Lampiran 1. *Listing* program Matlab Perhitungan SNR dan Kapasitas Kanal

```
%menghitung path loss, daya terima, snr, dan kapasitas kanal
k=1.38*10^-23;  %konstanta boltzman
T=300;          %suhu (K)
B=9*10^6;       %bandwidth efektif sistem (Hz)
b=9;            %bandwidth (MHz)
f=703;          %frekuensi kerja (MHz)
NF=2.5;         %noise figure (dB)
N=50;           %jumlah RB
R0=1000;        %jarak dalam (m)
R1=4000;
R=(R0:200:R1);
pi=3.14;
cp=0.0651;      %cyclic prefix
c=3*10^8;       %kecepatan gelombang radio di udara (m/s)
hb=50;          %tinggi efektif antena eNodeB (m)
Pt=23;          %daya transmitter user (dBm)
Gt=0;           %gain transmitter user (dB)
Gr=18;          %gain receiver eNodeB
Lt=2;           %cable loss (dB)
Lr=0;           %body loss (dB)
Lp1=(-10)*log10((0.43./(4*pi*R)).^2);                              %path loss
LOS
Lp2=(40*(1-((4*10^-3)*hb))*log10(R*10^-3))-18*log10(hb)+21*log10(f)+80;
%path loss NLOS
Pr1=Pt+Gt+Gr-Lp1-(10*log10(N))-Lt-Lr;   %daya terima LOS
Pr2=Pt+Gt+Gr-Lp2-(10*log10(N))-Lt-Lr;   %daya terima NLOS
No=10*log10(k*T)+10*log10(B)+NF;        %daya noise
SNR1=Pr1-No;                            %kondisi LOS
SNR2=Pr2-No;                            %kondisi NLOS
snr1=10.^(SNR1/10);                     %kondisi LOS
snr2=10.^(SNR2/10);                     %kondisi NLOS
snrsistem1=(1-cp).*snr1;                %kondisi LOS
snrsistem2=(1-cp).*snr2;                %kondisi NLOS
SNRsistem1=10.*log10(snrsistem1);       %SNR kondisi LOS
SNRsistem2=10.*log10(snrsistem2);       %SNR kondisi NLOS
kapasitaskanal1=b*log2(1+snrsistem1);   %data rate LOS
kapasitaskanal2=b*log2(1+snrsistem2);   %data rate NLOS
%plot grafik SNR
figure (1)
plot(R,SNR1,'-^b',R,SNR2,'-^r');
axis([1000 4000 0 100])
hold on;
grid on;
title('Grafik SNR terhadap Jarak');
xlabel('Jarak eNodeB terhadap user (m)');
ylabel('SNR (dB)');
%plot grafik kapasitas kanal
figure(2)
plot (R,kapasitaskanal1,'-^b',R,kapasitaskanal2,'-^r');
axis([1000 4000 0 200])
hold on;
grid on;
title('Grafik Kapasitas Kanal terhadap Jarak');
xlabel('Jarak eNodeB terhadap user (m)');
ylabel('Kapasitas Kanal (Mbps)');
```

