7.References:

[1] Anas "Mohammad Atef" Ata Salhab **,** **"**Co-channel Interference in Spread Spectrum MIMO Wireless Communication Systems" Jorgen University Of Science and Technology ,January 2007.

[2] AYAZ KHAN AFRIDI ,"Macro and femto network aspects for realistic LTE usage scenarios" , Stockholm, Sweden 2011.

[3] Shweta Sagari**,** "Adaptive Geolocation Based Interference control for hierarchical cellular network with femtocells" ,New Brunswick, New Jersey October, 2011.

[4] Sabarina Ismail, Chee Kyun Ng, Nor Kamariah Noordin, Aduwati Sali and Borhanuddin Mohd Ali " Review of interference avoidance schemes in femtocell networks", Faculty of Engineering, University Putra Malaysia July ,7, 2011.

[5] Yangyang Li, "Cognitive Interference Management in 4G Autonomous Femtocells", University of Toronto,2010.

[6] Hyunduk Jung and Jaiyong Lee, " Interference-Aware Downlink Resource Management for OFDMA Femtocell Networks" Korea ,March 31, 2011.

[7] Kan Zheng Senior Member, Mischa Dohler ,Jianquan Wang,Yuyu Wang*y*,and Wenbo Wang*y*,"Energy Efficient Wireless In Home:The Need For Interference Controlled Femtocells",2010.

Abdul Basit, Syed, "Dimensioning of LTE Network Description of [8] Models and Tool, Coverage and Capacity Estimation of 3GPP Long .Term Evolution radio interface", February, 2009

[9] M. M. Rana" Clipping Based PAPR Reduction Method for LTE OFDMA Systems", Bangladesh, 2010.

[10] Bersant Deva ,"LTE vs. WiMAX-Next Generation Telecommunication Networks",2011.

[11] UTKU ÖZTÜRK " Coordinated Multipoint Transmission in Femtocell Systems".2010.

[12] G. Vivier (SEQ),"Femto 68 ased network enhancement by interference management and coordination of information for seamless connectivity", 20 June 2010.

[13] Muhammad Farhan Khan , "Femtocellular Aspects on UMTS Architecture Evolution", April 20, 2010.

[14] http://www.arubanetworks.com

Peter Thornycroft , "Running for Coverage: A Review of Femtocells",White paper Aruba Networks,2008.

[15] Dieter Eberle, " LTE vs. WiMAX 4th generation telecommunication networks", Berlin Institute of Technology, Germany,2010.

[16] Jie Zhang," Femtocells: Technologies and Deployment", University of Bedforshire,UK,2010.

[17] Igor Bilogrevic, Murtuza Jadliwala and Jean-Pierre Hubaux , "Security Issues in Next Generation Mobile Networks: LTE and Femtocells", Switzerland,2010 .

[18] Joseph Boccuzzi, Michael Ruggiero,"Femtocell: Design &Application ",2011.

[19] UTKU ÖZTÜRK , "Coordinated Multipoint Transmission in Femtocell Systems", May 2011.

[20] Yang-Yang Li1, Martin Macuha2, Elvino S. Sousa1, Takuro Sato2 and Masahiko Nanri3, "Cognitive Interference management in 3G femtocells", 2009.

[21] Rachana Reddy Agumamidi, " Concept and Challenges of Femtocells",30 April 2010.

