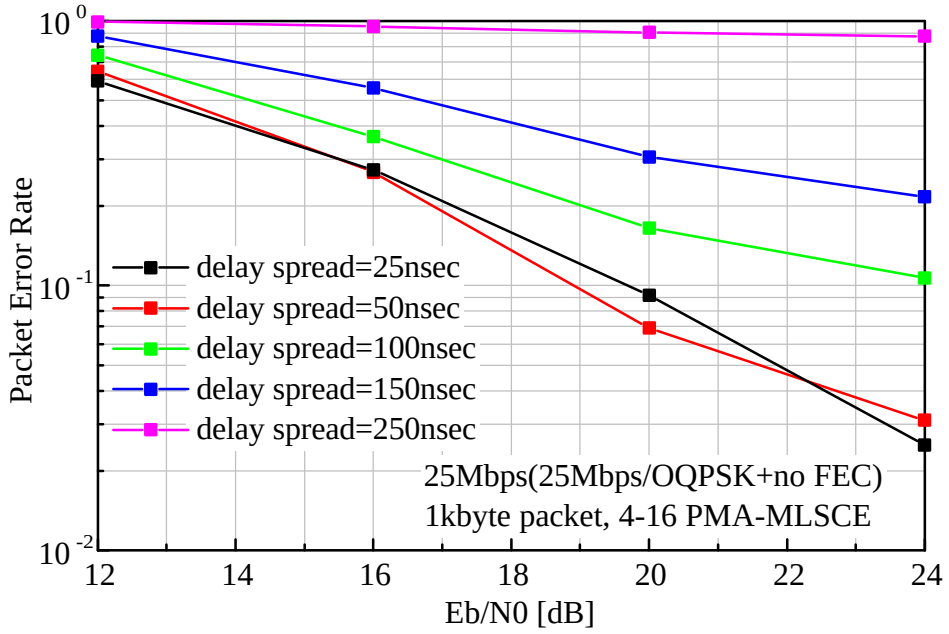
Graph 11 PER v.s. Eb/N0 (delay spread=250nsec, complex receiver)

3) PER vs. Received Power, Exponential Profile Rayleigh Fading channel, one graph (with all delay spread values T_{RMS} = 25 nsec, 50 nsec, 100 nsec, 150 nsec, 250 nsec) for each of the rates.

Simple receiver structure (4-16 PMA-MLSCE)

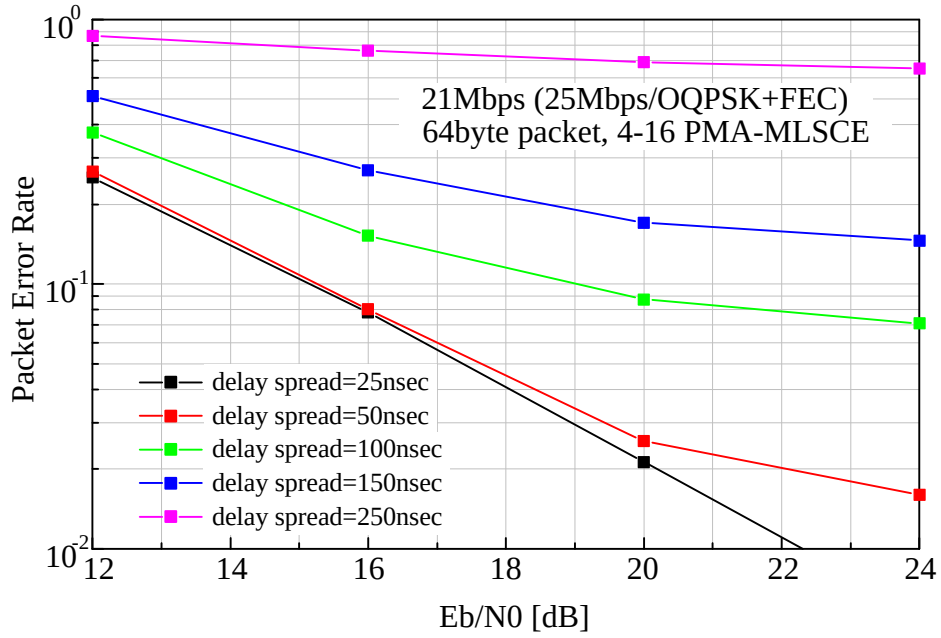


a) performance of 25Mbps (64byte packet)