Lampiran 2. *Listing* program Matlab Matriks Kapasitas Kanal setiap Skenario

```
kapasitaskanal1=[191.926358685424     187.191741554917     183.188680540725
179.721072102989    176.662425437618    173.926373511560    171.451314235375
169.191762904543    167.113177933022    165.188709599923    163.397073208766
161.721110057839    160.146785438811    158.662473474193    157.258435572366
155.926432815931];
kapasitaskanal2=[132.448509890239     124.873501054301     118.469150471730
112.921726787590    108.028880008491    103.652459050260    99.6939375251295
96.0805775726168    92.7571509678256    89.6807370578025    86.8173197632614
84.1394850819174    81.6248178398416    79.2547573870090    77.0137630824036
74.8886940733905];

%matriks 4 user tiap TTI kondisi LOS
user_A1=[kapasitaskanal1(1)      kapasitaskanal1(8)      kapasitaskanal1(8)
kapasitaskanal1(16)]
%matriks 4 user tiap TTI kondisi NLOS
user_A2=[kapasitaskanal2(1)      kapasitaskanal2(8)      kapasitaskanal2(8)
kapasitaskanal2(16)]
%matriks 8 user tiap TTI kondisi LOS
user_B1=[kapasitaskanal1(1)      kapasitaskanal1(1)      kapasitaskanal1(6)
kapasitaskanal1(6)          kapasitaskanal1(6)          kapasitaskanal1(10)
kapasitaskanal1(10) kapasitaskanal1(16)];
%matriks 8 user tiap TTI kondisi NLOS
user_B2=[kapasitaskanal2(1)      kapasitaskanal2(1)      kapasitaskanal2(6)
kapasitaskanal2(6)          kapasitaskanal2(6)          kapasitaskanal2(10)
kapasitaskanal2(10) kapasitaskanal2(16)];
%matriks 12 user tiap TTI kondisi LOS
user_C1=[kapasitaskanal1(1)      kapasitaskanal1(1)      kapasitaskanal1(1)
kapasitaskanal1(5)          kapasitaskanal1(5)          kapasitaskanal1(5)
kapasitaskanal1(10)         kapasitaskanal1(10)         kapasitaskanal1(10)
kapasitaskanal1(16) kapasitaskanal1(16) kapasitaskanal1(16)];
%matriks 12 user tiap TTI kondisi NLOS
user_C2=[kapasitaskanal2(1)      kapasitaskanal2(1)      kapasitaskanal2(1)
kapasitaskanal2(5)          kapasitaskanal2(5)          kapasitaskanal2(5)
kapasitaskanal2(10)         kapasitaskanal2(10)         kapasitaskanal2(10)
kapasitaskanal2(16) kapasitaskanal2(16) kapasitaskanal2(16)];
%matriks 16 user tiap TTI kondisi LOS
user_D1=[kapasitaskanal1(1)      kapasitaskanal1(1)      kapasitaskanal1(1)
kapasitaskanal1(1)          kapasitaskanal1(4)          kapasitaskanal1(4)
kapasitaskanal1(10)         kapasitaskanal1(10)         kapasitaskanal1(10)
kapasitaskanal1(10)         kapasitaskanal1(12)         kapasitaskanal1(12)
kapasitaskanal1(16)         kapasitaskanal1(16)         kapasitaskanal1(16)
kapasitaskanal1(16)];
%matriks 16 user tiap TTI kondisi NLOS
user_D2=[kapasitaskanal2(1)      kapasitaskanal2(1)      kapasitaskanal2(1)
kapasitaskanal2(1)          kapasitaskanal2(4)          kapasitaskanal2(4)
kapasitaskanal2(10)         kapasitaskanal2(10)         kapasitaskanal2(10)
kapasitaskanal2(10)         kapasitaskanal2(12)         kapasitaskanal2(12)
kapasitaskanal2(16)         kapasitaskanal2(16)         kapasitaskanal2(16)
kapasitaskanal2(16)];

%plot kondisi kanal tiap skenario
figure (1)
bar(1:4,[user_A1' user_A2'], 1);
axis([0 5 0 200])
title('Grafik Kapasitas Kanal Skenario 4 User');
xlabel('User ke-i');
ylabel('Kapasitas Kanal (Mbps)');
figure (2)
bar(1:8,[user_B1' user_B2'], 1);
axis([0 9 0 200])
title('Grafik Kapasitas Kanal Skenario 8 User');
```

```
xlabel('User ke-i');
ylabel('Kapasitas Kanal (Mbps)');

figure (3)
bar(1:12,[user_C1' user_C2'], 1);
axis([0 13 0 200])
title('Grafik Kapasitas Kanal Skenario 12 User');
xlabel('User ke-i');
ylabel('Kapasitas Kanal (Mbps)');

figure (4)
bar(1:16,[user_D1' user_D2'], 1);
axis([0 17 0 200])
title('Grafik Kapasitas Kanal Skenario 16 User');
xlabel('User ke-i');
ylabel('Kapasitas Kanal (Mbps)');
```

