Experiment No: 04

Name of the Experiment: Modelling A Wideband or Frequency-Selective Fading Channel in a Wireless Communication System by Using Rayleigh Multipath Fading Channel Objects and The Channel Visualization Tool.

Objective:

To model a Wideband or Frequency-Selective Fading channel in a wireless communication system by using Rayleigh and Ricean multipath fading channel objects and the channel visualization tool.

Introduction:

Rayleigh fading is caused by multipath reception. The mobile antenna receives a large number, say N, reflected and scattered waves. Because of wave cancellation effects, the instantaneous received power seen by a moving antenna becomes a random variable, dependent on the location of the antenna. Rayleigh fading is caused by multipath reception. The mobile antenna receives a large number, say N, reflected and scattered waves. Because of wave cancellation effects, the instantaneous received power seen by a moving antenna becomes a random variable, dependent on the location of the antenna.
Selective fading or frequency selective fading is a radio propagation anomaly caused by partial cancellation of a radio signal by itself — the signal arrives at the receiver by two different paths, and at least one of the paths is changing lengthening or shortening). This typically happens in the early evening or early morning as the various layers in the ionosphere move, separate, and combine. The two paths can both be skywave or one be groundwave. Selective fading manifests as a slow, cyclic disturbance; the cancellation effect, or "null", is deepest at one particular frequency, which changes constantly, sweeping through the received audio.

Code:

```
clc;
clear all;

sampleTime=1/500000;
maxDopplerShift = 200;

delayVector = 1.0e-004*[0 0.0400 0.0800 0.1200];
gainVector = [0 -3 -6 -9];
specDopplerShift = 100;
KFactor = 10;
```

```
rayChanObj = rayleighchan(sampleTime, maxDopplerShift,
delayVector, gainVector );
rayChanObj.Storehistory = 1;
ricChanObj= ricianchan(sampleTime, maxDopplerShift,
KFactor, delayVector, gainVector, specDopplerShift);
ricChanObj.StoreHistory = 1

hMod =
comm.QPSKModulator('BitInput',true,'PhaseOffset',pi/4);

bitsPerFrame = 1000;

mag = randi([0 1],bitsPerFrame, 1);

modSignal = step(hMod, mag);
filter(rayChanObj, modSignal);
filter(ricChanObj, modSignal);

channel_vis(rayChanObj, 'Visualization', 'ir');
channel_vis(rayChanObj, 'Animation','medium');
channel_vis(rayChanObj, 'SampleIndex',1);

delayVector = (0:3)*(4e-6);
gainVector = (0:3)*(-3);


maxDopplerShift = 5
channel_vis(ricChanObj,'Close');
h = scatterplot(0);
title('Received Signal after Rayleigh Fading');
xlabel('In-Phase Amplitude');
ylabel('Quadrature Amplitude');
xlim([-2 2]);
ylim([-2 2]);
grid on

rayChanObj = rayleighchan(sampleTime, maxDopplerShift,
delayVector,gainVector );
rayChanObj.Storehistory = 1;
rayChanObj.ResetBeforeFiltering = 0;
numFrame = 100;
bitsPerFrame = 200;
```

```
for n=1:numFrame
    mag = randi([0 1],bitsPerFrame, 1);
    modSignal = step(hMod, mag);
    rayFiltSig = filter(rayChanObj, modSignal);

set(get(get(h,'Children'),'Children'),'XData',real(rayFiltS
ig(6:end)),'YData',imag(rayFiltSig(6:end)));
    pause(0.05);
    drawnow;
end

close(h);
reset(rayChanObj);

rayChanObj.InputSamplePeriod = 1/500000;
h=scatterplot(0);
title('Received Sifnal after Rayleigh Fading');
xlabel('In-Phase Amplitude');
ylabel('Quadrature Amplitude')
xlim([-2 2]);
ylim([-2 2]);
grid on;

close(h);
reset(rayChanObj);
bitsPerFrame = 1000;
rayChanObj,MaxDopplerShift = 200;
numFrames = 13;
for n=1:numFrames
     mag = randi([0 1],bitsPerFrame, 1);
     modSignal = step(hMod, mag);
     filter(rayChanObj, modSignal);
end
channel_vis(rayChanObj,'Visualization','irw');
channel_vis(rayChanObj,'Animation', 'interframe');
channel_vis(rayChanObj,'Visualization','ir');
channel_vis(rayChanObj,'Animation','medium');
channel_vis(rayChanObj,'SampleIndex',1);
displayEndOfDemoMessage(mfilename)
```