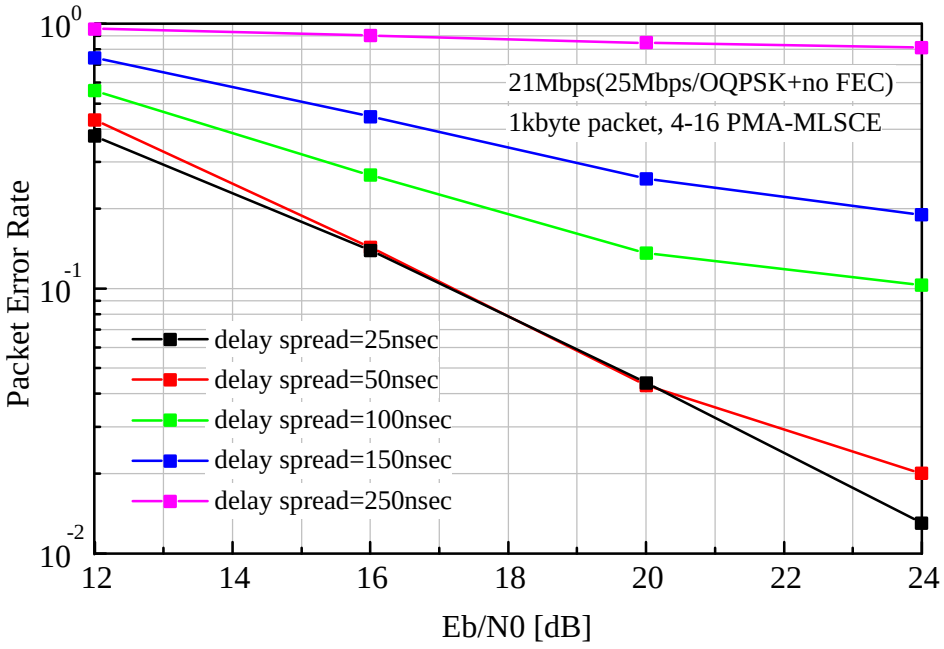


b) performance of 25Mbps (1kbyte packet)

Graph 12 PER v.s. Eb/N0 for 25Mbps transmission



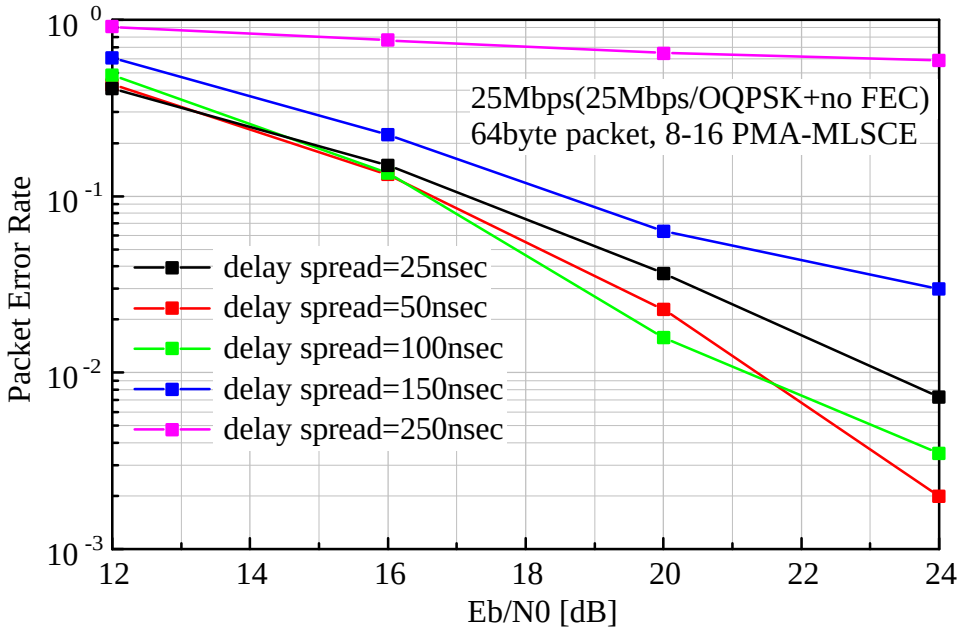
a) performance of 21Mbps (64byte packet)