Lampiran 3. *Listing* program Matlab Penjadwalan / Alokasi *Resource Block*

```
clc;
close all;

%%RB, TTI, dan ukuran matriks
m=100;            %jumlah TTI
n=50;             %jumlah RB
i=[4 8 12 16];    %variasi jumlah user
A=zeros(m,n);     %membentuk matriks (TTI x resource block)

%%membentuk  skenario untuk i user
user1=[191.926358685424 187.191741554917 183.188680540725 179.721072102989
176.662425437618    173.926373511560    171.451314235375    169.191762904543
167.113177933022    165.188709599923    163.397073208766    161.721110057839
160.146785438811 158.662473474193 157.258435572366 155.926432815931];

user2=[132.448509890239 124.873501054301 118.469150471730 112.921726787590
108.028880008491    103.652459050260    99.6939375251295    96.0805775726168
92.7571509678256    89.6807370578025    86.8173197632614    84.1394850819174
81.6248178398416 79.2547573870090 77.0137630824036 74.8886940733905];

%matriks 4 user tiap TTI kondisi LOS
user_A1=[user1(1) user1(8) user1(8) user1(16)];
%matriks 4 user tiap TTI kondisi NLOS
user_A2=[user2(1) user2(8) user2(8) user2(16)];
%matriks 8 user tiap TTI kondisi LOS
user_B1=[user1(1) user1(1) user1(6) user1(6) user1(6) user1(10) user1(10)
user1(16)];
%matriks 8 user tiap TTI kondisi NLOS
user_B2=[user2(1) user2(1) user2(6) user2(6) user2(6) user2(10) user2(10)
user2(16)];
%matriks 12 user tiap TTI kondisi LOS
user_C1=[user1(1) user1(1) user1(1) user1(5) user1(5) user1(5) user1(10)
user1(10) user1(10) user1(16) user1(16) user1(16)];
%matriks 12 user tiap TTI kondisi NLOS
user_C2=[user2(1) user2(1) user2(1) user2(5) user2(5) user2(5) user2(10)
user2(10) user2(10) user2(16) user2(16) user2(16)];
%matriks 16 user tiap TTI kondisi LOS
user_D1=[user1(1) user1(1) user1(1) user1(1) user1(4) user1(4) user1(10)
user1(10)  user1(10)  user1(10)  user1(12)  user1(12)  user1(16)  user1(16)
user1(16) user1(16)];
%matriks 16 user tiap TTI kondisi NLOS
user_D2=[user2(1) user2(1) user2(1) user2(1) user2(4) user2(4) user2(10)
user2(10)  user2(10)  user2(10)  user2(12)  user2(12)  user2(16)  user2(16)
user2(16) user2(16)];

kA1=sum(user_A1);       %alokasi untuk 4 user kondisi LOS
PA1=(n/kA1).*user_A1;
DA1=round(PA1);
kA2=sum(user_A2);       %alokasi untuk 4 user kondisi NLOS
PA2=(n/kA2).*user_A2;
DA2=round(PA2);
kB1=sum(user_B1);       %alokasi untuk 8 user kondisi LOS
PB1=(n/kB1).*user_B1;
DB1=round(PB1);
kB2=sum(user_B2);       %alokasi untuk 8 user kondisi NLOS
PB2=(n/kB2).*user_B2;
DB2=round(PB2);
kC1=sum(user_C1);       %alokasi untuk 12 user kondisi LOS
PC1=(n/kC1).*user_C1;
```

```
DC1=round(PC1);
kC2=sum(user_C2);       %alokasi untuk 12 user kondisi NLOS
PC2=(n/kC2).*user_C2;
DC2=round(PC2);
kD1=sum(user_D1);       %alokasi untuk 16 user kondisi LOS
PD1=(n/kD1).*user_D1;
DD1=round(PD1);
kD2=sum(user_D2);       %alokasi untuk 16 user kondisi NLOS
PD2=(n/kD2).*user_D2;
DD2=round(PD2);
```

