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tellado18k.m          Sat Jun 17 07:56:10 2017          1
clear all
format compact
M = 4;                %repetitions per bit
N = 256;              %max number of tones or subcarriers
Zl = 6;               %number of low freq zero tones
Zs = 4*M;             %number of Shively tones
ZH = 146;             %number of unused high freq tones
P = round(Zs/M)       %number of repeating bits
K = 3*10^7            %number of DMT symbols to simulate. 1e-6 is 3min, 1e-7 is 30min

PAR = zeros(1,K);
PARz = zeros(1,K); %Zero tones
PARs = zeros(1,K); %Shively
PARg = zeros(1,K);
tic
for k=1:K
    if mod(k,10^6)==0
        k
        toc
        tic
        fflush(stdout);
    end
    bits = sign(randn(1,P));
    repeat_bits = kron(bits,ones(1,M));
    X = .707*(sign(randn(1,N-Zl)) + j*sign(randn(1,N-Zl))); %random 4QAM symbols
    X(64-Zl) = 1; %model constant pilot
    Xz = X;
    Xz(end-Zs-ZH+1:end)=0;
    Xs = Xz;
    Xs(end-Zs-ZH+1:end-ZH)=repeat_bits;
    Y = [zeros(1,Zl), X, 0, fliplr(conj(X)), zeros(1,Zl-1)];
    Yz = [zeros(1,Zl), Xz, 0, fliplr(conj(Xz)), zeros(1,Zl-1)];
    Ys = [zeros(1,Zl), Xs, 0, fliplr(conj(Xs)), zeros(1,Zl-1)];
    y = ifft(Y);
    yz = ifft(Yz);
    ys = ifft(Ys);
    Ave = (y*y')/length(y);
    Peak = max(y.*y);
    Peakz = max(yz.*yz);
    Peaks = max(ys.*ys);
    PAR(k) = 10*log10(Peak); %PAR for 4QAM IFFT output
    PARz(k) = 10*log10(Peakz); %PAR for 4QAM IFFT output with zero tones
    PARs(k) = 10*log10(Peaks); %PAR for 4QAM IFFT output with Shively tones
    PARg(k) = 10*log10(max(randn(1,2*N).^2)); %PAR of a Gaussian symbol with 2*N points
end
PAR = real(PAR + 10*log10(2*N)); %normalize to correct for Matlab IFFT power loss of 2N
PARz = real(PARz + 10*log10(2*N));
PARs = real(PARs + 10*log10(2*N));
PARg = real(PARg + 10*log10((N-Zl)/N)); %normalize Guassian power to N-Zl tones out of N
Axis = 6:0.4:20;
Np = hist(PAR,Axis);
Ng = hist(PARg,Axis);
Nz = hist(PARz,Axis);
Ns = hist(PARs,Axis);

figure(2)
semilogy(Axis,1-cumsum(Np)/K,'o','LineWidth',2,'MarkerSize',9, ...
    Axis,1-cumsum(Ng)/K,'r-','LineWidth',2,'MarkerSize',10,Axis,1-cumsum(Nz)/K,'b-*', ...
    'MarkerSize',12,'LineWidth',2,Axis,1-cumsum(Ns)/K,'-+',' ...
    'LineWidth',2,'MarkerSize',10)
set(gca,'fontsize',18)
xlabel('PAR (dB)','fontsize',18)
ylabel('Clipping Probability per DMT symbol','fontsize',18)

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tellado18k.m          Sat Jun 17 07:56:10 2017          2
leg = legend('Scenario 1: 250 QAM4 Carriers','Scenario 2: Gaussian process',
            'Scenario 3: 182 QAM4 Carriers',
            'Scenario 4: 182 QAM4 Carriers & 52 Shively Carriers')
set(leg,'fontsize',18)
grid on,shg
axis([7 17 32/K 1])
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