Appendix

%variable declaration

```
%----------------------
clc
clear
clf,close all
simwl=1000;% the lengthy of the simulation widow which has a square shape [m]m=4; %  the numbers of femtocell in the macrocell.
user=300; %the total number of user in Macrocell.
cdf3=zeros(1,user);
m=4;     %4 femtocell
nchmn=100; %the total channel in macrocell.
pmacro=20;% watt power of macrocell transimter [w].
ch_femto1=0;
ch_femto2=0;
ch_femto3=0;
ch_femto4=0;
BW =(5*10^6); %MHz %bandwidth LTE
fequency =2*10^9;%Ghz carrier
r=40;%raduis femtocell
 pfemto =20*10^-3;%w;%power transmit max of femocell30dbmw
noise=3.98*10^-21;%-174;%dBmw;

%positioning the mobile
%----------------------
xpos=round(simwl*rand(1,user));
ypos=round(simwl*rand(1,user));
plot(xpos,ypos,'*black')
grid
hold on
xlabel('distance (meter)')
ylabel('distance (meter)')
%base station macro
%---------------------------------------
cx1=500;
```

```
cy1=500;
cxf1=40;
cyf1=40;
cxf2=140;
cyf2=40;
cxf3=440;
cyf3=440;
cxf4=610;
cyf4=440;

plot(cx1,cy1,'^b')
hold on
plot(cxf1,cyf1,'^b')
hold on
plot(cxf2,cyf2, '^')
hold on
plot (cxf3,cyf3,'^b')
hold on
plot(cxf4,cyf4,'^b')
hold on

%femto square1
%-----------------------------------------------------
line([0 80],[80 80])
hold on
line([80 80],[80 0])
hold on
%femto square2
%..................................................
line([100 100],[80 0])
hold on
line([100 180],[80 80 ])
hold on
line ([180 180],[80 0])
hold on
%femto square3
%--------------------------------------------------------
```

```
line([400 400],[400 480])
hold on
line([400 480],[400 400 ])
hold on
line ([400 480],[480 480])
hold on
line([480 480 ],[ 480 400 ])
hold on
%femto square4
%-----------------------------------------------------------------
line([570 570],[480 400])
hold on
line([570 650],[400 400 ])
hold on
line ([650 650],[ 480 400])
hold on

line([ 570 650 ],[ 480  480 ])
hold on

for i=1:user
   %femtocells
   %------------------------------
   if ((xpos(1,i)<=80)&&(ypos(1,i)<=80));
      plot(xpos(1,i),ypos(1,i),'*r');
      hold on
   end
   if ((xpos(1,i)<180)&&(xpos(1,i)>=100));
      if ((ypos(1,i)<=80)&&(ypos(1,i)>=0));
      plot(xpos(1,i),ypos(1,i),'*r')
      hold on
      %------------------------------
      end
   end
      if ((xpos(1,i)<=480)&&(xpos(1,i)>=400));
      if ((ypos(1,i)<=480)&&(ypos(1,i)>=400));
      plot(xpos(1,i),ypos(1,i),'*r')
```

```
hold on

end
end
%------------------------------------------------------
    if((xpos(1,i)<=650)&&(xpos(1,i)>=570));

if ((ypos(1,i)<=480)&&(ypos(1,i)>=400));
plot(xpos(1,i),ypos(1,i),'*r')
hold on

legend(' macrocell user','^ base station')

end
  end

end
%distance calculation
%--------------------------------------------

for k=1:user
  dxyposm(1,k)= sqrt(((xpos(1,k)-cx1)^2)+((ypos(1,k)-cy1)^2));

      dxyposf1(1,k)=sqrt(((xpos(1,k)-cxf1)^2)+((ypos(1,k)-cyf1)^2));

%static pathloss the equal channel gain
%----------------------------------------

ch_gainm(1,k) =((4*pi*2*10^9)^2/(3*10^8)^2)*(dxyposm(1,k))^2;

ch_gainf1(1,k) =((4*pi*2*10^9)^2/(3*10^8)^2)*(dxyposf1(1,k))^2;
          % second femto
%---------------------------------------------
    dxyposf2(1,k)=sqrt(((xpos(1,k)-cxf2)^2)+((ypos(1,k)-cyf2)^2));
                                        ch_gainf2(1,k)    =((4*pi*2*10^9)^2/
(3*10^8)^2)*(dxyposf2(1,k))^2;
       % third femto