Lampiran 4. *Listing* program Matlab Perhitungan BER

```
%menghitung path loss, daya terima, snr, dan BER
k=1.38*10^-23;  %konstanta boltzman
T=300;          %suhu (K)
B=9*10^6;       %bandwidth sistem (Hz)
b=9;            %bandwidth (MHz)
f=703;          %frekuensi kerja (MHz)
N=50;           %RB
NF=2.5;         %noise figure (dB),
R0=1000;        %jarak dalam (m)
R1=4000;
R=(R0:200:R1);
pi=3.14;
cp=0.0651;      %cyclic prefix
c=3*10^8;       %kecepatan gelombang radio di udara (m/s)
hb=50;          %tinggi efektif antena eNodeB (m)
Pt=23;          %daya transmitter user (dBm)
Gt=0;           %gain transmitter user (dB)
Gr=18;          %gain receiver eNodeB
Lt=2;           %cable loss (dB)
Lr=0;           %body loss (dB)
Lp1=(-10)*log10((0.43./(4*pi*R)).^2);                        %path loss LOS
Lp2=(40*(1-((4*10^-3)*hb))*log10(R*10^-3))-18*log10(hb)+21*log10(f)+80;
%path loss NLOS
Pr1=Pt+Gt+Gr-Lp1-(10*log10(N))-Lt-Lr;     %daya terima LOS
Pr2=Pt+Gt+Gr-Lp2-(10*log10(N))-Lt-Lr;     %daya terima NLOS
No=10*log10(k*T)+10*log10(B)+NF;          %daya noise
SNR1=Pr1-No;                              %kondisi LOS
SNR2=Pr2-No;                              %kondisi NLOS
snr1=10.^(SNR1/10);                       %kondisi LOS
snr2=10.^(SNR2/10);                       %kondisi NLOS
snrsistem1=(1-cp).*snr1;                  %kondisi LOS
snrsistem2=(1-cp).*snr2;                  %kondisi NLOS
SNRsistem1=10.*log10(snrsistem1);         %kondisi LOS
SNRsistem2=10.*log10(snrsistem2);         %kondisi NLOS

%bit rate
Rate1=B*log2(4);   %bit rate modulasi QPSK
Rate2=B*log2(16);  %bit rate modulasi 16QAM
 if SNR1>=31.31
     rate=Rate2;
 else
     rate=Rate1;
 end

 if SNR2>=31.31
     rate=Rate2;
 else
     rate=Rate1;
 end

%Eb/No
EbNoqpsk1=SNRsistem1+10*log10(B/rate);    %LOS
EbNoqpsk2=SNRsistem2+10*log10(B/rate);    %NLOS
EbNo16qam1=SNRsistem1+10*log10(B/rate);   %LOS
EbNo16qam2=SNRsistem2+10*log10(B/rate);   %NLOS

%probabilitas bit salah qpsk
a_qpsk1=exp(-(EbNoqpsk1));
```

```
b_qpsk1=sqrt(4*pi*EbNoqpsk1);
pbe_qpsk1=a_qpsk1./b_qpsk1;
a_qpsk2=exp(-(EbNoqpsk2));
b_qpsk2=sqrt(4*pi*EbNoqpsk2);
pbe_qpsk2=a_qpsk2./b_qpsk2;

%probabilitas bit salah 16qam
m=4;
mod=16;
x_16qam1=sqrt(6/(mod-1)*EbNo16qam1);
x_16qam2=sqrt(6/(mod-1)*EbNo16qam2);
a_16qam1=exp(-((x_16qam1).^2));
a_16qam2=exp(-((x_16qam2).^2));
b_16qam1=sqrt(pi*x_16qam1);
b_16qam2=sqrt(pi*x_16qam2);
erfc_16qam1=a_16qam1./b_16qam1;
erfc_16qam2=a_16qam2./b_16qam2;
pbe_16qam1=(sqrt(mod)-1)/sqrt((mod)*m)*erfc_16qam1;
pbe_16qam2=(sqrt(mod)-1)/sqrt((mod)*m)*erfc_16qam2;

%menghitung BER rata-rata sistem
i=[4 8 12 16];
berqpsk1=[2.70161545771673e-28   1.32504393245271e-27   5.08381357603620e-27
1.62961296018400e-26        4.55357488580486e-26        1.14178256656454e-25
2.62275320154539e-25        5.60409463750039e-25        1.12684274052523e-24
