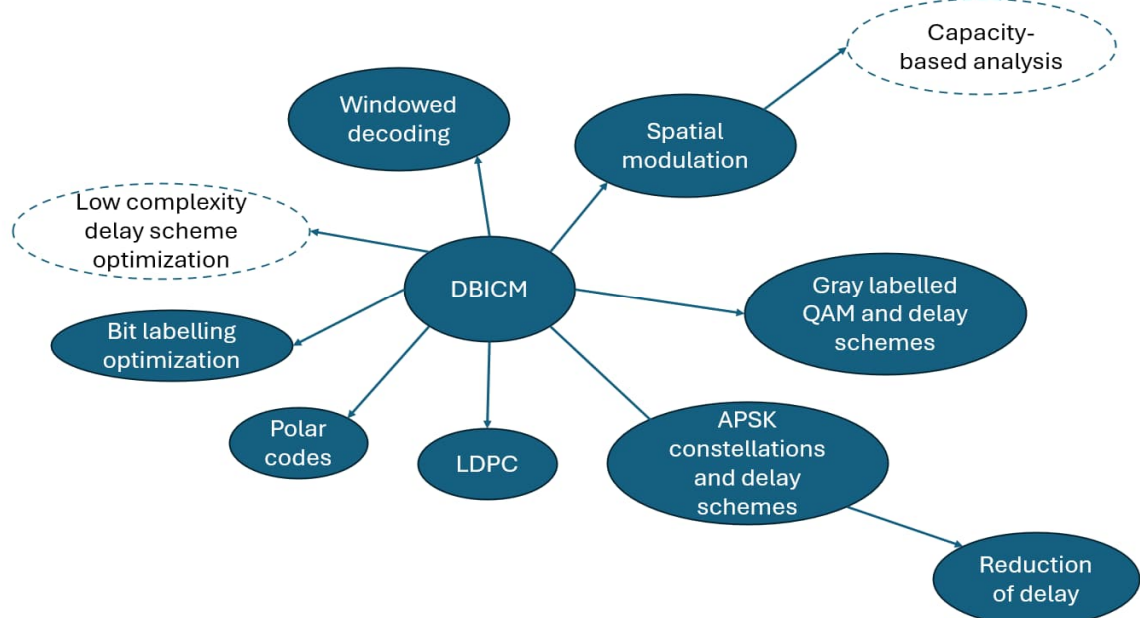


Gray labelled 16 QAM (2dB EsNo)						
Delay Scheme	Nearest neighbour 1/HMMSED	Nearest neighbour EXP	All 1/HMMSED	All EXP	Capacity (0.001 accuracy) - Need to recheck	Capacity(2nd attempt)
'0011'	2.03125	0.772696147	4.165865385	2.41858341871255	1.25901533673075	1.258991177
'1100'	2.03125	0.772696147	4.165865385	2.41858341871255	1.26037877245806	1.259225393
'1011'	2.03125	0.772696147	4.691372863	2.80594816781244	1.29932896506899	1.300479855
'0010'	2.03125	0.772696147	4.469951923	2.55502391436026	1.29971116402296	1.301100095
'0111'	1.987847222	0.736406485	4.924278846	2.95395273620700	1.29980021195055	1.301748307
'1000'	2.03125	0.772696147	4.469951923	2.55502391436026	1.30009703484244	1.300538544
'1101'	1.987847222	0.736406485	4.924278846	2.95395273620700	1.30102783831727	1.300923099
'0001'	1.987847222	0.736406485	4.198584402	2.36635336729689	1.30121956404851	1.300853306
'0100'	1.987847222	0.736406485	4.198584402	2.36635336729689	1.30141980274656	1.301572713
'1110'	2.03125	0.772696147	4.691372863	2.80594816781244	1.30260759474909	1.298572469
'1001'	1.987847222	0.736406485	4.228365385	2.38666824194011	1.34135837812926	1.342475453
'0101'	1.944444444	0.700116823	4.322382479	2.45083978820309	1.34197686915133	1.343370159
'0110'	1.987847222	0.736406485	4.228365385	2.38666824194011	1.34271268805413	1.341588688
'1010'	2.03125	0.772696147	4.245459402	2.36950783086548	1.34387040601005	1.339842957
'0000'	2.03125	0.772696147	5.762286325	3.60656166152688	BICM Capacity	1.258306137
'1111'	2.03125	0.772696147	5.762286325	3.60656166152688	BICM Capacity	1.258306137