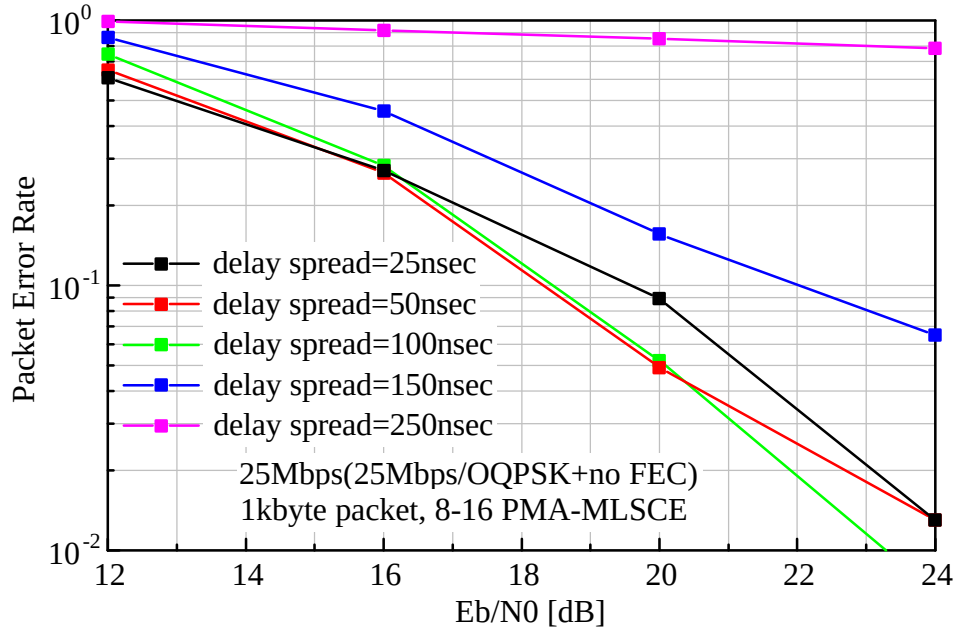
b) performance of 21Mbps (1kbyte packet)

Graph 13 PER v.s. Eb/N0 for 21Mbps transmission

Complex receiver structure (8-16 PMA-MLSCE)

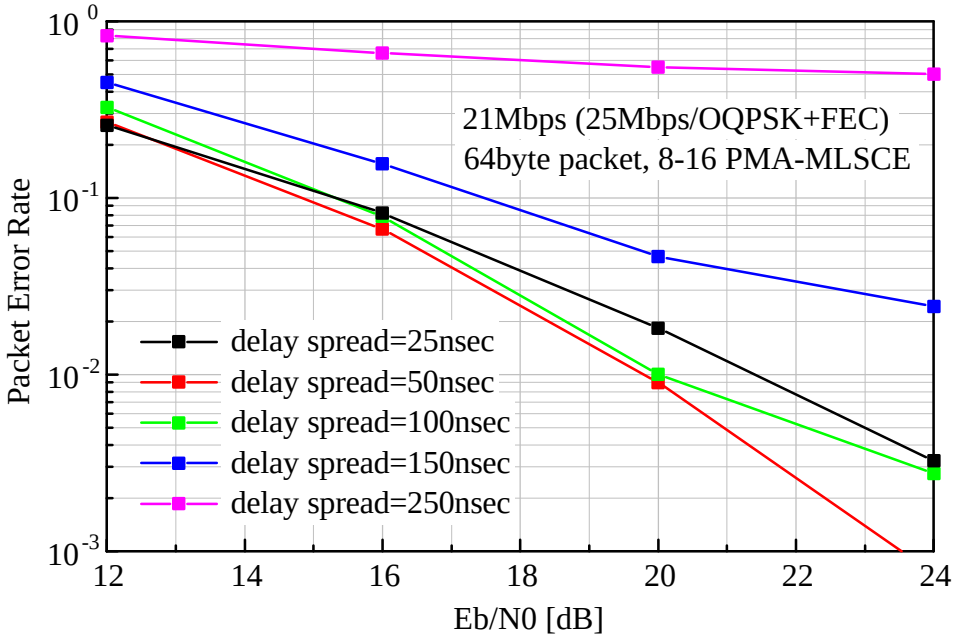


a) performance of 25Mbps (64byte packet)