2.15152070913915e-24        3.92875937012764e-24        6.90072677214350e-24
1.17141325138267e-23        1.92928570233619e-23        3.09295880079648e-23
4.83998835676036e-23];
berqpsk2=[1.30092818024435e-19   1.66549924859111e-18   1.43914983630716e-17
9.32592388138950e-17        4.85084561412587e-16        2.12147432590731e-15
8.06361857990731e-15        2.72967254505794e-14        8.38383088960838e-14
2.37024856372623e-13        6.23927338155323e-13        1.54336712719121e-12
3.61473793528906e-12        8.06625074844567e-12        1.72396486964724e-11
3.54463312552935e-11];
ber16qam1=[7.54957738348995e-12  1.43226384578474e-11  2.46161268251088e-11
3.93557145159291e-11        5.95392007755828e-11        8.62321940696080e-11
1.20564541537351e-10        1.63727311558541e-10        2.16970199437766e-10
2.81599265450626e-10        3.58974939675809e-10        4.50510244874971e-10
5.57669200329175e-10        6.81965377832007e-10        8.24960587086037e-10
9.88263672253456e-10];
ber16qam2=[2.39516046376394e-08  6.71330197158672e-08  1.60620625843078e-07
3.42250820595167e-07        6.67493563094161e-07        1.21401450512698e-06
2.08672115313876e-06        3.42329737338384e-06        5.40023347224117e-06
8.23936176267071e-06        1.22149100994505e-05        1.76610884253758e-05
2.49802259921426e-05        3.46514796659779e-05        4.72401366567941e-05
6.34075381771044e-05];

%%alokasi qpsk ke dalam matriks
%matriks 4 user tiap TTI kondisi LOS
userqpsk_A1=[berqpsk1(1) berqpsk1(8) berqpsk1(8) berqpsk1(16)];
%matriks 4 user tiap TTI kondisi NLOS
userqpsk_A2=[berqpsk2(1) berqpsk2(8) berqpsk2(8) berqpsk2(16)];
%matriks 8 user tiap TTI kondisi LOS
userqpsk_B1=[berqpsk1(1)  berqpsk1(1)  berqpsk1(6)  berqpsk1(6)  berqpsk1(6)
berqpsk1(10) berqpsk1(10) berqpsk1(16)];
%matriks 8 user tiap TTI kondisi NLOS
userqpsk_B2=[berqpsk2(1)  berqpsk2(1)  berqpsk2(6)  berqpsk2(6)  berqpsk2(6)
berqpsk2(10) berqpsk2(10) berqpsk2(16)];
%matriks 12 user tiap TTI kondisi LOS
```

```
userqpsk_C1=[berqpsk1(1)  berqpsk1(1)  berqpsk1(1)  berqpsk1(5)  berqpsk1(5)
berqpsk1(5)    berqpsk1(10)    berqpsk1(10)    berqpsk1(10)    berqpsk1(16)
berqpsk1(16) berqpsk1(16)];
%matriks 12 user tiap TTI kondisi NLOS
userqpsk_C2=[berqpsk2(1)  berqpsk2(1)  berqpsk2(1)  berqpsk2(5)  berqpsk2(5)
berqpsk2(5)    berqpsk2(10)    berqpsk2(10)    berqpsk2(10)    berqpsk2(16)
berqpsk2(16) berqpsk2(16)];
%matriks 16 user tiap TTI kondisi LOS
userqpsk_D1=[berqpsk1(1)  berqpsk1(1)  berqpsk1(1)  berqpsk1(1)  berqpsk1(4)
berqpsk1(4)    berqpsk1(10)    berqpsk1(10)    berqpsk1(10)    berqpsk1(10)
berqpsk1(12)    berqpsk1(12)    berqpsk1(16)    berqpsk1(16)    berqpsk1(16)
berqpsk1(16)];
%matriks 16 user tiap TTI kondisi NLOS
userqpsk_D2=[berqpsk2(1)  berqpsk2(1)  berqpsk2(1)  berqpsk2(1)  berqpsk2(4)