Figure:

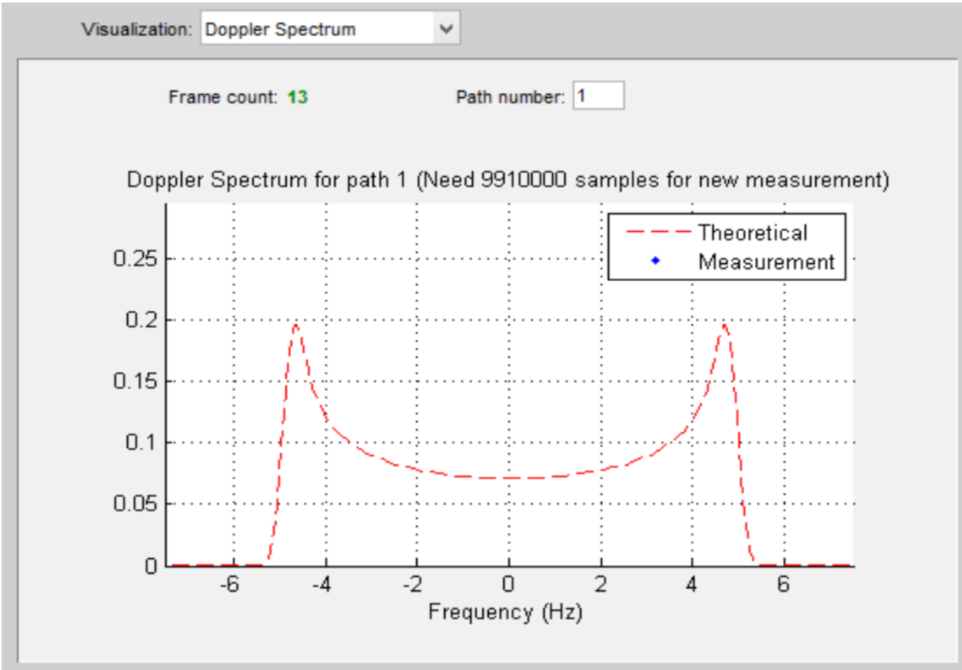

Fig 1(a): Doppler Spectrum QPSK Modulation

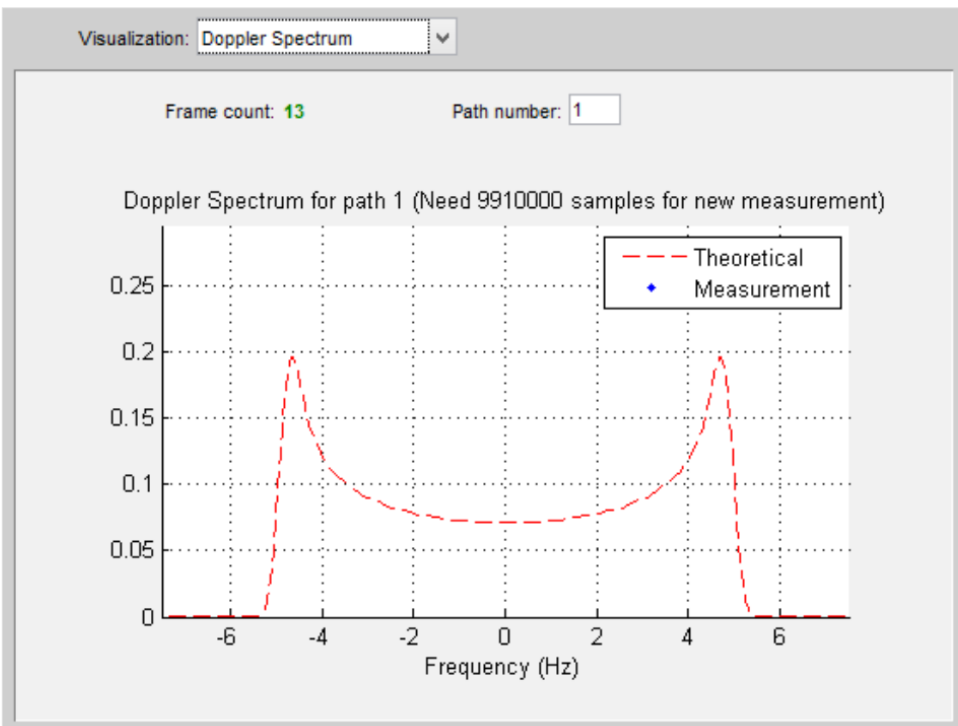

Fig 1(b): Doppler Spectrum 16-QAM Modulation

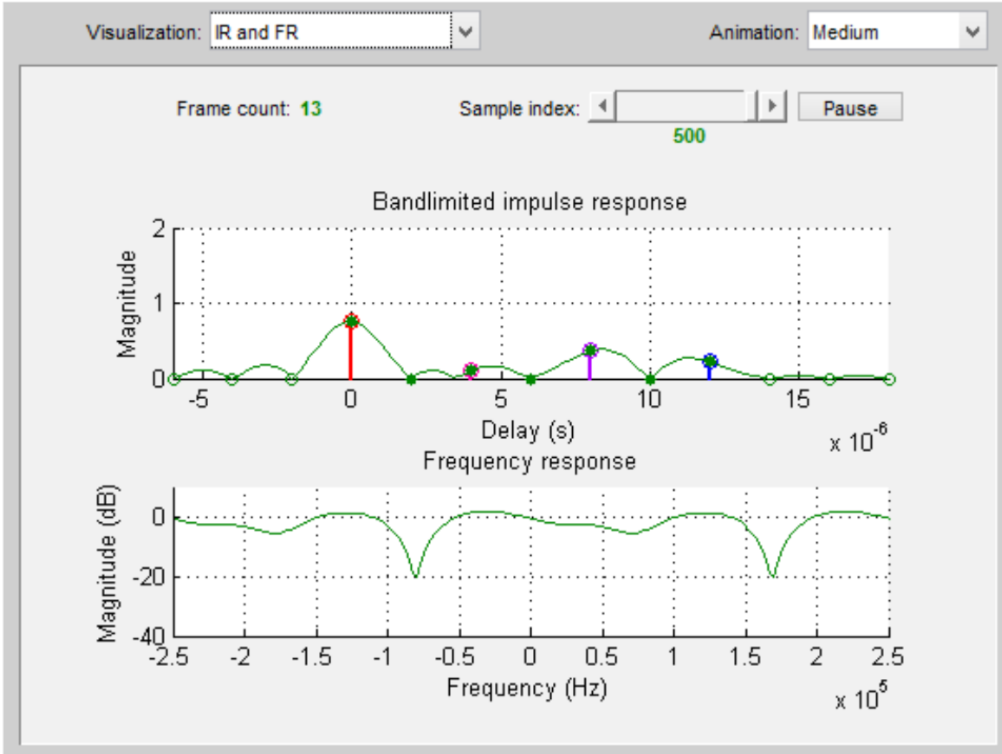

Fig 2(a): IR and FR for QPSK Modulation

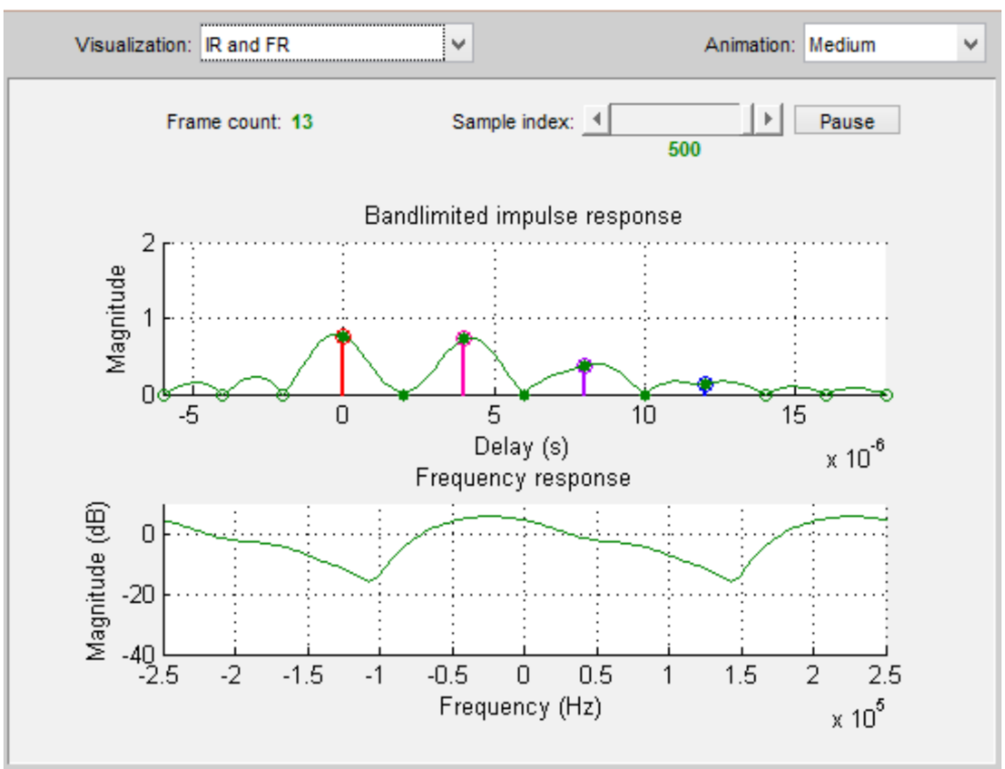

Fig 2(b): IR and FR for 4-QAM Modulation

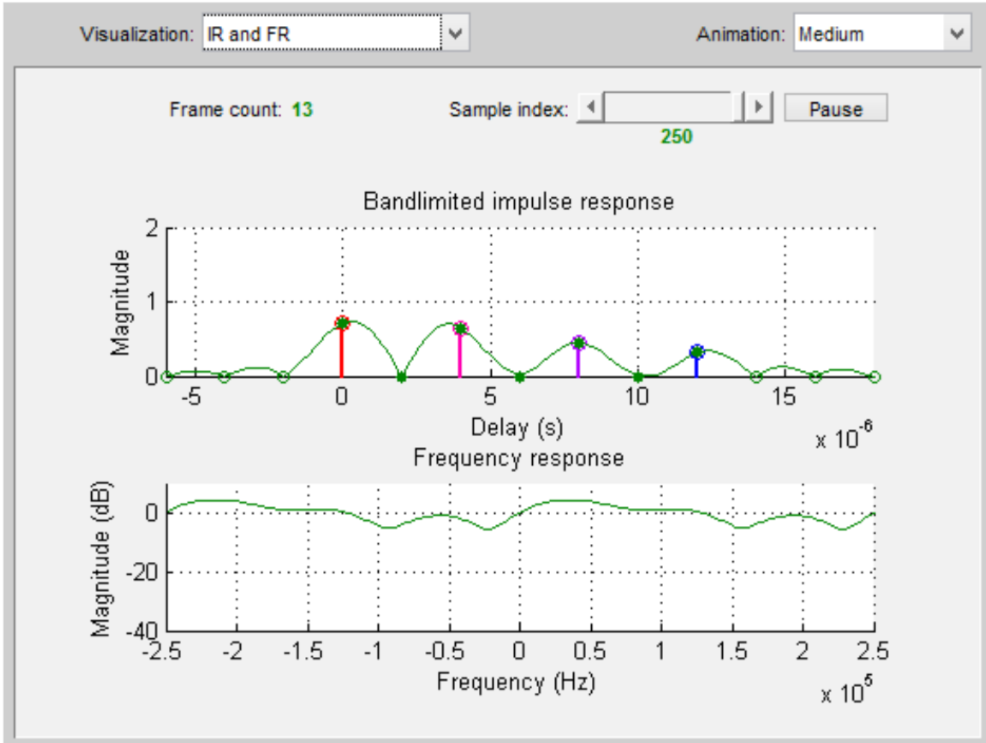

Fig 2(c): IR and FR for 16-QAM Modulation

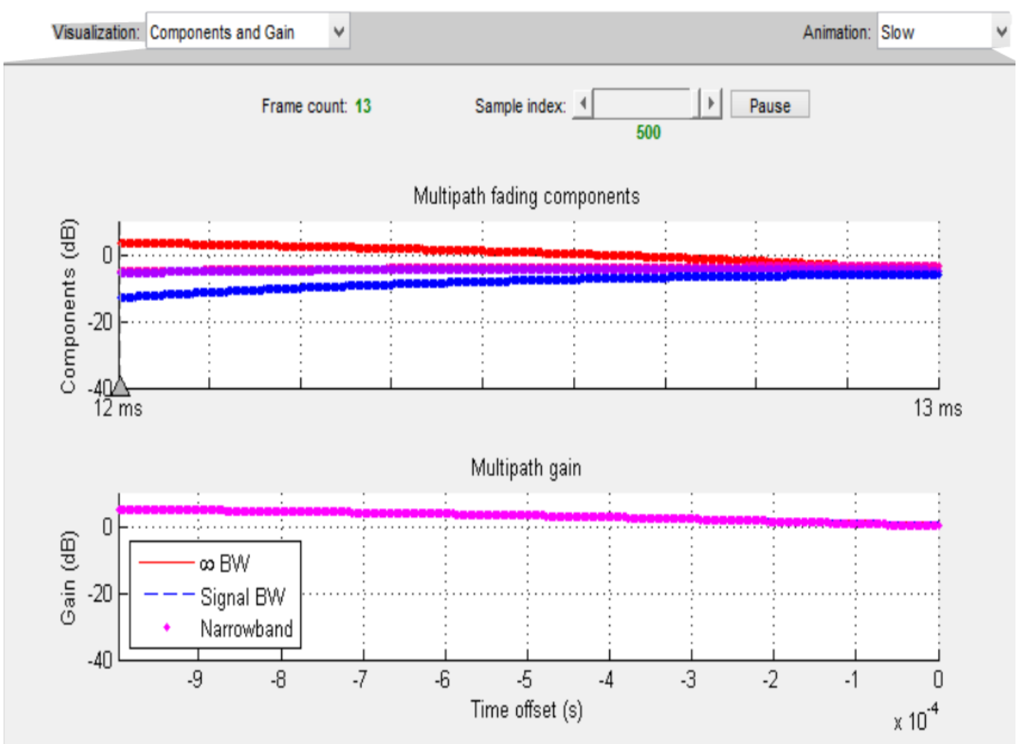

Fig 3(a): Components and Gain for QPSK modulation

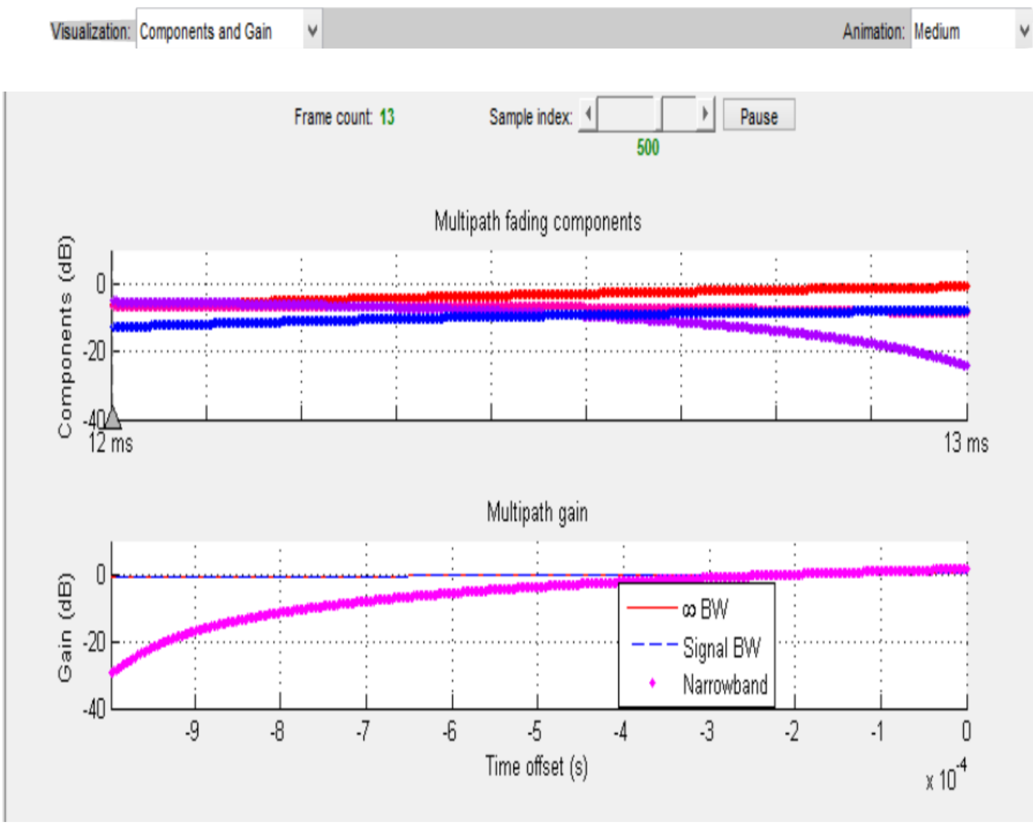