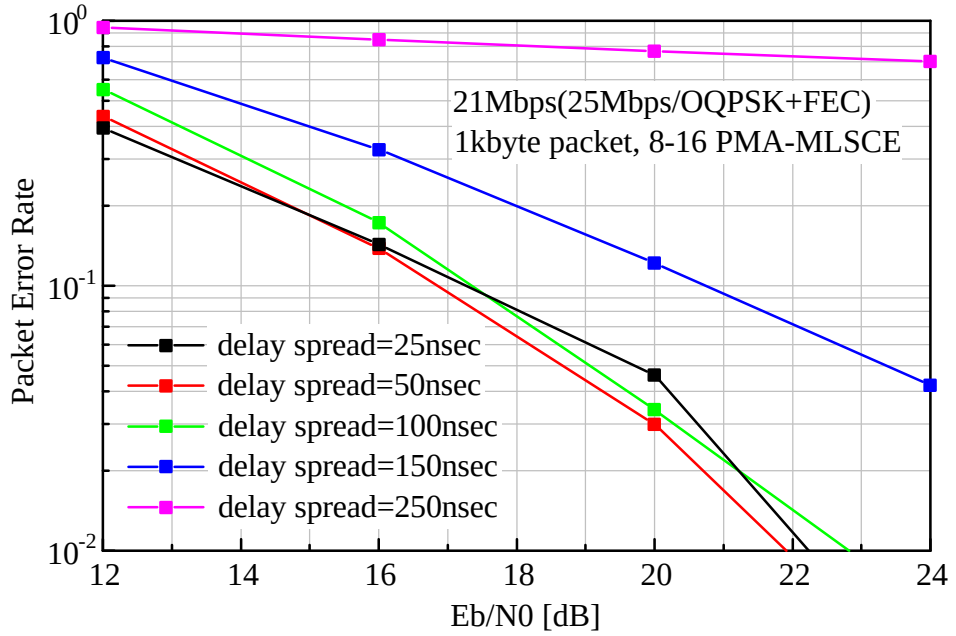


b) performance of 25Mbps (1kbyte packet)

Graph 14 PER v.s. Eb/N0 for 25Mbps transmission



a) performance of 21Mbps (64byte packet)

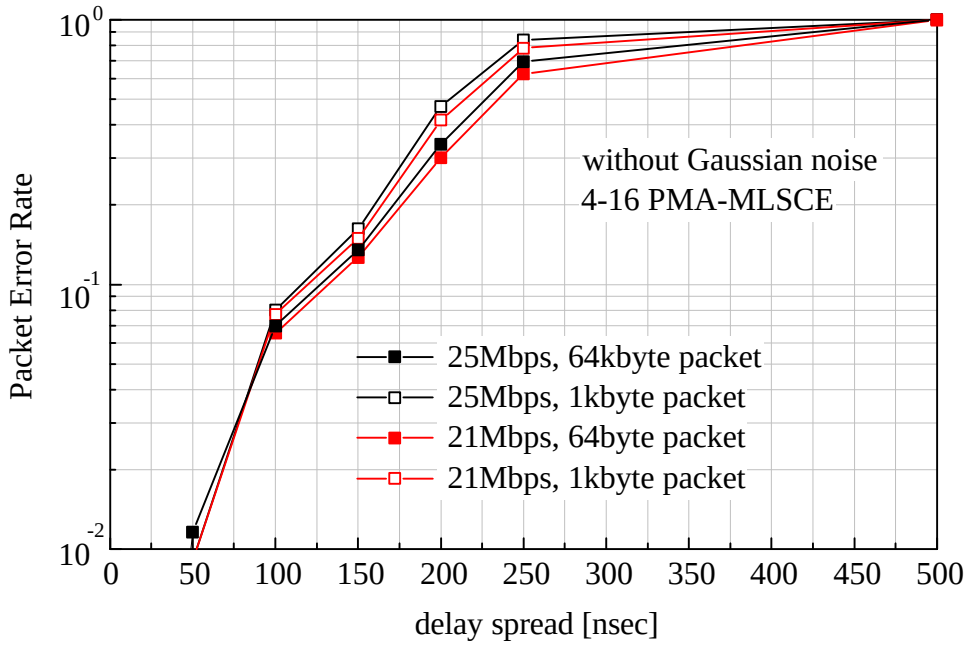


b) performance of 21Mbps (1kbyte packet)