berqpsk2(4)    berqpsk2(10)    berqpsk2(10)    berqpsk2(10)    berqpsk2(10)
berqpsk2(12)    berqpsk2(12)    berqpsk2(16)    berqpsk2(16)    berqpsk2(16)
berqpsk2(16)];

%%alokasi 16qam ke dalam matriks
%matriks 4 user tiap TTI kondisi LOS
user_A1=[ber16qam1(1) ber16qam1(8) ber16qam1(8) ber16qam1(16)];
%matriks 4 user tiap TTI kondisi NLOS
user_A2=[ber16qam2(1) ber16qam2(8) ber16qam2(8) ber16qam2(16)];
%matriks 8 user tiap TTI kondisi LOS
user_B1=[ber16qam1(1)  ber16qam1(1)  ber16qam1(6)  ber16qam1(6)  ber16qam1(6)
ber16qam1(10) ber16qam1(10) ber16qam1(16)];
%matriks 8 user tiap TTI kondisi NLOS
user_B2=[ber16qam2(1)  ber16qam2(1)  ber16qam2(6)  ber16qam2(6)  ber16qam2(6)
ber16qam2(10) ber16qam2(10) ber16qam2(16)];
%matriks 12 user tiap TTI kondisi LOS
user_C1=[ber16qam1(1)  ber16qam1(1)  ber16qam1(1)  ber16qam1(5)  ber16qam1(5)
ber16qam1(5)   ber16qam1(10)   ber16qam1(10)   ber16qam1(10)   ber16qam1(16)
ber16qam1(16) ber16qam1(16)];
%matriks 12 user tiap TTI kondisi NLOS
user_C2=[ber16qam2(1)  ber16qam2(1)  ber16qam2(1)  ber16qam2(5)  ber16qam2(5)
ber16qam2(5)   ber16qam2(10)   ber16qam2(10)   ber16qam2(10)   ber16qam2(16)
ber16qam2(16) ber16qam2(16)];
%matriks 16 user tiap TTI kondisi LOS
user_D1=[ber16qam1(1)  ber16qam1(1)  ber16qam1(1)  ber16qam1(1)  ber16qam1(4)
ber16qam1(4)   ber16qam1(10)   ber16qam1(10)   ber16qam1(10)   ber16qam1(10)
ber16qam1(12)   ber16qam1(12)   ber16qam1(16)   ber16qam1(16)   ber16qam1(16)
ber16qam1(16)];
%matriks 16 user tiap TTI kondisi NLOS
user_D2=[ber16qam2(1)  ber16qam2(1)  ber16qam2(1)  ber16qam2(1)  ber16qam2(4)
ber16qam2(4)   ber16qam2(10)   ber16qam2(10)   ber16qam2(10)   ber16qam2(10)
ber16qam2(12)   ber16qam2(12)   ber16qam2(16)   ber16qam2(16)   ber16qam2(16)
ber16qam2(16)];

%%ukuran rb tiap user tiap skenario
DA1=[14 12 12 11];
DA2=[17 12 12 9];
DB1=[7 7 6 6 6 6 6 6];
DB2=[8 8 6 6 6 5 5 5];
DC1=[5 5 5 4 4 4 4 4 4 4 4 4];
DC2=[5 5 5 4 4 4 4 4 4 3 3 3];
DD1=[4 4 4 4 3 3 3 3 3 3 3 3 3 3 3 3];
DD2=[4 4 4 4 4 4 3 3 3 3 3 3 2 2 2 2];

%% BER user dikalikan RB
yqpskA1=userqpsk_A1.*DA1;     %QPSK
yqpskA2=userqpsk_A2.*DA2;
```

```
yqpskB1=userqpsk_B1.*DB1;
yqpskB2=userqpsk_B2.*DB2;
yqpskC1=userqpsk_C1.*DC1;
yqpskC2=userqpsk_C2.*DC2;
yqpskD1=userqpsk_D1.*DD1;
yqpskD2=userqpsk_D2.*DD2;
yA1=user_A1.*DA1;              %16QAM
yA2=user_A2.*DA2;
yB1=user_B1.*DB1;
yB2=user_B2.*DB2;
yC1=user_C1.*DC1;
yC2=user_C2.*DC2;
yD1=user_D1.*DD1;
yD2=user_D2.*DD2;

%%BER sistem
bersistemqpsk1=[(sum(yqpskA1)/50)     (sum(yqpskB1)/50)     (sum(yqpskC1)/50)
(sum(yqpskD1)/50)];
bersistemqpsk2=[(sum(yqpskA2)/50)     (sum(yqpskB2)/50)     (sum(yqpskC2)/50)
(sum(yqpskD2)/50)];
bersistem16qam1=[(sum(yA1)/50) (sum(yB1)/50) (sum(yC1)/50) (sum(yD1)/50)];
bersistem16qam2=[(sum(yA2)/50) (sum(yB2)/50) (sum(yC2)/50) (sum(yD2)/50)];
```