Fig 3(b): Components and Gain for 4-QAM modulation

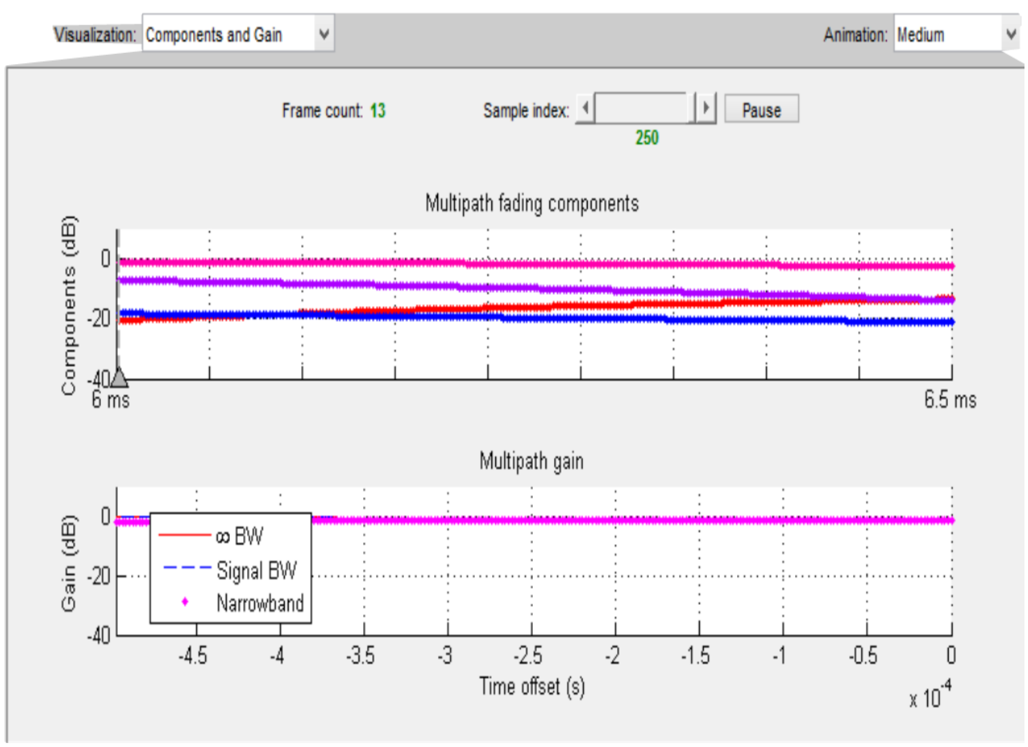

Fig 3(c): Components and Gain for 16-QAM Modulation

Result Analysis:

Fig.1(a), Fig.1(b) represented the Doppler spectrum of QPSK and 16- QAM modulation technique in wideband or frequency selective fading channel. The plot of Doppler spectrum showed only the theoretical value represented by dashed red line. We didn't get the measured value in the plot of Doppler spectrum because there needed 241500 and 244750 samples for new measurement in Fig.1(a), Fig.1(b) respectively. The Impulse response