$$I_{\text{BICM}} = \sum_{i=0}^{m-1} I(B_i; Y) \tag{8}$$

$$I(X; Y) = I(B_0, \dots, B_{m-1}; Y) \tag{9}$$

$$T = [0, 1, 0, 1] \tag{10}$$

$$I_{\text{DBICM}}^T = I(B_0; Y|B_1, B_3) + I(B_1; Y) + I(B_2; Y|B_1, B_3) + I(B_3; Y) \tag{11}$$

$$D^r = \frac{1}{m2^m} \sum_{i=1}^m \sum_{b=0}^1 \sum_{s_k \in \chi_b^i} \sum_{\hat{s}_k \in \chi_b^i} \frac{1}{|s_k - \hat{s}_k|^2} \tag{12}$$

$$D^a = \frac{1}{m2^m} \sum_{i=1}^m \sum_{b=0}^1 \sum_{s_k \in \chi_b^i} \sum_{\hat{s}_k \in \chi_b^i} \exp\left(-\frac{E_s}{4N_0} |s_k - \hat{s}_k|^2\right) \tag{13}$$

TABLE I
OPTIMUM DELAY SCHEME T* FOR UNIFORM GRAY LABELED M-QAM DBICM WITH CODE RATE 1/4, 1/3, 2/5 AND 1/2.

Modulation	Rate	Optimal Delay Scheme	Gap to CM (dB)	Gain over BICM (dB)
16-QAM	1/4	[0, 1, 0, 1]	0	0.55
	1/3	[0, 1, 0, 1]	0	0.4
	2/5	[0, 1, 0, 1]	0	0.3
	1/2	[0, 1, 0, 1]	0	0.2
64-QAM	1/4	[1, 0, 1, 1, 0, 1]	0.15	0.7
	1/3	[0, 1, 0, 0, 1, 0]	0.15	0.6
	2/5	[0, 0, 1, 0, 0, 1]	0.1	0.55
	1/2	[0, 0, 1, 0, 0, 1]	0.01	0.45
256-QAM	1/4	[0, 0, 1, 1, 0, 0, 1, 1]	0.3	0.65
	1/3	[1, 1, 0, 1, 1, 1, 0, 1]	0.25	0.65
	2/5	[0, 0, 1, 1, 0, 0, 1, 1]	0.25	0.65
	1/2	[0, 0, 0, 1, 0, 0, 0, 1]	0.15	0.6
1024-QAM	1/4	[1, 1, 0, 1, 1, 1, 1, 0, 1, 1]	0.25	0.85
	1/3	[1, 0, 0, 1, 1, 1, 0, 0, 1, 1]	0.25	0.8
	2/5	[0, 0, 0, 1, 1, 0, 0, 0, 1, 1]	0.25	0.8
	1/2	[0, 0, 0, 1, 1, 0, 0, 0, 1, 1]	0.25	0.65

Y. Liao, M. Qiu, and J. Yuan, "Design and analysis of delayed bit-interleaved coded modulation with ldpc codes," IEEE Transactions on Communications, vol. 69, no. 6, pp. 3556–3571, 2021.