Lampiran 5. *Listing* program Matlab Perhitungan *Throughput* dan *Fairness*

```
clc;
close all;

k1=4;k2=8;k3=12;k4=16;

user1=[191.926358685424 187.191741554917 183.188680540725 179.721072102989
176.662425437618    173.926373511560    171.451314235375    169.191762904543
167.113177933022    165.188709599923    163.397073208766    161.721110057839
160.146785438811 158.662473474193 157.258435572366 155.926432815931];
user2=[132.448509890239 124.873501054301 118.469150471730 112.921726787590
108.028880008491    103.652459050260    99.6939375251295    96.0805775726168
92.7571509678256    89.6807370578025    86.8173197632614    84.1394850819174
81.6248178398416 79.2547573870090 77.0137630824036 74.8886940733905];

%matriks 4 user tiap TTI kondisi LOS
user_A1=[user1(1) user1(8) user1(8) user1(16)];
%matriks 4 user tiap TTI kondisi NLOS
user_A2=[user2(1) user2(8) user2(8) user2(16)];
%matriks 8 user tiap TTI kondisi LOS
user_B1=[user1(1) user1(1) user1(6) user1(6) user1(6) user1(10) user1(10)
user1(16)];
%matriks 8 user tiap TTI kondisi NLOS
user_B2=[user2(1) user2(1) user2(6) user2(6) user2(6) user2(10) user2(10)
user2(16)];
%matriks 12 user tiap TTI kondisi LOS
user_C1=[user1(1) user1(1) user1(1) user1(5) user1(5) user1(5) user1(10)
user1(10) user1(10) user1(16) user1(16) user1(16)];
%matriks 12 user tiap TTI kondisi NLOS
user_C2=[user2(1) user2(1) user2(1) user2(5) user2(5) user2(5) user2(10)
user2(10) user2(10) user2(16) user2(16) user2(16)];
%matriks 16 user tiap TTI kondisi LOS
user_D1=[user1(1) user1(1) user1(1) user1(1) user1(4) user1(4) user1(10)
user1(10) user1(10) user1(10) user1(12) user1(12) user1(16) user1(16)
user1(16) user1(16)];
%matriks 16 user tiap TTI kondisi NLOS
user_D2=[user2(1) user2(1) user2(1) user2(1) user2(4) user2(4) user2(10)
user2(10) user2(10) user2(10) user2(12) user2(12) user2(16) user2(16)
user2(16) user2(16)];

%% 4 user
%throughput 4 user LOS
r_A1=mean(user_A1); %data rate rata2
N_A1(1:k1)=(1/r_A1).*user_A1(1:k1);
% fairness 4 user LOS
p_A1=round(user_A1);
D_A1(1:k1)=(p_A1(1:k1).^2);
G_A1=sum(D_A1);
H_A1=i(1)*G_A1;
fairness_A1=((sum(user_A1))^2)/H_A1;
%throughput 4 user NLOS
r_A2=mean(user_A2);
N_A2(1:k1)=(1/r_A2).*user_A2(1:k1);
% fairness 4 user NLOS
p_A2=round(user_A2);
D_A2(1:k1)=(p_A2(1:k1).^2);
G_A2=sum(D_A2);
H_A2=i(1)*G_A2;
fairness_A2=((sum(user_A2))^2)/H_A2;
```

```
%% 8 user
%throughput 8 user LOS
r_B1=mean(user_B1);
N_B1(1:k2)=(1/r_B1).*user_B1(1:k2);
% fairness 8 user LOS
p_B1=round(user_B1);
D_B1(1:k2)=(p_B1(1:k2).^2);
G_B1=sum(D_B1);
H_B1=i(2)*G_B1;
fairness_B1=((sum(user_B1))^2)/H_B1;
% throughput 8 user NLOS
r_B2=mean(user_B2);
N_B2(1:k2)=(1/r_B2).*user_B2(1:k2);
% fairness 8 user NLOS
p_B2=round(user_B2);
D_B2(1:k2)=(p_B2(1:k2).^2);
G_B2=sum(D_B2);
H_B2=i(2)*G_B2;
fairness_B2=((sum(user_B2))^2)/H_B2;

%% 12 user
% throughput 12 user LOS
r_C1=mean(user_C1);
N_C1(1:k3)=(1/r_C1).*user_C1(1:k3);
% fairness 12 user LOS
p_C1=round(user_C1);
D_C1(1:k3)=(p_C1(1:k3).^2);
G_C1=sum(D_C1);
H_C1=i(3)*G_C1;
fairness_C1=((sum(user_C1))^2)/H_C1;
% throughput 12 user NLOS
r_C2=mean(user_C2);
N_C2(1:k3)=(1/r_C2).*user_C2(1:k3);
% fairness 12 user NLOS
p_C2=round(user_C2);
D_C2(1:k3)=(p_C2(1:k3).^2);
G_C2=sum(D_C2);
H_C2=i(3)*G_C2;
fairness_C2=((sum(user_C2))^2)/H_C2;

%% 16 user
%throughput 16 user LOS
r_D1=mean(user_D1);
N_D1(1:k4)=(1/r_D1).*user_D1(1:k4);
% fairness 16 user LOS
p_D1=round(user_D1);
D_D1(1:k4)=(p_D1(1:k4).^2);
G_D1=sum(D_D1);
H_D1=i(4)*G_D1;
fairness_D1=((sum(user_D1))^2)/H_D1;
% throughput 16 user NLOS
r_D2=mean(user_D2);
N_D2(1:k4)=(1/r_D2).*user_D2(1:k4);
% fairness 16 user NLOS
p_D2=round(user_D2);
D_D2(1:k4)=(p_D2(1:k4).^2);
G_D2=sum(D_D2);
H_D2=i(4)*G_D2;
fairness_D2=((sum(user_D2))^2)/H_D2;

%%throughput sistem
```

```
ThroughputA=[(N_A1)
    (N_A2)];
ThroughputB=[(N_B1)
    (N_B2)];
ThroughputC=[(N_C1)
    (N_C2)];
ThroughputD=[(N_D1)
    (N_D2)];

%%throughput sistem
ThmaxLOS=[max(N_A1) max(N_B1) max(N_C1) max(N_D1)];
ThmaxNLOS=[max(N_A2) max(N_B2) max(N_C2) max(N_D2)];

%%fairness sistem
fairnessLOS=[fairness_A1 fairness_B1 fairness_C1 fairness_D1];
fairnessNLOS=[fairness_A2 fairness_B2 fairness_C2 fairness_D2];

%%plot throughput
figure (1)
bar(i,[ThmaxLOS' ThmaxNLOS'], 1);
axis([0 20 0 1.5])
title('Grafik Throughput terhadap Jumlah User');
xlabel('Jumlah user');
ylabel('Throughput');

%%plot fairness
figure (2)
bar(i,[fairnessLOS' fairnessNLOS'], 1);
axis([0 20 0 1.2])
title('Grafik Fairness terhadap Jumlah User');
xlabel('Jumlah user');
ylabel('Fairness');
```