and Frequency response of QPSK, 4-QAM and 16-QAM modulation in wireless communication system was depicted in Fig.2(a), fig.2(b), Fig.2(c). The plot of Impulse response showed magnitude of the multipath response (infinite bandwidth) and the band limited channel response. The component with the smallest delay value was shown in red, and the component with the largest delay value was shown in blue. Components with intermediate delay values were shades between red and blue, becoming bluer for larger delays. The bandlimited channel response was represented by the green curve. This response was the result of convolving the multipath impulse response, described above, with a sinc pulse of period, T in wide band or frequency selective fading channel. In Fig.2(a), the plot of frequency response QPSK modulation, magnitude decreased 0dB to -20dB for 0.75MHz and 1.7MHz frequency In Fig.2(b), the plot of frequency response of 4 QAM modulation, magnitude decreased 0dB to -18dB for 0.9MHz and 1.4MHz frequency In Fig.2(c), the plot of frequency response of 16-QAM modulation, magnitude was approximately constant in 0dB. Fig.3(a), Fig.3(b), Fig.3(c) showed the component and gain of QPSK, 4-QAM and 16-QAM modulation technique of a wide band using Rayleigh and Rician multipath fading channel. The plot of component showed the magnitudes of the multipath gains over time, using the same color code as that used for the multipath impulse response. The triangle marker and vertical dashed line represent the start of the current frame and the plot of gain showed the collective gains for the multipath channel for three signal bandwidths. The narrow band (magenta dots) was the magnitude of the narrowband phasor in the above plot. This curve was sometimes referred to as the narrowband fading envelope. Current signal bandwidth (dashed blue line) was the sum of the magnitudes of the channel filter impulse response samples (the solid green dots in the impulse response plot). This curve represents the maximum signal energy that could be captured using a RAKE receiver. Infinite bandwidth (solid red line): was the sum of the magnitudes of the multipath component gains.

Conclusion:

After observing we conclude that 16-QAM is better compared with other two modulation technique of wide band or frequency selective fading channel.