```

```
%----------------------------------------------

dxyposf3(1,k)=sqrt(((xpos(1,k)-cxf3)^2)+((ypos(1,k)-
cyf3)^2));

ch_gainf3(1,k)   =((4*pi*2*10^9)^2/
(3*10^8)^2)*(dxyposf3(1,k))^2;

 % fourth  femto
%----------------------------------------------

  dxyposf4(1,k)=sqrt(((xpos(1,k)-cxf4)^2)+((ypos(1,k)-cyf4)^2));

   ch_gainf4(1,k) =((4*pi*2*10^9)^2/(3*10^8)^2)*(dxyposf4(1,k))^2;
        end

%channel gain
 %------------------------------------------------

   for k=1:user;

ch_ferencem(1,k)=pmacro*ch_gainm(1,k);

% channel gain femtocell
%------------------------------------------
  ch_ferencef1(1,k)=pfemto*ch_gainf1(1,k);
  ch_ferencef2(1,k)=pfemto*ch_gainf2(1,k);
  ch_ferencef3(1,k)=pfemto*ch_gainf3(1,k);
  ch_ferencef4(1,k)=pfemto*ch_gainf4(1,k);

%cognitive interference femtocell
%--------------------------------------------
sense1(1,k)=(ch_gainf1(1,k))^2/ch_ferencef1(1,k);

  sense2(1,k)=(ch_gainf2(1,k))^2/ch_ferencef2(1,k);

   sense3(1,k)=(ch_gainf3(1,k))^2/ch_ferencef3(1,k);
```

```
sense4(1,k)=(ch_gainf4(1,k))^2/ch_ferencef4(1,k);

maxsense1(1,k)=max(sense1(1,k));

maxsense2(1,k)=max(sense2(1,k));

maxsense3(1,k)=max(sense3(1,k));

maxsense4(1,k)=max(sense4(1,k));
   %sense channel
%-----------------------------------------------------
         SINRf1(1,k)=pfemto*maxsense1(1,k);
         SINRf2(1,k)=pfemto*maxsense2(1,k);
         SINRf3(1,k)=pfemto*maxsense3(1,k);
         SINRf4(1,k)=pfemto*maxsense4(1,k);

         %--------------------------------------------

          SINRff1(1,k)=.75*pfemto*maxsense1(1,k);
         SINRff2(1,k)=.75*pfemto*maxsense2(1,k);
         SINRff3(1,k)=.75*pfemto*maxsense3(1,k);
         SINRff4(1,k)=.75*pfemto*maxsense4(1,k);

         SINRff11(1,k)=.5*pfemto*maxsense1(1,k);
         SINRff12(1,k)=.5*pfemto*maxsense2(1,k);
         SINRff13(1,k)=.5*pfemto*maxsense3(1,k);
         SINRff14(1,k)=.5*pfemto*maxsense4(1,k);

         SINRff21(1,k)=.25*pfemto*maxsense1(1,k);
         SINRff22(1,k)=.25*pfemto*maxsense2(1,k);
         SINRff23(1,k)=.25*pfemto*maxsense3(1,k);
         SINRff24(1,k)=.25*pfemto*maxsense4(1,k);

    %SINR total for femtocells
    %------------------------------------------
```

```
SINRf(1,k)=(SINRf1(1,k)+SINRf2(1,k)+SINRf3(1,k)
+SINRf4(1,k))/4;SISINRff(1,k)=(SINRff1(1,k)+SINRff2(1,k)
+SINRff3(1,k)+SINRff4(1,k))/4;
SINRff1(1,k)=(SINRff11(1,k)+SINRff12(1,k)+SINRff13(1,k)
+SINRff14(1,k))/4;
SINRff2(1,k)=(SINRff21(1,k)+SINRff22(1,k)+SINRff23(1,k)
+SINRff24(1,k))/4

        sinrf(1,k)=10*log10(SINRf(1,k));

         sinrff(1,k)=10*log10(SINRff(1,k));
         sinrff1(1,k)=10*log10(SINRff1(1,k));

          sinrff2(1,k)=10*log10(SINRff2(1,k));

      %bit error
      % --------------------------------------

           x_dB(1,k)=(sinrf(1,k))/10;

           x_linear(1,k)=10.^(x_dB(1,k)/10);

            %macro of SINR
   %---------------------------------------------
SINRm(1,k)=(pmacro*(ch_gainm(1,k))^2)/(ch_ferencef1(1,k)
+ch_ferencef2(1,k)+ch_ferencef3(1,k)+ch_ferencef4(1,k)+
ch_ferencem(1,k)+noise);

            sinrm(1,k)=10*log10(SINRm(1,k));
            %BERmacro-----------------

            x1_dB(1,k)=sinrm(1,k)/10;

           x1_linear(1,k)=10.^(x1_dB(1,k)/10);

  % data rate macro and femto capacity of shanon@CDF
  %----------------------------------------------
```

```
cf(1,k)=BW*log2(1+SINRf(1,k));