Lampiran 6. Hasil Perhitungan Parameter dengan Skenario Lain

Tabel 1. SNR tiap *User*

Jumlah *user*	*User* ke-i	Jarak terhadap eNodeB (m)	SNR (dB)	
			LOS	NLOS
7	1	200	78,46684	66,96030
	2	1000	64,48744	44,59326
	3	2000	58,46684	34,96030
	4	3000	54,94502	29,32538
	5	4000	52,44624	25,32734
	6	5000	50,50804	22,22622
	7	6000	48,92442	19,69242

Tabel 2. Kapasitas Kanal dan Alokasi *Resource Block* tiap *User*

User ke-i	Jarak *user* dengan eNodeB (m)	Kapasitas Kanal (Mbps)		Jumlah *Resource Block*	
		LOS	NLOS	LOS	NLOS
1	200	233.7211	199.3196	10	14
2	1000	191.9264	132.4485	8	9
3	2000	173.9264	103.6525	7	7
4	3000	163.3971	86.8173	7	6
5	4000	155.9264	74.8887	6	5
6	5000	150.1318	65.6594	6	5
7	6000	145.3972	58.1493	6	4

Tabel 3. BER Sistem

Jumlah *user*	BER Sistem			
	QPSK		16QAM	
	LOS ($*10^{-22}$)	NLOS ($*10^{-11}$)	LOS ($*10^{-9}$)	NLOS ($*10^{-4}$)
7	0.90059	0.45863	0.27651	0.23936

Tabel 4. *Throughput* tiap *User*

User ke-i	Jarak *user* dengan eNodeB (m)	*Throughput*	
		LOS	NLOS
1	200	1.3472	1.9353
2	1000	1.1063	1.2860
3	2000	1.0025	1.0064
4	3000	0.9418	0.8430
5	4000	0.8988	0.7271
6	5000	0.8654	0.6375
7	6000	0.8381	0.5646

Ket: = maksimum

Tabel 5. *Fairness*

Jumlah *user*	*Fairness*	
	LOS	NLOS
7	0,9739	0,8366