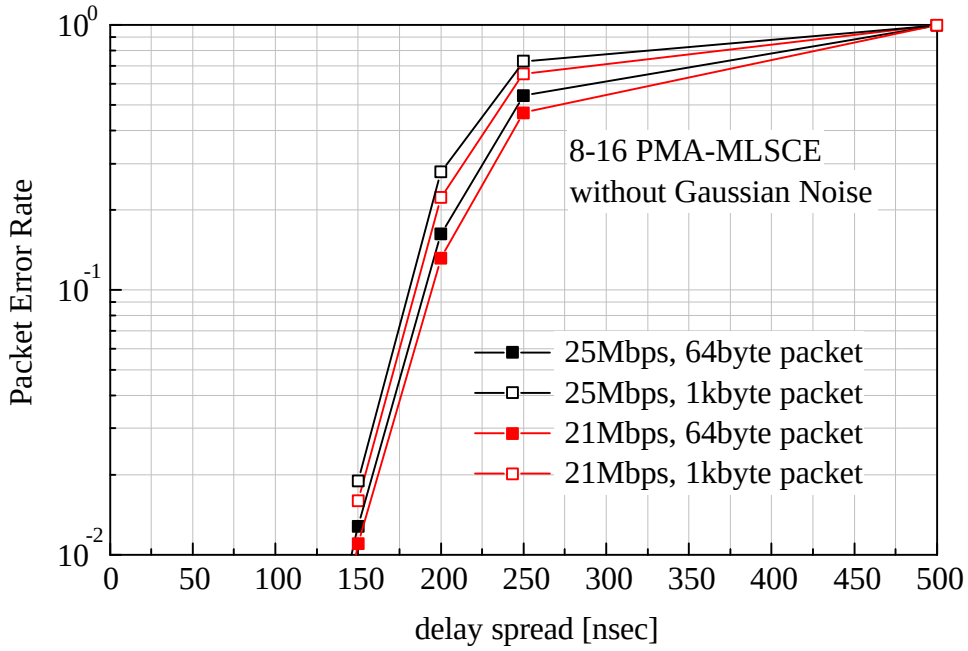
Graph 15 PER v.s. Eb/N0 for 21Mbps transmission

4) Attach one graph (with all rates) of PER vs. T_{RMS} without additive noise, covering a range of 10 nsec to 500 nsec

Simple receiver structure

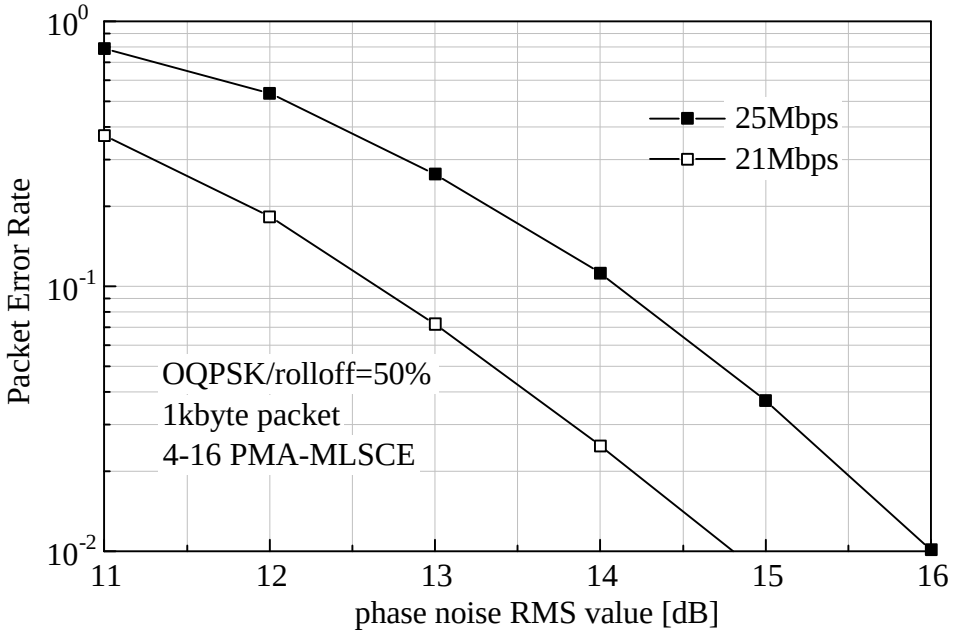


Graph 16 PER v.s. delay spread (simple receiver structure)