64-QAM Gray labelled (Constellation constrained capacity at 1/2 rate is 9 dB EsNo)				
Delay Scheme	Nearest neighbour 1/HMMSED	Capacity (2dB - EsNo)	Nearest neighbour Exp (2dB - EsNo)	Nearest neighbour Exp (9dB - EsNo)
'001001'	6.526041667	1.246492638	0.83086582	0.536473134
'001101'	6.608072917	1.286698412	0.843913746	0.5540063
'101001'	6.608072917	1.286872311	0.843913746	0.5540063
'001011'	6.619310516	1.271965565	0.820403858	0.55672065
'011001'	6.619310516	1.271820881	0.820403858	0.55672065
'001010'	6.683298611	1.280222274	0.830717187	0.568721485
'010001'	6.683298611	1.281648647	0.830717187	0.568721485
'101101'	6.690104167	1.329280045	0.856961673	0.571539467
'011101'	6.701341766	1.311204503	0.833451785	0.574253816
'101011'	6.701341766	1.313779134	0.833451785	0.574253816
'011011'	6.712579365	1.295717578	0.809941897	0.576968166
'000001'	6.729600694	1.209988858	0.856235123	0.577923818
'001000'	6.729600694	1.212084765	0.856235123	0.577923818
'001100'	6.729600694	1.26534822	0.856235123	0.577923818
'001110'	6.729600694	1.255900838	0.856235123	0.577923818
'001111'	6.729600694	1.212511905	0.856235123	0.577923818
'100001'	6.729600694	1.26776502	0.856235123	0.577923818
'110001'	6.729600694	1.253514603	0.856235123	0.577923818
'111001'	6.729600694	1.210262734	0.856235123	0.577923818
'010101'	6.765329861	1.323790625	0.843765114	0.586254652
'101010'	6.765329861	1.319835045	0.843765114	0.586254652
'010011'	6.77656746	1.306155389	0.820255226	0.588969002
'011010'	6.77656746	1.305894973	0.820255226	0.588969002
'000101'	6.811631944	1.250485612	0.86928305	0.595456984
'100101'	6.811631944	1.305249017	0.86928305	0.595456984
'101000'	6.811631944	1.250799965	0.86928305	0.595456984
'101100'	6.811631944	1.30583119	0.86928305	0.595456984
'101110'	6.811631944	1.293901627	0.86928305	0.595456984
'101111'	6.811631944	1.252509635	0.86928305	0.595456984
'110101'	6.811631944	1.294053	0.86928305	0.595456984
'111101'	6.811631944	1.252783561	0.86928305	0.595456984
'000011'	6.822869544	1.23805984	0.845773162	0.598171334
'011000'	6.822869544	1.23505102	0.845773162	0.598171334
'011100'	6.822869544	1.291530778	0.845773162	0.598171334
'011110'	6.822869544	1.279554095	0.845773162	0.598171334
'011111'	6.822869544	1.23792789	0.845773162	0.598171334
'100011'	6.822869544	1.291346422	0.845773162	0.598171334
'110011'	6.822869544	1.282945929	0.845773162	0.598171334
'111011'	6.822869544	1.238436889	0.845773162	0.598171334
'010010'	6.840555556	1.313555884	0.830586554	0.600969837
'000010'	6.886857639	1.243777083	0.856086491	0.610172169
'010000'	6.886857639	1.242731647	0.856086491	0.610172169
'010100'	6.886857639	1.295567497	0.856086491	0.610172169
'010110'	6.886857639	1.285938188	0.856086491	0.610172169
'010111'	6.886857639	1.246078589	0.856086491	0.610172169
'100010'	6.886857639	1.29923653	0.856086491	0.610172169
'110010'	6.886857639	1.288908105	0.856086491	0.610172169
'111010'	6.886857639	1.24484187	0.856086491	0.610172169
'000000'	6.933159722	1.175486112	0.881604427	0.619374502
'000100'	6.933159722	1.229416156	0.881604427	0.619374502
'000110'	6.933159722	1.217226737	0.881604427	0.619374502
'000111'	6.933159722	1.176222193	0.881604427	0.619374502
'100000'	6.933159722	1.228858778	0.881604427	0.619374502
'100100'	6.933159722	1.287017325	0.881604427	0.619374502
'100110'	6.933159722	1.275036206	0.881604427	0.619374502
'100111'	6.933159722	1.230770951	0.881604427	0.619374502
'110000'	6.933159722	1.21739841	0.881604427	0.619374502
'110100'	6.933159722	1.274026043	0.881604427	0.619374502
'110110'	6.933159722	1.263809776	0.881604427	0.619374502
'110111'	6.933159722	1.21672333	0.881604427	0.619374502
'111000'	6.933159722	1.176934441	0.881604427	0.619374502
'111100'	6.933159722	1.230564962	0.881604427	0.619374502
'111110'	6.933159722	1.218117067	0.881604427	0.619374502
'111111'	6.933159722	1.175486112	0.881604427	0.619374502

Elapsed time is 116.893438 seconds.

ans =

Columns 1 through 6

1.30121956404851	1.29971116402296	1.25901533673075	1.30141980274656	1.34197686915133	1.34271268805413
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Columns 7 through 12

1.29980021195055	1.30009703484244	1.34135837812926	1.34387040601005	1.29932896506899	1.26037877245806
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Columns 13 through 14

1.30102783831727	1.30260759474909
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>> capacityvalues = sum(capEst,1)

capacityvalues =

Columns 1 through 6

1.30121956404851	1.29971116402296	1.25901533673075	1.30141980274656	1.34197686915133	1.34271268805413
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Columns 7 through 12

1.29980021195055	1.30009703484244	1.34135837812926	1.34387040601005	1.29932896506899	1.26037877245806
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Columns 13 through 14

1.30102783831727	1.30260759474909
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