 cff(1,k)=BW*log2(1+SINRff(1,k));
  cff1(1,k)=BW*log2(1+SINRff1(1,k));
  cff2(1,k)=BW*log2(1+SINRff2(1,k));
cm(1,k)=BW*log2(1+SINRm(1,k));
end
  fmax=max(sinrf);
mmax=max(sinrm);

%cdf macro femto
%------------------------------
for k=1:user;
data(1,k)=sinrm(1,k);
maxd=max(data);
    normalized_data = data/maxd;
      data1(1,k)=sinrf(1,k);
        dsum1 = max(data1);
normalized_data1 = data1/dsum1;
%.......................cdf femtocell powercontrol
dataf(1,k)=sinrff(1,k);
dsumf=max(dataf);
normalized_dataf=dataf/dsumf;
dataf1(1,k)=sinrff1(1,k);
dsumf1=max(dataf1);
normalized_dataf1=dataf1/dsumf1;
dataf2(1,k)=sinrff2(1,k);
dsumf2=max(dataf2);
normalized_dataf2=dataf2/dsumf2;
end

%cdf data rate
%---------------------------------
cdf2=zeros(1,user);
cdff=zeros(1,user);
cdff1=zeros(1,user);
cdff2=zeros(1,user);
```

```
for k=1:user
cdf(k) =sum (normalized_data(1,k));

cdf1(k) = sum(normalized_data1(1,k));
cdff(k)=sum(normalized_dataf(1,k));
cdff1(k)=sum(normalized_dataf1(1,k));
cdff2(k)=sum(normalized_dataf1(1,k));
end

BER=0.5*erfc(sqrt((x_linear)));
BER1=0.5*erfc(sqrt((x1_linear)));
%---------------------
for k=1:user
maxcm=max(cm);
maxcf=max(cf);
norm(1,k)=cm(1,k)/maxcm ;
norf(1,k)=cf(1,k)/maxcf;
cdf2(1,k)=norm(1,k)+cdf2(1,k);
cdf3(1,k)=norf(1,k)+cdf3(1,k);
end
% plot SINR macro and femto
%-------------------------------------

figure
plot(sinrm)
xlabel('NO of subscribers')
ylabel('SINR(dB)')
hold on
plot(sinrf,'r' )
grid on
legend('macrocell','femtocell')

%plot of data rate macro and femto
%-----------------------------------------------
figure
plot(cm)
grid on
```

```
            hold on

            plot(cf,'r')
            grid on
xlabel('No of subscribers ')

            ylabel('Data Rate [bps] ' )

            legend('macrocell','femtocell')

            % Plot bit error rate of femtocell with SINR
            % --------------------------------------------------------

            figure

    semilogy(smooth(BER),'*r')
            grid on

            hold on

  semilogy(smooth(BER1,'lowess'))
grid on
xlim([0 300])
ylim([10^-7 10])
            xlabel('No of subscriber')
            ylabel('BER')
            legend('femtocell','macrocell')

            hold on

            legend('femtocell','macrocell')
 %plot cdf SINRand data rate
  %--------------------------------
 figure
cdf(1)=0
sinrf(1)=0;
cdf1(1)=0;
```

```
%sinrff(1)=0;
cdff(1)=0;
sinrm(1)=0;
plot(sinrf,cdf1,'r')
hold on
plot(sinrm,cdf)
grid on
xlabel('SINR(dB)')
ylabel('CDF ')
legend('femtocell','macrocell')
figure
cm(1)=0;
cdf2(1)=0;
cf(1)=0;
cdf3(1)=0;

plot(cm,cdf2)
hold on
plot(cf,cdf3,'r')
hold off
grid on
legend('macrocell','femtocell')
xlabel('data rate (bps)')
ylabel('CDF')
    figure
   plot (sinrf,'black')
    hold on
    plot(sinrff,'r')
    hold on
     plot(sinrff1,'b')
     hold on
     plot(sinrff2,'y')
    hold on

  xlabel('NO of subscribers' )
  ylabel('SINR(db)')
  legend(' pmax=20mw','p=15mw','p=10mw','p=5mw')
```

```
   grid on
   figure
   sinrff(1)=0
   sinrff1(1)=0
   sinrff2(1)=0
   cdf1(1)=0;
cdff(1)=0;
cdff1(1)=0;
cdff2(1)=0;
   plot(sinrf,cdf1,'black')
   hold on

plot(sinrff,cdff,'r')
   hold on
  plot(sinrff1,cdff1,'b')
  hold on
  plot(sinrff2,cdff2,'y')
    hold on
    grid on
    xlabel('SINR(db)')
    ylabel('CDF')
    legend('pmax=20mw','p=15mw','p=10mw','p=5mw')
```