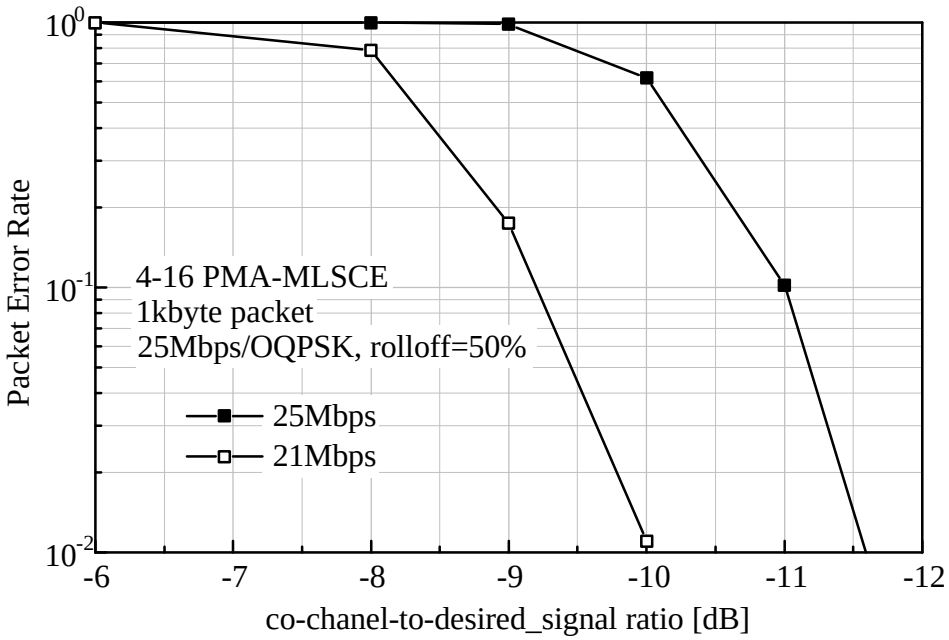
Graph 17 PER v.s. delay spread (complex receiver structure)

5) Attach one graph (with all rates) of PER vs. RMS phase noise (without thermal noise), for 1000 byte packet length.



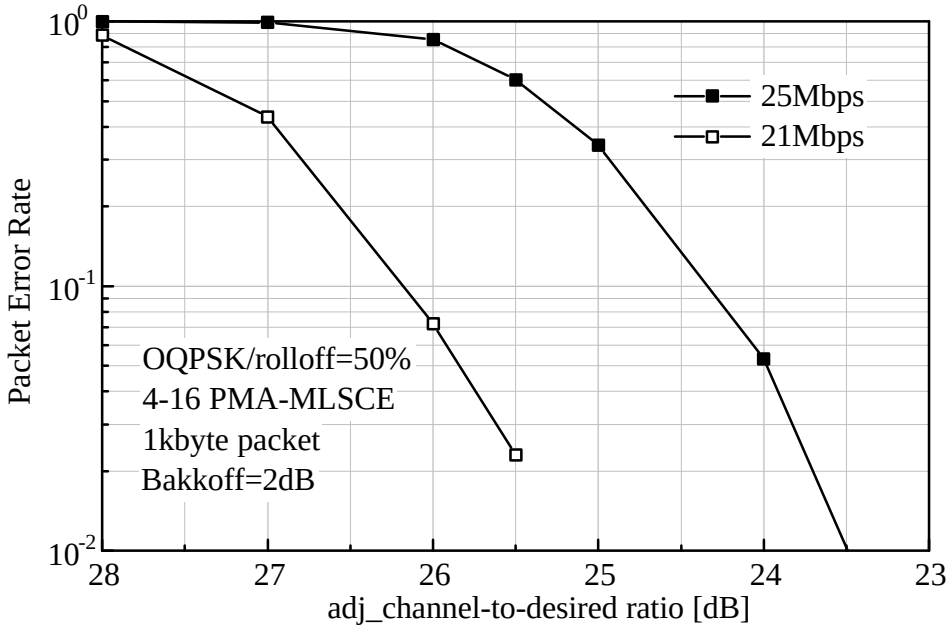
Graph 18 PER v.s.phase noise for 1kbyte packet

6) Attach one graph (with all rates) of PER vs.CCI (without thermal noise), for 1000 byte packet length. The CCI is defined as 10 log((interferer power)/(desired power)), i.e. smaller CCI means less interference.



Graph 19 PER v.s. CCI for 1kbyte packet

7) Attach one graph (with all rates) of PER vs.ACI (without thermal noise), for 1000 byte packet length. The ACI is defined as 10 log((interferer power)/(desired power)), i.e. smaller ACI means less interference. Set the Backoff according to U-NII regulations.



Graph 20 PER v.s. ACI